Wetherby Skip Services Ltd

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Revision 1

Quarry Works Deposit for Recovery Site

Groundwater Risk Assessment

HOOPER-SARGENT LIMITED

Environmental Permitting Consultancy

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1 Introduction

1.1 Relevant Regulatory and Guidance Requirements

This Groundwater Risk Assessment (GWRA) has been prepared by Hooper-Sargent Limited (HSL) on behalf of Wetherby Skip Services Limited (WSSL, the proposed Operator) who have applied for a bespoke Deposit for Recovery Environmental Permit (DfR Permit) for their Quarry Work Site (the Quarry Works Site) located on Field Lane, South Elmshall, near Wakefield. The DfR Permit application was selected for Duly Making checks in April 2024 and consequent to that the Environment Agency (Agency) requested more information in their email dated 26 April 2024. This GWRA seeks to address the following questions in the Agency Not Duly Made (NDM) request for additional information (the full list of information requested is detailed in the accompanying HSL cover letter referenced 2405-016/L/001):

1. Please provide an assessment of the risks posed by the waste deposit to groundwater.

   Reason: *Whilst the proposed permitted waste list is akin to that of standard rules permit, the volume of waste required is above this limit and therefore does not meet the standard rules assessment. The groundwater risk assessment should review the requirement for an attenuation layer and consider a likely source term including sulphate and the impact that this may have on the underlying principal aquifer.*

This GWRA is based on the information compiled in the accompanying Conceptual Site Model (CSM) Report referenced 2405-016/R/001 and the revised Environmental Risk Assessment referenced 2405-016/R/002. The outcome of the risk assessments enables the Operator to counter any potentially polluting aspects of the Site by incorporation of relevant mitigation measures.

1.2 GWRA Report Content

This GWRA incorporates the essential components listed in the Agency's guidance on the preparation of hydrogeological risk assessments for Deposit for DfR activities[1] as follows:

- Produce an initial CSM based on a desk study, Ground Investigations (GI) and environmental monitoring. This investigative process has informed characterisation of the following:
- Section 2 - Site Pollution Source Term. This will describe the pre-operational setting of the site and how it will develop throughout its operational lifetime. This will reference the type of waste to be used in the DfR activity and acceptance procedures to be employed at the site. In addition to the waste to be used in the DfR activity it will consider sources of pollution not associated with the proposed DfR activity on and off site, including pre-operational Ground Investigation (GI) works where relevant.
- Section 3 – Pathways. This section will examine the pathways through which potential emissions from the site could impact sensitive receptors. It will review the current

[1] Groundwater risk assessment for your environmental permit - GOV.UK (www.gov.uk)

setting of the site and any changes that may occur in the future as a result of on-site and potential off-site development.

- Section 4 – Receptors. Similar to Section 3, the number, type and vulnerability of current potentially sensitive receptors will be characterised as well as future potential receptors.
- Section 5 – detailed Conceptual Site Model. The information compiled in Sections 2 to 4 will be used to construct the CSM and highlight aspects which require further consideration as part of a more detailed risk assessment.
- Section 6 – Risk Assessment. This will examine the CSM compiled in the preceding sections and attempt to establish the risk to receptors from any emissions from the DfR deposits and how the physical presence of that material may influence emissions from other sources.

2 Sources of Pollution

2.1 Supporting Information

A comprehensive desk study and GI of the Site was carried out on behalf of WSSL in 2018 by ARP Geotechnical Limited (ARP) and was submitted to the Agency with the original DfR Permit application. The objective of the GI was to characterise any existing sources of contamination on site along with the wider site setting, and consider the risks primarily from a Contaminated Land perspective. The factual data collected as part of that GI (as detailed in ARP report referenced WSK/Olr1V2, the ARP Report) will be referenced in the compilation of this CSM as appropriate along with other information sources.

2.2 Historical Development

Appendix C of the ARP Report includes historical maps for the period 1854 to 2018 (1: 10560, 1:10,000 and 1:2500 scale where available). The historical development of the Site based on this information is summarised in Table 1 below and supplemented by observations taken from Google Earth images for the period 1999 to 2023.

Table 1 – Quarry Works Historical Development

Period / Source / Map Scale	On Site (within proposed Permit Boundary)	Off-Site
1854 Yorkshire 1:10,560	Site located within undeveloped agricultural land seemingly call *South Elmsall Field*.	Field Lane runs east to west along southern Site boundary. South Elmsall a small village to southwest. South Elmsall Quarries are present < 250m to the southeast, with Minsthorpe Limestone Quarry ~250 m to the north and another unnamed quarry ~250 m to the west. The Great Northern and Western Railway transits west-northwest to east-southeast ~600 m to the southwest of the current Site. Draw Well is noted at the junction of Hacking Lanem Trough Lane and Crab Tree Lane to the south. Bullsyke Well is noted ~200 m to the southwest of that. A ditch seemingly receiving discharge from Bullsyke Well flows south under the railway and into the Frickley Beck 950 m to the south of Site. Another Draw Well and springs are noted further to the east.
1894 Yorkshire 1:2,500	No significant change.	Limekilns noted across the South Elmsall Quarries site. A large chimney is located in the centre of the South Elmsall Quarries site (labelled in 1932 1:2,500 map). A tramway network extends across the quarry floor with a point of confluence toward the south of the site. This runs through a cutting and into a tunnel beneath Hacking / Trough Lane. The track daylights to the east of Crab Tree Lane and runs parallel to it to the south where it connects via a junction to the railway.
1894 Yorkshire 1:10,560	No significant change.	South Elmsall Quarries occupies the land to up to Field Lane.

Period / Source / Map Scale	On Site (within proposed Permit Boundary)	Off-Site
1906 Yorkshire 1:2,500	Quarrying activities appear to have commenced in the southern area of the Site. A trackway now connects the Site to the South Elmsall Quarries site to the south under Field Lane. Based on subsequent maps this is a tramway.	No significant change.
1907 Yorkshire 1:10,560	No significant change.	Limekilns are noted with Elmshall Quarries. The Wath Branch of the WB & WRJR Railway has been constructed to the east of Site.
1930 Yorkshire 1:10,560	Quarry workings occupy the full Site area. The track connecting the site through the tunnel is no longer shown. What appears to be a raised embankment feature is shown in its place on the quarry floor to the south of the tunnel.	The South Elmsall Quarry has extended further west along Field Lane. A housing estate has been constructed on the immediate west boundary of the Site. A tramway is noted within South Elmsall Quarries, some limekilns noted as disused. Significant expansion observed in South Elmsall to the south west.
1932 Yorkshire 1:2,500	A tunnel is noted to extend underneath Field Lane between the Site and the South Elmsall Quarries site.	No trackway appears to connect to the tunnel under Field Lane to the north.
1938 – 1948 Yorkshire 1:10,560	No significant change.	The Priory housing estate has been constructed 350 m southwest of the Site.
1956 Ordnance Survey Plan 1:10,000	No significant change.	No significant change.
1962 Ordnance Survey Plan 1:2,500	Scrubby vegetation noted within void indicating disuse.	Allotment gardens are noted on the immediate northern boundary of the Site.
1967 Ordnance Survey Plan 1:10,000	No significant change.	South Elmsall Quarries now listed as disused.
1971 Ordnance Survey Plan 1:2,500	Entrance to Site marked with ‘Depot’.	A housing estate is being constructed adjacent to the western boundary of the former South Elmsall Quarries, 100 m south west of Site. A depot is located in the base of the mineral workings associated with the South Elmsall Quarries site
1982 Ordnance Survey Plan 1:2,500	No significant change.	The land to the southeast of Site (former South Elmsall Quarries site) is labelled as a refuse tip.
1983 Ordnance Survey Plan 1:10,000	A hair-pin trackway is identified from the site entrance into the quarry. Two buildings are present in the southeastern part of the void.	A depot is identified on the north-eastern boundary of the site. The northern portion of the former South Elmsall Quarries has been shaded to indicate a refuse or slag heap. The backfill extends westwards to align midway along the southern Site boundary. The Wath Branch of the WB & WRJR Railway has been decommissioned.
1986 Ordnance Survey Plan 1:2,500	No significant change.	The land to the southwest of Site (former South Elmsall Quarries site) is labelled as a refuse tip.
1992 Ordnance Survey Plan 1:10,000	No significant change.	Several large warehouses have been built on land 170 m to the north of the Site (Dale Lane Industrial Estate). The extent of the refuse tip to the south is equivalent to the western extent of the Site.
1999 Google Earth aerial photograph	A concrete hardstanding used for carparking is placed over the entrance envelope. Tyre stockpiles occupy most of the area within the Site. 3 Buildings	A property has been built on the land immediately to the north of Site. The land to the southeast appears to be restored to farmland. The land to the south appears to be

Period / Source / Map Scale	On Site (within proposed Permit Boundary)	Off-Site
	are located within the southeastern portion of the site. The Site perimeter is lined with trees / shrubs.	rough ground with some tipping of what appears to be soils or aggregates.
2000 Raster Mapping 10k	Additional buildings are visible on site.	The Dale Lane Industrial Estate has been extended to the east (40 m from Site boundary) and north with the addition of more large warehouses. A drain is noted to the east of the warehouse to the east of Site.
2002 Google Earth aerial photograph	Concrete hardstanding clearly visible along length of access track from road and the whole south east area of the Site. It is unclear of the remaining ground is asphalt or unsealed hardstanding.	No significant change.
2009 Google Earth aerial photograph	Tyre depot activities appear to have reduced, with all but one building demolished. Numerous tyre stockpiles are still present along with sporadic soils stockpiles. Stripping of vegetation / soils has exposed what appears to be in-situ minerals deposits or an overburden stockpile on western boundary, north of the access ramp.	Remaining area of former South Elmsall Quarries restored to rough pasture. Activities in depot to west of former quarry appears to have ceased, with only the building remaining.
2013 Google Earth aerial photograph	Tyre depot activity appears to have ceased with all tyres removed. Single building remains with vegetation re-establishing itself on western boundary.	Former depot building has been removed.
2018 Street View 1:10,000	Two buildings noted on Site.	No significant change.
2014 to 2023 Google Earth aerial photographs	Site is derelict, ongoing revegetation.	No significant change.

2.2.1 Historical Summary

On-Site

Quarry excavations at the Site appear to commence between 1894 and 1906 and cease prior to the 1960s. It is assumed the Site was part of the wider South Elmsall Quarries activity due to the physical connection between the two sites by a tunnel and a trackway. After quarrying ceased the Site was subsequently used as a tyre depot or stockyard until 2013 at the latest. Section 5.9 of the ARP Report makes reference to the use of the depot as a transfer station for used industrial tyres. There is no record of the permit still being in form on the Public Register. During its peak activity the Site included 3 buildings and a concrete hardstanding that still covers the majority of the Site area. The Site is now disused with two derelict buildings remaining at the Site entrance and base of the quarry, and being progressively reclaimed by vegetation.

Off-Site

The main South Elmsall Quarries site occupied the land to the south of Field Lane. Activities ceased there in the 1960s and the remaining void was restored to fields by landfilling. A small area of void remains on the western extent of that quarry. This was used as an industrial / commercial depot until the 2000s and is now unoccupied. Another smaller area of void is also present on the eastern boundary and that has been classified as a SSSI of geological interest. A trackway connected the Site to the main quarry, and this extended through another tunnel on the southern boundary of the main quarry where it daylighted on Crab Tree Lane. Wells and springs were noted across the downslope area to the south of Site. Residential properties were developed on the west and north boundary in the 1930s and still remain. The land to the east has been progressively developed for commercial use with an aggregate depot on the immediate eastern boundary and the Dale Lane Industrial Estate which is dominated by large warehouses built in the 1990s onwards.

The physical ground conditions under and around the void resulting from its historical development will be discussed in Section 3 – Pathways. Any contamination associated with the material in the existing ground will be discussed in Section 2.5 – Other Pollution Sources.

2.3 Existing Void

The cessation of quarrying activities left a >60,000 m^3 void at the Site prior to deposit of any imported materials. Access to the Site is currently gained via the site entrance off Field Lane via an engineered concrete hardstanding that previously served as a vehicle parking area. The derelict remains of the former site office are located on the northern extent of this hardstanding. The elevation of the former parking area is approximately 66.5 mAOD.

Access to the former quarry void is via a single lane track sealed with concrete hardstanding that descends northwards by ~ 6 m in elevation via a shallow ramp. At the foot of the ramp (60 mAOD) the concrete surface is extended northwards into what appears to be a turning apron to assist vehicles in making a 180° turn to the east and into the main depot area. According to the trial pit logs in the ARP Report, the ground to the north of the turning apron and either side of the track leading to the southern area of the void, is unsealed made ground consisting of sand, gravel or cobble-sized aggregates or quarry overburden. The ground level in the northern area of the Site is relatively flat at around 59.5 mAOD to 60 mAOD.

The majority of the southern area of Site was fully sealed with concrete hardstanding. When the tyre depot was active three buildings were located along the eastern face of the former quarry void. The two northern-most buildings were of a Nissan Hut design (semi-circular curved roof) and the southern-most with a pitched roof. During the site inspection carried out by ARP in 2018 they noted the presence of an inspection pit where the now removed Nissan Hut was located (Appendix B, Photograph 16 of ARP Report). It is assumed this was used for vehicle maintenance. Heavy oil staining was noted on the concrete slab within the northern-most Nissan Hut and on the concrete surfacing external to it. The Operator has advised that the oil staining has since been removed. It is understood the remaining Nissan Hut was damaged by fire and is now derelict. This will be removed prior to commencement of infilling activities. The ARP Report describes the presence of several stockpiles of possible quarry material or demolition material in the southeast area of the southern void. It also describes the presence of used tyres apparently associated with large industrial vehicles.

Section 10.2 of the ARP Report describes walls of the former quarry void as having been cut to a near vertical face on all sides. According to the Oakwood Land Survey topographical survey a 2 m high stockpile of material is present on the eastern boundary of the void and based on Google appears to have been placed there between 2009 and 2023. The topographical survey shows a benched feature on the western boundary just north of the bottom of the access ramp. The embankment leading down from the ramp and former site office / parking area has a shallower ~1v:2h gradient. The ground elevation in the southern-most extent of the void is typically 57.5 mAOD and represents the topographical low point of the site.

2.4 Proposed Infill Materials

2.4.1 Waste Types

The Quarry Works Site will be classified as a Deposit for Recovery Activity using non-hazardous waste that meets the Waste Acceptance Criteria (WAC) for an inert landfill Site as detailed in Council Decision 2003/33/EC: establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to Directive 1999/31/EC (the Annex to the Landfill Directive (LFD) - Council Decision 1999/31/EC). The type of material to be accepted at the DfR activity will be referenced in this report as meeting the “LFD Inert WAC”. It is anticipated that the types of waste to be deposited in the site will consist of Construction and Demolition (C&D) wastes arising from or processed at an off-site permitted facility run by the Operator and excavation wastes arising from mineral extraction activities, commercial or domestic development sites. Further details are included in the revised Waste Acceptance Criteria and List of Waste Document referenced 2405-016/R/005.

The C&D wastes will comprise separate fractions of concrete, brick, tiles and ceramics or mixtures thereof. Materials arising from the physical treatment of aggregates originally arising from mineral wastes will also be imported for deposit. These materials are anticipated to be primarily granular in composition with a range pf particle sizes from sand to large cobbles. This material will contain a negligible organic content and will specifically exclude other materials associated with C&D activities such as plasterboard, wood, metals or plastics.

The excavation wastes from mineral extraction activities will be interburden or overburden only, or waste gravel, sand or clays and crushed rocks. The material excavated from commercial or domestic developments will be limited to sub-soil or stones and exclude peat, topsoil or any other organic material e.g. vegetation that may produce gas or an organic-rich leachate under anaerobic conditions. Subsoil or stones should contain a small or negligible organic content when excavated. Any clay or similar components within the subsoils will increase the cohesive properties of the overall DfR matrix and similarly reduce the permeability of it. Surface water run-off may mobilise solids from the surface of this material during heavy rainfall events and if a pathway exists, be washed into sensitive surface water receptors such as a stream or pond. This may cause siltation on the bed of the water course or increase the turbidity of the water.

Where this material is generated from greenfield sites or where there is no suspicion of contamination, they can be accepted without testing to LFD Inert WAC requirements. The likelihood is however that the supplier will normally provide GI testing data for all material proposed for recovery at the site. The absence of GI data and / or a site description will prompt the Operator to ask for more information or a visit to the source site. If none is provided to the Operator then the material will be refused.

2.4.2 Soluble Pollutants

The waste to be accepted for use in the DfR activity will be limited to material that meets the description criteria of inert waste in Section 2.1.1 of the Annex to the LFD; or, if testing is required, the leaching and total concentrations Waste Acceptance Criteria (WAC) specified in Section 2.1.2 of the LFD Inert WAC.

Section 2.1.2.1 of the LFD Inert WAC provides total leachable limits for a range of substances subject to a 2:1 and a 10:1 eluent to solid ratio. In a 10:1 liquid: solid ratio test, the maximum allowable eluent concentrations will be 10% of the total leachable concentration. Those eluent concentrations represent a worst-case scenario as it is unlikely that all samples subject to LFD Inert WAC testing will produce an eluent concentration at an equivalent value. For the most conservative soluble substances such as sulphate, the maximum allowable concentration would be 100 mg/l, which is 40% of the equivalent Drinking Water Standard (250 mg/l) that is commonly used as an Environmental Quality Standard. This would not require an attenuation layer to restrict the vertical flow and hence increase the dilution potential of sulphate in the underlying aquifer.

2.5 Other Pollution Sources

2.5.1 Pre-Operational Site Investigation

The ARP Report includes details of a GI carried out at Site in October 2018. The ARP Report states that scope and extent of the GI was based on the requirements of BS10175 : 2011 + A2 : 2017 "*Investigation of potentially contaminated sites - Code of practice*" and sought to fully characterise the site and provide geotechnical information to aid the design of the site. The site was gridded to 25 m intervals and 10 Trial Pits (TP), 7 windowless holes (WS) and 1 hole drilled using Cable Percussive (CP) methods were deployed across that grid or at locations of particular interest. The purpose of the CP hole (BH1) was to establish the depth of fill in the southwest area of site near the entrance. None of the trial pits or boreholes progressed into the Cadeby Dolostone bedrock beneath the Site and typically terminated on contact with the Dolostone. The position of the GI locations is detailed on ARP drawing referenced "Exploratory Hole Location Plan" as replicated in Figure 1 below.

A total of 23 solid samples were taken from each of the sample locations with 2 samples taken 5 of the locations. The samples were subject to a range of laboratory tests including metals, hydrocarbons, asbestos, Soil Organic Matter (SOM), pH and sulphate. No water samples were taken for testing due to an absence of standing water in the installations on completion. The laboratory data extracted from that report is attached as Appendix A to this report. Made ground was encountered at all locations and the physical ground conditions are discussed in Section 3.2.2.

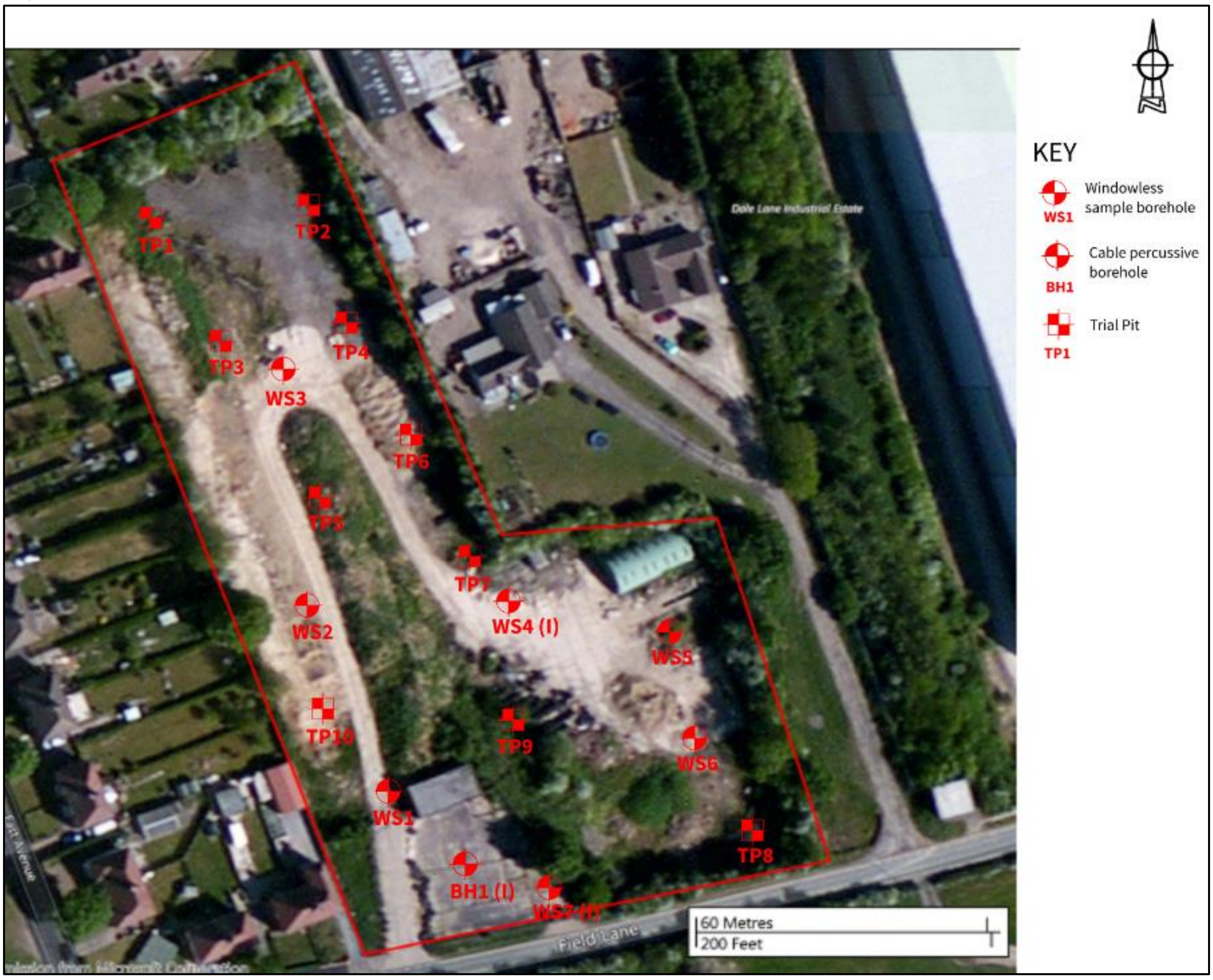
2.5.2 Made Ground Quality

Total metal concentrations were relatively low and did not exceed any hazardous thresholds. No asbestos fibres or mono Phenols were identified in the samples. The pH was alkali. Soil Organic Material (SOM) ranged from 4.9 % to 19 %. Total Petroleum Hydrocarbons (TPH) (C8 to

C35) were present across the site up to a concentration of 2,200 mg/kg, with a mean of 399 mg/kg and 50th percentile of 78 mg/kg. Total Polycyclic Aromatic Hydrocarbons (PAH) was reported between <0.1 mg/kg and 80 mg/kg. Total sulphate was between 300 mg/kg and 9000 mg/kg, with an average of 1,204 mg/kg. Water soluble sulphate (2:1) was recorded in the range < 50 mg/l to 670 mg/l and an average of 117 mg/l.

The testing reflects the prevalence of made ground across the site and possibly the historical use as a tyre storage and vehicle maintenance depot. The more elevated TPH readings i.e. > 500 mg/kg were associated with samples taken from surface level made ground (TP1, TP2 and TP3) to the north of Site and TP7 at 0.6 m and TP9 at 1.2 m toward the middle / south of site. All of these locations were positioned in unsealed ground away from the concrete slab. The highest soluble sulphate concentrations were associated with TP1, TP2, TP9, WS4 and WS6. TP9, WS4 and WS6 were samples taken from beneath a concrete slab.

Figure 1 – GI Location Plan



BH1 was drilled through the concrete hardstanding of the ground level site entrance area to determine the depth of fill placed there to build the site entrance area and access ramp down into the quarry void. The installation log for BH1 indicates made ground is present to a depth of 10.7 m below ground level (mbgl) or from approximately 65.5 mAOD to 57.8 mAOD. This is equivalent to the topographical low point of the former quarry void immediately east of the site entrance (57.5 mAOD). The bottom 3 m of the fill was described as quarry waste or overburden. The material above that was described as clayey, gravelly sand or sandy clay containing dolostone, brick, concrete and wood fragments.

The testing carried out on the made ground material encountered beneath the site indicates it has a chemical composition somewhat comparable to that expected of waste suitable for disposal within a Landfill Directive compliant inert landfill site. This material contains low concentrations of total metals which may not leach from that material in concentrations that would exceed the LFD Inert WAC. No phenols were detected above the laboratory reporting limit of 1 mg/kg and total PAHs were below the LFD Inert WAC of 100 mg/kg. 10% of the soluble sulphate concentrations would be above the LFD Inert WAC (equivalent to the 1:2 leachability test eluent concentration of 280 mg/l) and 27 % of the TPH data may be above the 500 mg/kg Inert WAC mineral oil limit. This may be overly conservative as the available TPH data did not differentiate between the Aliphatic and Aromatic components and may not have been subject to clean-up. The average SOM concentration was 11.7 %, however SOM is not a direct equivalent to Total Organic Carbon (TOC) due to the test method. A conversion factor of 1.72 can be applied to SOM[2] and if so indicates the TOC would approximate to 6.8 % and would likely be above the LFD Inert WAC.

No testing of Benzene, Toluene, Ethylbenzene and Xylenes (BTEX) or Polychlorinated Biphenols (PCBs) was carried out, however the absence of light-end hydrocarbons suggests BTEX substances would not be present. PCBs are rarely present in made ground and typically associated with material excavated from sites which contained old electrical infrastructure insulated with PCBs.

In summary, the material to be imported to Site for use in the DfR activity would likely contain lower concentrations of certain substances than the existing material on Site, particularly TOC, TPH and sulphate. This is because it would only be accepted for deposits if it met the more conservative limits imposed by the LFD Inert WAC.

2.5.3 Off-site Sources of Pollution

Landfilling

The primary source of off-site contamination is expected to be the inert landfill site located in the former South Elmsall Quarries void south of Field Lane immediately south of the Site. It is understood this landfill was operated by South Elmsall Quarries Ltd. The engineering specification or environmental pollution controls for this site are unknown, as are the exact waste inputs. It is assumed the management of the landfill reflected the regulatory standards at the time of filling i.e. no requirement for a Landfill Directive compliant attenuation layer or WAC testing for waste inputs. Three BGS registered boreholes are located in the former South Elmsall Quarries Site, approximately 150 m to the southeast[3]. The boreholes appeared to be drilled after the former quarry had been partially landfilled. This assumption is based on the

[2] Total Organic Carbon | Fact Sheets | soilquality.org.au
[3] 107249 (bgs.ac.uk)

ground elevations on the logs which is approximately 10 m lower than current ground levels. The installation logs record the presence of 1.9 to 4.9 m of fill consisting of clayey sand, broken bricks, glass, ash, decayed vegetation and magnesian limestone fragments in varying combinations.

Landfilling of the former South Elmsall Quarries site appears to have started at some point between 1971 and 1982 based on the historical mapping. The BGS registered borehole logs located within that site are dated 1976 and already show an existing depth of fill. BGS registered borehole referenced SE41SE/50[4] dated 1976 was located in the northern area of the former quarry void, north of the concrete turning apron. The log for that borehole does not record fill in the Site, however the datum is comparable to current ground levels. It is reasonable to assume that both sites may have been filled with material from the same source and possibly by the same Operator.

Askew Aggregates operate a landfill site 515 m to the south-southeast of the Site in a former brickworks quarry. The planning consent[5] for that site allows the excavation of a proportion of historical deposits of ash from that site and backfilling with inert waste and soils. The planning statement submitted in support of the application[6] references installation of boreholes in the South Elmsall Quarries Landfill between 1980 and 2006. It states the boreholes were 11 m deep, that they penetrated 200 mm into the underlying Dolostone and were all dry. It describes the placement of a 1 m thick clay landfill cap and that no water was encountered during the GI. An inspection of the northern face of the ash tip showed no signs of water ingress. The northern area of that void was excavated down to 26.61 mAOD[7].

Waste Treatment

The Askew Aggregates depot to the immediate east of site appears to have historically processed soils and aggregates likely brought to site from elsewhere. The Google Earth image from 2009 appears to show a stockpile area with a mixture of material in it. This may be mixed construction and demolition waste which may have contained contaminants from the source site. This material appears to have been removed by 2013 however.

2.6 Pollution Source Summary

The 60,849 m^3 void at the Site will be filled with 145,000 tonnes of non-hazardous, inert soil, stones and other aggregates sourced from permitted waste treatment facilities and commercial or domestic development sites. By committing to this range of waste types the proposed Operator is minimising the potential for soluble pollutants or free liquids being mobilised from the waste after deposit which may impact sensitive receptors. The extensive

[4] 107244 (bgs.ac.uk)
[5] 09/02426/FUL | Excavation, screening, crushing and removal of ash from former brickworks quarry; import, screening and crushing of inert materials and soils; and restoration to meadow grassland; ponds and wetland and woodland | Cherry Lea Field Lane South Elmsall Pontefract Wakefield WF9 2EA
[6] 09_02426_FUL-0-2076071.pdf (wakefield.gov.uk)
[7] 09_02426_FUL-Site_Plans_full_scheme_HI-02_rev_B-396035.pdf (wakefield.gov.uk)

made ground deposits already present in the Site would likely be classified as non-hazardous waste. It would not be described as inert waste against contemporary standards due to the organic content likely exceeding the 3 % TOC threshold. Measured concentrations of sulphate and TPH at certain locations would also exceed the LFD Inert WAC.

The Site is considered to be an extension of the much larger quarry to the immediate south of Field Lane. That part of the quarry was subject to extensive landfilling activity in the early 1970s and with the exception of two small area east and west of it, was filled to surrounding ground levels. The Site is described on signage as an inert landfill but was not subject to the same restrictions as contemporary inert landfills subject the constraints of LFD Inert WAC. The waste disposed of in that site may be similar to the waste deposits in the Site i.e. have an TOC content in excess of 3% along with other potentially polluting substances. Another former quarry 515 m south of the Site was backfilled with ash. A planning consent was issued in 2009 to excavate some of that ash and replace it with inert waste. It is assumed a permit has been issued for that site although details have not been obtained.

There is a legacy of landfilling within the site and in the land immediately south of it with disposal activities unconstrained by the requirements of the Landfill Directive in terms of waste acceptance and containment engineering. This may have impacted groundwater and surface water quality. The deposit of a relatively small volume of inert waste which will be compliant with the requirements of the Landfill Directive is not expected to exacerbate the impact of this legacy.

3 Pathways

3.1 Geological Pathways

The Site is located in a former limestone quarry likely excavated to its fullest extent by the 1930s. The bedrock is described by the British Geological Survey (BGS) 1:50,000 Series Geology Maps as Dolostone of the Cadeby Formation, formerly described as the Cadeby (Magnesian Limestone) Formation. The BGS[8] describes Dolostone as *"…grey to buff grey, commonly oolitic or granular, with subordinate mudstone, dolomitic siltstone and sandstone."* No faults are present in the Dolostone at the site or the immediate vicinity. The BGS does not describe the presence of superficial geology at the site or the local vicinity. The Dolostone is expected to be present beneath the site and laterally so. The three boreholes drilled through the landfill to the southeast describe the dolostone beneath the landfill as having small solution cavities lined with dolomite and soft brown clay in the bedding planes.

A fault is noted along the southern boundary of the former South Elmsall Quarries site to the south and denotes the southernmost extent of the Cadeby Dolostone. The Pennine Upper Coal Measures Formation is shown to the south of the fault line and underlies the Cadeby Dolostone.

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[8] BGS Lexicon of Named Rock Units - Result Details

Medici et al (2019)[9] describe the hydraulic conductivity of the Dolostone in the unfaulted Cadeby Limestone as being within a range of 3.35 $x10^{-9}$ m/s to 1.08 x 10^{-8} m/s. No site-specific data is available to verify what the permeability is in the locality of the Site. The study describes laminar flow of water in un-faulted sections via sub-horizontal, sub-parallel and laterally persistent bedding planes. The intervening rock matrix is described as relatively impermeable reflected by the low hydraulic conductivity values detailed above.

3.1.1 Groundwater Levels and flow direction

The absence of boreholes drilled into the Cadeby Dolostone in or close to the site means it is not possible to verify what the current water level is, the hydraulic gradient is or the direction of groundwater flow. In general terms Medici et al references groundwater flow as being driven toward the east due to topographic influences.

A spring is noted just north of Hacking Lane on Hacking Hill until around 1962 and that land has since been occupied by No. 6 Hacking Lane. The adjacent road level on Hacking Lane is 53.0 mAOD and the spring is approximately 25 m up slope of this at around 56 mAOD. The position of this spring appears to be at the interface between the Cadeby Dolostone and the adjacent Pennine Upper Coal Measures Formation and may represent the interface between the two strata.

Springs were also noted to the southeast of Site adjacent to Pasture Lane at an elevation of around 30 mAOD and the now removed Mork Royd Lane at an elevation of around 38 mAOD. A draw well was located at the T-junction of Hacking Lane, Trough Lane and Crab Tree Lane 300 m the south of Site. Bullsyke Well was located 200 m to the southwest of the draw well and historical mapping appears to show a ditch running southwards from it. This may indicate it was a shallow well or under artesian conditions. Another draw well was present 400m to the southeast of Site near the former Quarry Farm off Trough Lane.

The ground level on Field Lane immediately adjacent to the South Elmsall Quarry SSSI 225 m to the east is 55 mAOD (based on OS Mapping). A UKRIGS Education Project location briefing note for the site [10] states that the eastern face of the former quarry is “a 7m section through Permian Magnesian Limestones”. The site is not described as having standing water in it and therefore is assumed to be dry to at least 48 mAOD.

There is a small area of remaining void associated with the former South Elmsall Quarries site located to the southwest of Site. Historical mapping suggests this area was not subject to landfilling with an access road and building present down to it since at least 1962. The lowest current ground level within the void is 59.54 mAOD in the northeast corner based on a drawing submitted with a planning application for a housing development in the void[11]. Made ground

[9] G. Medici, L.J. West, S.A. Banwart. (2019) ‘Groundwater flow velocities in a fractured carbonate aquifer-type: Implications for contaminant transport’, *Journal of Contaminant Hydrology,* Volume(222 April 2019), Pages 1-16

[10] SE3_locaccess.pdf (geohubliverpool.org.uk)

[11] 07/00921/OUT | Residential development (outline: 25 dwellings) including demolition of buildings on site. | High Street (Former Scrap Yard) South Elmsall Pontefract West Yorkshire WF9 2DG (wakefield.gov.uk)

was encountered in most trial pits dug around the site to a depth of 3 to 4 m. Rock head was encountered in Trial Pit referenced TP2 at an elevation of 56.36 mAOD, based on the closest ground level[12] and the trial pit summary[13]. No standing water has been observed within the base of that void. A rock head level of 56.36 mAOD is comparable with the estimated elevation of the spring noted to the southwest on historical mapping (property off Hacking Lane).

Water level monitoring in the three boreholes installed through the landfill to the south in 1976 indicate a groundwater level in the dolostone of 43 mAOD to 45 mAOD. This data is nearly 50 years old and should be treated with caution accordingly, however it is still possible the groundwater in the Dolostone is approximately 10 m below the base of the Site.

Based on the presence of spring lines and wells, groundwater flow may be influenced by topography, faults or the interaction between geological units. These features are located at the interface between the two geological units (Hacking Lane) and close to a fault line (Draw Well near T-Junction). The other springs may be associated with permeable strata in the adjacent Upper Coal Measures Formation e.g. sandstone interbedded with mudstone or siltstone.

3.1.2 Water Levels in Made Ground

Water levels were measured monthly over the period September to December 2018 and in June 2024 at the three monitoring points WS4, WS7 and BH1. The response zone of all three installations was limited to the made ground deposits only. The base of BH1 was approximately 0.75 m above the intact Dolostone and WS4 0.07 m above the dolostone. WS7 did not contact the Dolostone during drilling.

BH1 was dry throughout the 2018 period, but a level of 57 mAOD equivalent to 0.84 m head of water above the Dolostone was measured in June 2024. A water level of 56.04 to 56.32 mAOD was recorded in WS4 during 2018 and 56.93 mAOD in June 2024. This is equivalent to a head of 0.79 m to 1.71 m above the top of the Dolostone. The water level in WS7 was 61.45 to 61.63 mAOD in 2018 and absent in 2024.

The water level in WS7 in 2018 was approximately 5m higher in elevation compared to BH1 and WS4. It is assumed this represents a perched water body in the waste deposits. A standing head of water in BH1 and WS4 in granular made ground, suggests that water does not drain freely into the underlying Dolostone. This is reflective of the hydraulic conductivity values described in Section 3.1 above.

3.2 Anthropogenic Pathways

3.2.1 Quarry Tunnel

Based on the OS mapping a tunnel that connected the Site under Field Lane to the much larger South Elmsall Quarries to the south, is expected to be present midway along the southern boundary of the Site. The floor elevation, dimensions and structure of this tunnel is not known. The entrance to the tunnel is not visible in the southern face of the quarry wall directly below

[12] 07_00921_OUT-Site_Plans-371623.pdf (wakefield.gov.uk)
[13] 07_00921_OUT--1872237.pdf (wakefield.gov.uk)

Field Lane and it is unknown if the tunnel was backfilled and if so, what with. The undisturbed Dolostone beneath Field Lane and any material used to infill the tunnel is possibly the only physical barrier between the two sites.

A trackway is recorded as running through the tunnel from one site to the other. It is assumed the ground would need to be level to operate the trackway. Historical mapping indicates the presence of raised embankments on the southern side of the tunnel after the trackway was removed. This suggests the base of excavation to the south was at a lower level. The historical mapping shows the tramway extending from the tunnel and southwards to the central chimney. This is joined by other tramways at a single point of confluence south of the central chimney. The tramway then travels into a cutting and then another tunnel under Hacking Lane. This tunnel daylights immediately west of Crab Tree Lane, south of Hacking Lane. The 1907 historical map shows the tramway running parallel to Crab Tree Lane and joining the railway to the south, past the Brickworks to the immediate east. The tramway appears to have been decommissioned by the date of the 1956 map.

Figure 3.8 of The Enzygo Flood Risk Assessment report submitted with the permit application shows the position of a land drain flowing east to west parallel to Hacking Lane. The head of this drain is in the vicinity of the Draw Well noted on the historical maps but it is not known if they were linked. It is also on the vicinity of the tramway tunnel from the former quarry under Hacking Lane. The ground elevation level on Hacking Lane is 53.6 mAOD. The invert of the land drain is not known nor is the invert of the former tunnel. The drain flows west and then south through the fields. It is assumed it connects with the drain noted on historical mapping that received water from the 'Bullsyke Well' approximately 150 m south of Hacking Lane. The historical mapping shows this drain to flow under the railway and discharge into the Frickley Beck. An inspection of the area in the expected location of the former tunnel entrance south of Hacking Lane by ARP in June 2024, did not identify the tunnel or any running water flowing from it.

3.2.2 Made Ground

The GI carried out in 2018 established that made ground was present across the entirety of the site, with the most significant deposit associated with the access ramp that extends down into the void from the southwest corner of Site. Where present the concrete slab was 0.08 to 0.23 m thick and where verified by contact with the underlying Dolostone, the total depth of made ground ranged from 1.3 m to 6 m (excluding BH1). Where present, quarry waste deposits above the dolostone were 0.2 to 1.5 m thick. The quarry waste was typically described as *pale yellow or yellowish brown, silty gravelly sand. Gravel is sub angular fine to medium of dolostone*. The imported made ground deposits are assumed to have been imported to site from sources elsewhere as they differ in description to on-site material derived only from the Dolostone. This granular material was made up of varying combinations of bricks, concrete, dolostone with occasional / rare fragments of coal, plastic, metal, glass, roots, timber, ceramics or ash.

The granular nature of this material is assumed to have a relatively high permeability as evidenced by the lack of standing water or retained water in most of the exploratory boreholes or trial pits at the Site. Section 10.7 of the ARP Report described some water strikes in the made ground within the base of the quarry, predominantly in the southeast area of site (TP9, WS6 and WS5) with a water level between 54.5 mAOD and 56.2 mAOD.

The presence of the concrete slab will act as a barrier to vertical transmission of water. The retention of water in the granular backfill described in Section 3.1.2 may be due to the underlying lower permeability dolostone beneath the site fill. The placement of new fill comprising granular and cohesive materials may therefore restrict the rate of infiltration through to the underlying waste and into the Dolostone aquifer.

3.2.3 Buried Services or voids

Utilities and other services information provided by LinesearchbeforeUdig indicates there are no buried services (electricity, water or sewage) that cross the Site. The Site is not yet connected to the storm sewer and the nearest part of the network appears to be to the immediate west of the Site entrance. The fate of any water discharged to that sewer is unclear but the presence of a sewage treatment works directly south of the Site adjacent to the Frickley Beck suggests it may flow toward that.

A vehicle inspection pit was located within the area of a former workshop on the eastern boundary of the quarry. The construction of the pit is unknown. A photograph of the pit (Photograph 16 in the ARP Report) indicates it was lined with concrete and damp silt had accumulated in the base.

3.2.4 Boreholes

BGS registered borehole referenced SE41SE/50[14] dated 1976 was located in the northern area of the former quarry void, north of the concrete turning apron. The purpose of the borehole was evidently to log the much deeper strata in the underlying coal seams 335 m below. The ground level at time of drilling was 59.44 mAOD. This is comparable with the current ground levels in the northern area of Site. It is therefore possible that the backfill noted in the ARP Report was present at that time. The fate of the borehole is unknown but it may potentially have been backfilled on completion of drilling. If filled with granular material it may represent a pathway to lower strata.

BH1 and two of the WS holes (WS4 and WS7) were retained after the 2018 GI to measure liquid levels and ground gas concentrations. None of the boreholes were progressed into the Cadeby Dolostone. The remaining WS holes and TPS were backfilled with arisings. A site visit on 11 June 2024 confirmed that WS4, WS7 and BH1 were still present and serviceable as monitoring points.

[14] 107244 (bgs.ac.uk)

4 Receptors

4.1 Groundwater Receptors

4.1.1 Aquifer Designation and Vulnerability

The Agency has designated the Cadeby Dolostone bedrock below and surrounding the Site as a Principal Aquifer and describes Principal Aquifers as "*Principal and secondary aquifers provide significant quantities of drinking water, and water for business needs. They may also support rivers, lakes and wetlands.*"[15] There is no superficial deposits present in the vicinity of the Site. Historical monitoring data from the BGS-registered boreholes to the south east suggests the water table could be around 10 m below the base of the Site.

The Magic Map website[16] lists the groundwater in the aquifer as having a medium to high vulnerability which means there is a medium to high likelihood of potential pollutants reaching the sensitive aquifer. The nearest groundwater Source Protection Sone (SPZ) is an SPZ1 located 2.6 km to the west, southwest of the site. An SPZ1 is defined by the travel time of 50-days or less for water to travel from any point within the zone at or below the water table. There are no other SPZs within 4 km of the Site.

The groundwater in the adjacent and underlying Upper Pennine Coal Measures is classed as a Secondary A Aquifer and describes them as "...*permeable layers that can support local water supplies, and may form an important source of base flow to rivers*."

The spring on Hacking Lane may be issuing water from the interface between the Cadeby Dolostone and Upper Pennine Coal Measures. The Draw Well and land drain to the immediate south of the landfill are in the vicinity of a fault between the Cadeby Dolostone and Upper Pennine Coal Measures. The Cadeby Dolostone is absent to the south of this fault and the water could be ground water issuing from the unit to the north of the fault. The springs and wells further south are assumed to be groundwater water issuing from saturated sandstone layers in the Upper Pennine Coal Measures strata, which otherwise dips to the east. No water was observed to seep from the northern face of the former ash tip which was excavated to 26.61 mAOD.

4.1.2 Groundwater Abstractions

The SPZ1 detailed above is associated with a groundwater abstraction licence issued by the Agency for J Marr (Property) Ltd for 83,220 m^3/year. This location is positioned in the Pennine Upper Coal Measures Formation Secondary Aquifer and outside of the Principal Aquifer associated with the Site. The next nearest groundwater abstraction is 4.2 km to the south of Site near Hooton Pagnell.

[15] Protect groundwater and prevent groundwater pollution - GOV.UK (www.gov.uk)
[16] Magic Map Application (defra.gov.uk)

None of the wells described in the historical mapping are noted as having active abstractions licences registered to them.

4.2 Surface Water Receptors

The closest named watercourse in the vicinity is the Frickley Beck which flows west to east 950m south of the site at its closest point. A sewage works is also located on the northern bank of the beck at that point and it is assumed there may be some discharge from the sewage works into the beck. The Frickley Beck transitions into the Hampole Dike further downstream.

It is assumed the land drain to the south of the South Elmsall Quarries landfill site still flows under the railway line to the south and into the Frickley Beck.

The Frickley Beck is not designated as a protected habitat but may be the eventual indirect receptor to clean surface water discharges from the Site. The water quality in the Beck from Frickley Beck to the Skell[17] is described by the Agency as having a "Moderate" ecological classification with a "poor" classification for biological elements and "Moderate" for Physico-Chemical elements. The primary cause of these classifications is attributed to the discharges from wastewater treatment.

A large drain apparently flowing from the Dale Lane industrial estate is present 215 m to the east. There appears to be no clear connection to this drain from the Site.

It is assumed surface water run-off from the completed development site will discharge into the storm sewer to the west of the Site entrance and not the drainage system to the east.

4.2.1 Surface Water Abstractions

The Agency have issued an abstraction licence to G Haigh & Son for the abstraction of up to 24,000 m^3/year of water from the Frickley Beck 2.4 km to the east-southeast for spray irrigation purposes.

4.3 Sensitive Habitats

According to the Magic Map website[18] The South Elmsall Quary SSSI is located 265 m to the east of the Site. The site is not designated as a SSSI because of its status as a sensitive habitat. The reason given for the Natural England citation for the site[19] is as follows:

"The quarry shows the rocks of the Wetherby Member of the Zechstein Cadeby Formation. Here is exposed a patch reef, eighty metres across and eight metres in thickness, made up for the most part of bryozoan sandstone with algal laminated sandstone above. The grainstones beneath contain a varied bivalve fauna. This exposure is unique amongst the British Marine Permian rocks, the reef being the most complete and best-exposed of its type."

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[17] Ea Beck from Frickley Beck to the Skell | Catchment Data Explorer | Catchment Data Explorer
[18] Magic Map Application (defra.gov.uk)
[19] 1004301.pdf (naturalengland.org.uk)

Although there is no sensitive habitat to impact, contaminated liquid could potentially discolour the exposed quarry face or physically degrade it as a consequence of a chemical reaction.

There are no other potentially sensitive habitats, ancient woodland or ancient monuments within 500 m of the Site that could be impacted by a deterioration in groundwater quality. The nearest potentially sensitive habitat is the Upton Country Park LNR approximately 1.3 km to the north.

5 Conceptual Site Model (CSM)

5.1 Summary

The information provided in the preceding sections details the likely sources of any potential polluting emissions associated with the Site and surrounds, the pathways that those potential emissions may take to move from their source, and, the receptors potentially vulnerable to any such emissions. Using that information a CSM has been compiled and translated into a visual representation of the Site prior to its development and on completion of the DfR activity. Consideration has also been given to the status of the CSM after completion of any built development that will be constructed on the Site.

5.1.1 Source

The primary source of any potentially harmful emissions associated with the proposed DfR activity is the deposit of 145,000 tonnes of non-hazardous, inert wastes arising from waste treatment activities or excavated from uncontaminated development sites. This material will be subject to strict waste acceptance criteria which will ensure the potential for contaminating liquid emissions is minimised. It is anticipated this material will comprise primarily of excavated soils and stones which when placed and compacted will be geotechnically stable and with an overall low permeability. Adherence to LFD Inert WAC-based waste acceptance criteria will ensure it does not contain elevated concentrations of readily soluble substances such as sulphate.

The material to be deposited as part of the DfR activity will be placed in a former quarry void which has been previously subject to disposal of imported wastes on top of quarry waste (Dolostone). The existing waste deposits is anticipated to cover the entirety of the quarry floor and was used to construct the Site entrance area and access ramp down into the quarry. Testing of the material historically deposited at site indicates it is granular and non-hazardous, but it is unlikely to meet the LFD Inert WAC due its organic content, leachable sulphate and TPH content.

The Site is located immediately adjacent to a significant historical landfill site which was used to backfill the former South Elmsall Quarries site to the south. This site is described as being filled with inert wastes, however the age of the site means it would not have been subject to the LFD in terms of engineering or waste acceptance standards. This site has evidently been covered with a 1m thick layer of clay, but does not have an engineered liner or attenuation layer. A waste transfer station activity evidently for the transfer of industrial tyres, was historically operated in the Site in accordance with a waste management licence. Oil staining was noted on the concrete hardstanding external to and inside a former workshop, however this has since been removed.

5.1.2 Pathways

The proposed DfR activity will be located within a former Cadeby Dolostone quarry. The Dolostone is understood to have a relatively low permeability with transmission of water via laminar flow in sub-horizontal bedding planes. Borehole installation logs in the locality describe bedding planes in the Dolostone filled with soft brown clay. There are no recorded faults within the Dolostone in the immediate vicinity of the site, through which water flow rates may be significantly higher.

The existing waste deposits in the Site are granular in nature and likely to have a higher vertical permeability than the underlying Dolostone. The DfR deposits to be placed above them will likely have a lower permeability as this may include cohesive subsoils excavated from development sites. The subsurface nature of the Site means that any precipitation-derived surface water is wholly currently confined to the quarry void and will soak into the ground away from the existing concrete slab. It is considered likely that any liquid encountered during borehole or trial pit installations and subsequent monitoring, represents leachate from that material. Retention of water in the waste deposits is likely to be a function of the poor vertical drainage associated with the un-faulted Dolostone. No standing water has been observed within the Site and therefore water is assumed to be able to eventually soakaway.

Historical mapping indicates the presence of a tunnel which connected the Site to the former South Elmsall Quarries site under Field Lane. It is not known if or how this tunnel was backfilled and it may represent a direct pathway to the landfilled wastes to the south of Field Lane. The trackway that ran through the tunnel transited across the full length of the quarry to the south and daylighted from another tunnel on its southern boundary. This may act as a discrete lateral pathway for liquid passing through the historical waste deposits in the Quarry Works Site to enter the landfill site immediately to the south.

An exploratory borehole was drilled through the northern base of the Site to prove the underlying coal measures strata. This borehole is no longer evident on site and the nature / material used in any decommissioning techniques employed is unknown.

Buried services are associated with the surrounding residential and commercial buildings, although none cross into the Site. The platform constructed from the completion of the DfR activity will be used for a residential development and therefore require sub-surface foundations and services to be excavated into it. These will then connect to external Mains services, including management of surface water run-off.

5.1.3 Receptors

The groundwater in the Cadeby Dolostone is classified as a Principal Aquifer and a medium to high vulnerability to pollution. There are no SPZs or private groundwater abstractions within 2.6 km of the Site. The nearest named water course is Frickley Beck 950 m to the south of the Site.

Groundwater issuing from springs, wells, land drains or a former tunnel to the south of the Site has likely passed under or through the substantial waste deposits in the South Elmsall Quarries landfill immediately to the south of the Quarry Works Site.

It is assumed clean surface water run-off from the completed development site will be directed via a formal drainage system to the existing storm sewer located to the west of the Site entrance. There will continue to be no direct discharges to surface water receptors after completion of the DfR activity.

There are no sensitive habitats that may be impacted by the proposed DfR activity. The nearest potentially sensitive site is the South Elmsall Quarry SSSI, however this is designated as a result of the geological strata of interest. This represents a small area of an unfilled quarry void and is surrounded by landfilled waste. The base elevation of the SSSI is lower than the Site but is continually dry. The SSSI component of interest is therefore understood to be above the water table.

5.2 CSM Cross Sections

The cross sections in Figures 2a to 2c, 3a to 3c in the accompanying CSM Report are a visual representation of the information compiled in Sections 2 to 4 above. The sections, chainage and topographical elevations are based on Oakwood Land Surveys drawing referenced FL/CSF/500: *Cross Sections Final Levels* are illustrative only and not to scale. The vertical axis of each section has also been exaggerated by 5 times relative to the horizontal scale in order to include more detail. Where information is missing or unknown, a '?' symbol illustrates that uncertainty or assumption made.

Figures 2a and 3a show the Site in long section (north to south) and short section (west to east) respectively. They show the extent of the existing imported waste and quarry waste fill, including the access ramp that extends down and northwards from the Site entrance in the southwest. They show the position of the GI locations carried out in 2018 and the strata encountered by them, along with the estimated position of the BGS-registered borehole in the northern part of the quarry (Figure 2a). The landfill to the south is shown on the southern side of Field Lane, along with a suggested position of the inter-connecting tunnel (depth, height and length unknown). The height and extent of the adjacent buildings is illustrative only.

The blue arrows represent precipitation falling on the surface of the existing ground and either flowing across the surface or infiltrating the in-situ waste material. This then percolates through or over the waste, potentially accumulating soluble substances and forming a leachate (red arrows). Figure 2a shows the possible accumulation of slow draining leachate from the existing waste deposits above the Dolostone after rainfall events. This also could potentially be draining into the adjacent landfill or vice versa. The presence of the BGS-registered borehole may be creating a preferential pathway through the Dolostone and draining water from the northern area of Site.

Figures 2b and 3b show the site at an intermediate stage of filling. The smaller red arrows illustrate the expectation that the volume of liquid that enters the collective infill mass in the site will reduce as will infiltration into the ground underneath. This is due to the substantial thickness of a likely more cohesive, low permeability fill above the existing more permeable waste deposits and the enhanced capacity for surface drainage. This material will be complaint with the LFD Inert WAC and therefore also represent a lower pollution potential than the existing waste deposits. It shows the progressive construction of the surface water system to begin direction of surface water away from site that would otherwise percolate through the underlying wastes and into the ground.

Figure 2c and 3c depict the Site after deposit of waste has been completed with the DfR activity. The smaller red arrows illustrate the expectation that the volume of liquid that enters the site will and infiltrates the ground underneath will be significantly reduced.

6 Groundwater Risk Assessment

6.1 Lifecycle Analysis

The potential risk associated with the Site may change from its current partially filled state to the completion of the final landform and likely residential development. An analysis of the risk at each discrete stage based on Section 5 has been carried out to establish if the risk increases, decreases or is unchanged.

6.2 Current Status

The Site in its current state consists of a former sub-surface Dolostone quarry that has been partially filled with quarry waste (Dolostone) and imported waste fill material. The quarry waste typically has been placed directly on the undisturbed Dolostone bedrock. The quarry waste assumed to have a low pollution potential equitable to the bedrock it sits on. It is in a broken granular state however so will likely have a higher permeability than the bedrock.

The 2018 ARP GI indicates the imported fill has been placed across the entirety of the former quarry floor and forms the structure of the ground level hardstanding at the Site entrance and the 80 m long access ramp into the base of the quarry. The diagonal slope gradient of east-facing embankment to the hardstanding and ramp is approximately 1v:2h. The total depth of made ground which consists primarily of imported fill, ranges between 1.3 m in TP3 (north) to 10.7 m (BH1, Site entrance). Testing of this largely granular material suggests it would have a low potential to leach metals but would likely exceed the LFD Inert WAC for sulphate in 15% of samples and mineral oils in 27% of samples. All samples will likely exceed the LFD Inert WAC for TOC and potentially dissolved organic carbon.

The former quarry is entirely below surrounding ground levels and therefore any rain that falls on the Site will either evaporate or soak into the ground. Concrete hardstanding covers approximately one third of the site surfaces, however it is not kerbed and the integrity of any expansion joints is unknown. Adjacent to the concrete surfacing is the granular imported fill and on sustained rainfall events the majority of water is likely to run into that granular ground. The recessed position of the quarry floor shelters it from wind and provides shades from direct sunlight. The rate of evaporation may therefore be reduced. Conservatively it can be assumed that the majority of precipitation that falls within the Site will soak into the ground and potentially generate a leachate with a greater pollution potential than material subject to compliance with the LFD Inert WAC.

The limiting factor for percolation of this liquid into the underlying Dolostone Principal Aquifer is likely the Dolostone itself. The granular nature of the quarry waste and imported waste fill above likely has a higher vertical permeability than the Dolostone. Any liquid encountering the Dolostone is likely to be retained within the made ground whilst it slowly drains into the underlying Dolostone. The Dolostone is reported as having a maximum hydraulic conductivity (1.08×10^{-8} m/s) that is lower than that required of a LFD compliant attenuation layer for an inert landfill site i.e. 1×10^{-7} m/s. The placement of an attenuation layer will therefore not influence the dispersal of soluble substances such as sulphate.

The Site may also be drained via a lateral pathway into the adjacent landfill site via the former tunnel under Field Lane. The position, depth, construction and nature of any backfill in the tunnel is unknown, likewise the basal elevation of the former quarry adjacent to the Site. It is understood a tramway connected the two sites however so it is reasonable to assume the ground was level between the two. The landfill itself has been restored and reportedly has a 1 m thick clay capping layer. This may restrict infiltration into the landfill.

Although there is no data to confirm it, it is assumed groundwater flow is influenced by topography and issues from springs, land drains, faults or wells further to the south of the adjacent landfill. Liquid potentially contaminated by imported granular fill may therefore be currently percolating into the underlying Dolostone Principal Aquifer through the base of the former quarry and flowing under the adjacent landfill to the south. Leachate may also be flowing laterally out of the Site via a disused tunnel and into the adjacent landfill, where it in combination with leachate generated by that site, is soaking into the Dolostone over a much wider area. Leachate from the landfill along with a contribution from the Site may also be issuing on the southern boundary of the landfill from springs or the land drain.

The adjacent landfill is approximately 12 ha in area compared to the 1.2 ha area of waste in the Site. The Site also contains a shallower depth of imported waste than the adjacent landfill, where the waste is reported to be 11 m deep. The impact of the existing wastes in the Site is therefore likely to be low compared to the much larger landfill regardless of groundwater flow direction. The immediate proximity of the two sites would make it difficult to distinguish between emissions from the existing waste deposits in either site, particularly if the waste deposits are from a similar source. If left in its current state, the Quarry Works Site could continue to discharge water to ground that may be contaminated by the existing fill or contribute to the discharge from the landfill to the immediate south.

6.3 Progression of Deposit

The Operator does not propose to remove any of the existing fill material from the Quary Works Site prior to commencement of infilling under the proposed DfR permit. The concrete slab will be left in place as this will form a robust running surface for visiting HGVs and be easier to clean of mud and debris. All vegetation or organic-rich soils that have accumulated within the void will be removed prior to infilling activities. Infilling activities will commence in the southern area of the void first. This area of Site is understood to be largely sealed with the concrete hardstanding, with the exception of the embankment up to the hardstanding at the Site entrance. The level ground immediately east of the access ramp and the concrete site road is unsealed. Visiting HGVs will be able to use the concrete surfacing the drive into the Site and back up into the southern area to deposit their loads. A dedicated 360 excavator will then place and track in the material. In order for vehicles to access the point of deposit, part of the material will be formed into a ramp with a sufficiently shallow gradient to enable a HGV to drive up. When the ramp becomes necessary it will be surfaced with hard-core or stoney material to provide a robust running surface and reduce risk of soft mud generation.

The placement of LFD Inert WAC-compliant aggregates, soils and stones on the southern hardstanding area is unlikely to impact drainage. The permeability of the DfR material is likely to be variable as it will be a mix of granular and cohesive material. The embankment may still represent a more permeable pathway into the ground that water percolating through the infilled material or running off it could flow into. Any infiltrating water or run-off will potentially have a lower pollution potential as it will be from waste compliant with the LFD Inert WAC.

As the DfR activity progresses northwards through the quarry the area of existing waste deposits will gradually diminish. It is likely deposit in the southern area of Site will cease when the southern and eastern-most extents are up to approved level. Construction of the pre-development surface water drainage scheme will be implemented along the south and east boundary simultaneously to ensure water is directed toward the storm sewer and not neighbouring properties. Deposit activities will then move to the northern-most area of Site. The area of concrete hardstanding at the toe of the ramp will be retained for as long as possible until it is necessary to connect the two areas of deposit. The material will then be placed in horizontal lifts. Priority will be placed on continuing the perimeter drain northwards along the eastern boundary enabling the DfR material to be profiled to direct water towards it. Placement of DfR material will then continue southwards up the ramp until the void is filled.

The gradual placement of LFD Inert WAC-compliant granular and cohesive fill in the void is expected to result in no net difference in terms of impact to groundwater. Any run-off from this material or leachate generated as water percolates through it should have a lower pollution potential than the existing waste deposits. The placement of fill which has a net lower permeability will also reduce the rate at which water flows through the existing fill. The rate of emission into the underlying Dolostone is likely limited by the lower permeability Dolostone itself. Construction of the perimeter surface water drainage system will commence when the DfR material is up to level in the south of the Site. From that point onwards an increasing proportion of the water previously infiltrating through the existing waste deposits will be directed to the storm sewer. Completed areas of Site will be seeded to create a temporary vegetated surface which will introduce evapotranspiration as a means to reduce infiltration and run off, as well as stabilise the surface. The potential for emissions to groundwater to occur will either remain unchanged or more likely, gradually decrease in magnitude.

6.4 Completion of Deposit and Development

On completion of the infilling activity a pre-development surface water management scheme constructed around the perimeter of the Site. This will direct a significant proportion of water previously percolating through the existing waste deposits and into the underlying Cadeby Dolostone Principal Aquifer. The quality of the surface water running off the site and into the storm sewer will be determined by the waste acceptance procedures enforced through the permit and will ensure it is an acceptable quality to eventually discharge to surface water.

6.5 Conclusion

The infilling of the Field Lane Quarry Works as a Deposit for Recovery (DfR) Activity will likely result in a reduction of emissions to groundwater under the current Site. Currently the majority of water that enters the site via overland flow or precipitation soaks into the existing non-inert waste deposits. Any leachate formed by this process either slowly soaks into the underlying Dolostone or migrates laterally via a former tunnel and trackway into the adjacent landfill site. As this landfill is reportedly capped, the flow of liquid into it from the Site may be facilitating mobilisation of pollutants that would otherwise be undisturbed.

Backfilling of the Site with a combination of inert granular and cohesive construction, demolition and excavation wastes will reduce surface water infiltration into the existing non-inert wastes. This is because the DfR material will likely have a lower overall permeability which will slow the rate of infiltration and hence emissions. On completion of the landform, the construction of the surface water scheme will divert the majority of precipitation to the storm sewer, further reducing the volume of water entering the ground.

6.6 Requisite Surveillance

Due to the position of the large landfill site on its immediate southern boundary, it is not proposed to install groundwater monitoring boreholes in the site. It is not practicably possible to ensure a 10 m distance from the edge of the waste deposits on the southern boundary due to the proximity of Field Lane. It is also not possible to install boreholes on the other site boundaries due to the proximity of the Site ownership boundary to the steep quarry faces. Installing boreholes into the base of the quarry is not considered sustainable as they will likely get damaged during the infilling activities and represent a direct pathway into the underlying Dolostone, where none currently exists.

Reliance on control of emissions from the Site will therefore be placed on strict adherence to the waste acceptance procedures to ensure all DfR waste inputs represent a lower pollution potential to groundwater than the existing, non-hazardous waste deposits.

The mitigation and monitoring measures are detailed in the Environmental Setting and Site Design report (ESSD) which should be written with due regard to Agency Guidance (the ESSD Guidance)[20].

[20] Landfill operators: environmental permits - What to include in your environmental setting and site design report - Guidance - GOV.UK (www.gov.uk)

APPENDIX A – ARP GI Testing Data

A P P E N D I X H

LABORATORY TEST CERTIFICATES AND SCREENING VALUES

ARP

A R P   G E O T E C H N I C A L   L I M I T E D

SOIL CONTAMINANT SCREENING VALUES

SITES FOR COMMERCIAL USE

Determinand	**S4UL (mg/kg)**			**C4SL (mg/kg)**		
Arsenic	640			640		
Cadmium	190			410		
Chromium (trivalent)	8600					
Chromium (hexavalent)	33			49		
Lead				2300		
Inorganic Mercury	1100					
Selenium	12000					
Copper	68000					
Nickel	980					
Zinc	730000					
Acidity (pH)	*Should be Greater Than 5					
	1% SOM	**2.5% SOM**	**6% SOM**	**1% SOM**	**2.5% SOM**	**6% SOM**
Acenaphthene	84000	97000	100000			
Acenaphthylene	83000	97000	100000			
Anthracene	520000	540000	540000			
Benzo(a)anthracene	170	170	180			
Benzo(a)pyrene	35	35	36			77
Benzo(b)fluoranthene	44	44	45			
Benzo(g,h,I)perylene	3900	4000	4000			
Benzo(k)fluoranthene	1200	1200	1200			
Chrysene	350	350	350			
Dibenzo(a,h)anthracene	3.5	3.6	3.6			
Fluoranthene	2300	2300	2300			
Fluorene	63000	68000	71000			
Indeno(1,2,3-cd)pyrene	500	510	510			
Naphthalene	190	460	1100			
Phenanthrene	22000	22000	23000			
Pyrene	54000	54000	54000			
Phenols	440	690	1300			
Total TPH	*Above 2000, speciate and compare with values below:					
C5 to C6 Aliphatic	3200	5900	12000			
C6 to C8 Aliphatic	7800	17000	40000			
C8 to C10 Aliphatic	2000	4800	11000			
C10 to C12 Aliphatic	9700	23000	47000			
C12 to C16 Aliphatic	59000	82000	90000			
C16 to C35 Aliphatic	1600000	1700000	1800000			
C35 TO C44 Aliphatic	1600000	1700000	1800000			
C5 to C7 Aromatic (Benzene)	26000	46000	86000			
C7 to C8 Aromatic (Toluene)	56000	110000	180000			
C8 to C10 Aromatic	3500	8100	17000			
C10 to C12 Aromatic	16000	28000	34000			
C12 to C16 Aromatic	36000	37000	38000			
C16 to C21 Aromatic	28000	28000	28000			
C21 TO C35 Aromatic	28000	28000	28000			
C35 TO C44 Aromatic	28000	28000	28000			
Asbestos	*Should be None Detected			*Should be None Detected		

* In House Value/Approach   S4UL = Suitable 4 Use Level, CIEH/LQM 2014   C4SL = Cat 4 Screening Level, DEFRA, 2014

Blank cell indicates no published value or in-house value.   Some values presented are above saturation limits.

ARP GEOTECHNICAL LIMITED
SOIL CONTAMINANT SCREENING VALUES
RESIDENTIAL WITH HOME-GROWN PRODUCE

Determinand	S4UL (mg/kg)			C4SL (mg/kg)		
Arsenic	37			37		
Cadmium	11			22		
Chromium (trivalent)	910					
Chromium (hexavalent)	6			21		
Lead				200		
Inorganic Mercury	40					
Selenium	250					
Copper	2400					
Nickel	130					
Zinc	3700					
Acidity (pH)	*Should be Greater Than 5			*Should be Greater Than 5		
	1% SOM	**2.5% SOM**	**6% SOM**	**1% SOM**	**2.5% SOM**	**6% SOM**
Acenaphthene	210	510	1,100			
Acenaphthylene	170	420	920			
Anthracene	2,400	5,400	11,000			
Benzo(a)anthracene	7.2	11	13			
Benzo(a)pyrene	2.2	2.7	3			5
Benzo(b)fluoranthene	2.6	3.3	3.7			
Benzo(g,h,I)perylene	320	340	350			
Benzo(k)fluoranthene	77	93	100			
Chrysene	15	22	27			
Dibenzo(a,h)anthracene	0.24	0.28	0.3			
Fluoranthene	280	560	890			
Fluorene	170	400	860			
Indeno(1,2,3-cd)pyrene	27	36	41			
Naphthalene	2.3	5.6	13			
Phenanthrene	95	220	440			
Pyrene	620	1,200	2,000			
Phenols	120	200	380			
Total TPH	*Above 500, speciate and compare with values below:					
C5 to C6 Aliphatic	42	78	160			
C6 to C8 Aliphatic	100	230	530			
C8 to C10 Aliphatic	27	65	150			
C10 to C12 Aliphatic	130	480	760			
C12 to C16 Aliphatic	1100	2,400	4,300			
C16 to C35 Aliphatic	65,000	92,000	110,000			
C35 TO C44 Aliphatic	65,000	92,000	110,000			
C5 to C7 Aromatic (Benzene)	70	140	300			
C7 to C8 Aromatic (Toluene)	130	290	660			
C8 to C10 Aromatic	34	83	190			
C10 to C12 Aromatic	74	180	380			
C12 to C16 Aromatic	140	330	660			
C16 to C21 Aromatic	260	540	930			
C21 TO C35 Aromatic	1100	1,500	1,700			
C35 TO C44 Aromatic	1100	1,500	1,700			
Asbestos	*Should be None Detected			*Should be None Detected		

* In House Value/Approach S4UL = Suitable 4 Use Level, CIEH/LQM 2014 C4SL = Cat 4 Screening Level, DEFRA, 2014

Blank cell indicates no published value or in-house value. Some values presented are above saturation limits.

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Concept Life Sciences

Certificate of Analysis

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M16 9FE
Tel : 0161 874 2400
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Report Number: 764416-1

Date of Report: 25-Sep-2018

Customer: ARP Associates and ARP Geotechnical Ltd
5 & 6 Northwest Business Park
Servia Hill
Leeds
LS6 2QH

Customer Contact: Mr Owain Gwilym

Customer Job Reference: NRP/01
Customer Purchase Order: NRP/01
Customer Site Reference: Field Lane, South Elmsall
Date Job Received at Concept: 04-Sep-2018
Date Analysis Started: 06-Sep-2018
Date Analysis Completed: 25-Sep-2018

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation

This report should not be reproduced except in full without the written approval of the laboratory

Tests covered by this certificate were conducted in accordance with Concept Life Sciences SOPs

All results have been reviewed in accordance with Section 25 of the Concept Life Sciences, Analytical Services Quality Manual

UKAS TESTING 1549

MCERTS THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

Report checked and authorised by :
Aneta Dybek-Echtermeyer
Customer Service Advisor

Issued by :
Chloe Kitto
Customer Service Advisor

Concept Reference: 764416
Project Site: Field Lane, South Elmsall
Customer Reference: NRP/01

Soil Analysed as Soil
MCERTS Preparation

				Concept Reference	**764416 001**	**764416 002**	**764416 005**	**764416 008**	**764416 011**
				Customer Sample Reference	**BH1**	**TP1**	**TP2**	**TP3**	**TP4**
				Bottom Depth		**0.30**	**0.20**	**0.15**	**0.60**
				Depth	**0.30**	**0**	**0**	**0**	**0.50**
				Date Sampled	**30-AUG-2018**	**31-AUG-2018**	**31-AUG-2018**	**31-AUG-2018**	**31-AUG-2018**
				Matrix Class	**Sandy Soil**	**Topsoil**	**Topsoil**	**Topsoil**	**Topsoil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Moisture @105C	T162	AR	0.1	%	**12**	**12**	**2.4**	**5.5**	**9.3**
Retained on 10mm sieve	T2	M40	0.1	%	<0.1	<0.1	<0.1	<0.1	<0.1

Concept Reference: 764416
Project Site: Field Lane, South Elmsall
Customer Reference: NRP/01

Soil Analysed as Soil
MCERTS Preparation

				Concept Reference	**764416 013**	**764416 015**	**764416 019**	**764416 023**	**764416 025**
				Customer Sample Reference	**TP5**	**TP6**	**TP7**	**TP8**	**TP9**
				Bottom Depth	**0.10**				
				Depth	**0**	**0.05**	**0.60**	**2.10**	**1.20**
				Date Sampled	**31-AUG-2018**	**31-AUG-2018**	**31-AUG-2018**	**31-AUG-2018**	**31-AUG-2018**
				Matrix Class	**Topsoil**	**Topsoil**	**Sandy Soil**	**Clay**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Moisture @105C	T162	AR	0.1	%	**4.1**	**8.6**	**12**	**18**	**13**
Retained on 10mm sieve	T2	M40	0.1	%	<0.1	<0.1	<0.1	<0.1	<0.1

Concept Reference: 764416
Project Site: Field Lane, South Elmsall
Customer Reference: NRP/01

Soil Analysed as Soil
MCERTS Preparation

				Concept Reference	**764416 026**	**764416 027**	**764416 029**	**764416 032**	**764416 034**
				Customer Sample Reference	**TP9**	**TP10**	**WS1**	**WS2**	**WS3**
				Bottom Depth			**0.70**	**1.30**	**0.50**
				Depth	**1.80**	**1**	**0.60**	**1.20**	**0.40**
				Date Sampled	**31-AUG-2018**	**31-AUG-2018**	**30-AUG-2018**	**30-AUG-2018**	**30-AUG-2018**
				Matrix Class	**Clay**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Moisture @105C	T162	AR	0.1	%	**12**	**8.4**	**12**	**5.7**	**13**
Retained on 10mm sieve	T2	M40	0.1	%	<0.1	<0.1	<0.1	<0.1	<0.1

Concept Reference: 764416
Project Site: Field Lane, South Elmsall
Customer Reference: NRP/01

Soil Analysed as Soil
MCERTS Preparation

				Concept Reference	**764416 036**	**764416 037**	**764416 039**	**764416 042**	**764416 043**
				Customer Sample Reference	**WS4**	**WS4**	**WS5**	**WS6**	**WS7**
				Bottom Depth	**1.70**	**2.60**	**1.50**	**3**	**0.40**
				Depth	**1.60**	**2.50**	**1.30**	**2.50**	**0.20**
				Date Sampled	**30-AUG-2018**	**30-AUG-2018**	**30-AUG-2018**	**30-AUG-2018**	**30-AUG-2018**
				Matrix Class	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Clay**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Moisture @105C	T162	AR	0.1	%	**18**	**13**	**16**	**13**	**16**
Retained on 10mm sieve	T2	M40	0.1	%	<0.1	<0.1	<0.1	<0.1	<0.1

Concept Reference: 764416
Project Site: Field Lane, South Elmsall
Customer Reference: NRP/01

Soil Analysed as Soil
ARP Geotechnical Standard Suite

				Concept Reference	764416 001	764416 002	764416 005	764416 008	764416 011
				Customer Sample Reference	**BH1**	**TP1**	**TP2**	**TP3**	**TP4**
				Bottom Depth		**0.30**	**0.20**	**0.15**	**0.60**
				Depth	**0.30**	**0**	**0**	**0**	**0.50**
				Date Sampled	**30-AUG-2018**	**31-AUG-2018**	**31-AUG-2018**	**31-AUG-2018**	**31-AUG-2018**
				Matrix Class	**Sandy Soil**	**Topsoil**	**Topsoil**	**Topsoil**	**Topsoil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Arsenic	T6	M40	2	mg/kg	**7**	**9**	**3**	**7**	**20**
Cadmium	T6	M40	1	mg/kg	<1	<1	<1	<1	<1
Chromium	T6	M40	1	mg/kg	**11**	**25**	**20**	**44**	**24**
Chromium VI	T6	A40	1	mg/kg	<1	<1	<1	<1	<1
Copper	T6	M40	1	mg/kg	**22**	**22**	**12**	**36**	**40**
Lead	T6	M40	1	mg/kg	**34**	**48**	**33**	**78**	**49**
Mercury	T6	M40	1	mg/kg	<1	<1	<1	<1	<1
Nickel	T6	M40	1	mg/kg	**10**	**16**	**12**	**22**	**28**
Selenium	T6	M40	3	mg/kg	<3	<3	<3	<3	<3
Zinc	T6	M40	1	mg/kg	**56**	**110**	**120**	**190**	**110**
SO4(Total)	T6	A40	0.01	%	**0.90**	**0.16**	**0.12**	**0.20**	**0.07**
(Water Soluble) SO4 expressed as SO4	T242	A40	0.05	g/l	<0.05	**0.24**	**0.09**	<0.05	**0.07**
pH	T7	A40			**7.7**	**8.1**	**8.8**	**8.2**	**8.2**
Phenols(Mono)	T546	AR	1	mg/kg	<1	<1	<1	<1	<1
TPH (C8-C35)(Total)	T206	M105	1	mg/kg	(13) **19**	(9,13) **2200**	(9,13) **730**	(13,9) **1900**	(13) **83**
Asbestos ID	T27	A40			N.D.	N.D.	N.D.	N.D.	N.D.
Soil Organic Matter	T287	A40	0.1	%	**11**	**6.6**	**19**	**14**	**4.9**

Concept Reference: 764416
Project Site: Field Lane, South Elmsall
Customer Reference: NRP/01

Soil Analysed as Soil
ARP Geotechnical Standard Suite

				Concept Reference	764416 013	764416 015	764416 019	764416 023	764416 025
				Customer Sample Reference	**TP5**	**TP6**	**TP7**	**TP8**	**TP9**
				Bottom Depth	**0.10**				
				Depth	**0**	**0.05**	**0.60**	**2.10**	**1.20**
				Date Sampled	**31-AUG-2018**	**31-AUG-2018**	**31-AUG-2018**	**31-AUG-2018**	**31-AUG-2018**
				Matrix Class	**Topsoil**	**Topsoil**	**Sandy Soil**	**Clay**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Arsenic	T6	M40	2	mg/kg	**10**	**5**	**7**	**4**	**6**
Cadmium	T6	M40	1	mg/kg	<1	<1	<1	<1	<1
Chromium	T6	M40	1	mg/kg	**28**	**34**	**20**	**6**	**9**
Chromium VI	T6	A40	1	mg/kg	<1	<1	<1	<1	<1
Copper	T6	M40	1	mg/kg	**39**	**31**	**31**	**39**	**27**
Lead	T6	M40	1	mg/kg	**58**	**59**	**41**	**25**	**26**
Mercury	T6	M40	1	mg/kg	<1	<1	<1	<1	<1
Nickel	T6	M40	1	mg/kg	**18**	**19**	**14**	**5**	**9**
Selenium	T6	M40	3	mg/kg	<3	<3	<3	<3	<3
Zinc	T6	M40	1	mg/kg	**160**	**150**	**100**	**51**	**64**
SO4(Total)	T6	A40	0.01	%	**0.06**	**0.08**	**0.08**	**0.04**	**0.22**
(Water Soluble) SO4 expressed as SO4	T242	A40	0.05	g/l	<0.05	<0.05	**0.07**	<0.05	**0.67**
pH	T7	A40			**8.2**	**7.9**	**8.2**	**8.4**	**7.8**
Phenols(Mono)	T546	AR	1	mg/kg	<1	<1	<1	<1	<1
TPH (C8-C35)(Total)	T206	M105	1	mg/kg	(13) **190**	(13) **240**	(13) **600**	(13) **2**	(13) **1600**
Asbestos ID	T27	A40			N.D.	N.D.	N.D.	N.D.	N.D.
Soil Organic Matter	T287	A40	0.1	%	**12**	**11**	**13**	**12**	**9.2**

Concept Reference: 764416
Project Site: Field Lane, South Elmsall
Customer Reference: NRP/01

Soil Analysed as Soil
ARP Geotechnical Standard Suite

				Concept Reference	**764416 026**	**764416 027**	**764416 029**	**764416 032**	**764416 034**
				Customer Sample Reference	**TP9**	**TP10**	**WS1**	**WS2**	**WS3**
				Bottom Depth			**0.70**	**1.30**	**0.50**
				Depth	**1.80**	**1**	**0.60**	**1.20**	**0.40**
				Date Sampled	**31-AUG-2018**	**31-AUG-2018**	**30-AUG-2018**	**30-AUG-2018**	**30-AUG-2018**
				Matrix Class	**Clay**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Arsenic	T6	M40	2	mg/kg	**2**	**5**	<2	**3**	**7**
Cadmium	T6	M40	1	mg/kg	<1	<1	<1	<1	<1
Chromium	T6	M40	1	mg/kg	**5**	**12**	**5**	**6**	**8**
Chromium VI	T6	A40	1	mg/kg	<1	<1	<1	<1	<1
Copper	T6	M40	1	mg/kg	**28**	**17**	**7**	**21**	**23**
Lead	T6	M40	1	mg/kg	**23**	**20**	**14**	**15**	**32**
Mercury	T6	M40	1	mg/kg	<1	<1	<1	<1	<1
Nickel	T6	M40	1	mg/kg	**5**	**14**	**4**	**7**	**9**
Selenium	T6	M40	3	mg/kg	<3	<3	<3	<3	<3
Zinc	T6	M40	1	mg/kg	**54**	**47**	**72**	**53**	**81**
SO4(Total)	T6	A40	0.01	%	**0.03**	**0.05**	**0.03**	**0.04**	**0.07**
(Water Soluble) SO4 expressed as SO4	T242	A40	0.05	g/l	<0.05	<0.05	<0.05	<0.05	<0.05
pH	T7	A40			**8.8**	**8.5**	**8.7**	**8.5**	**9.0**
Phenols(Mono)	T546	AR	1	mg/kg	<1	<1	<1	<1	<1
TPH (C8-C35)(Total)	T206	M105	1	mg/kg	(13) <1	**(13) 140**	**(13) 3**	**(13) 4**	**(13) 15**
Asbestos ID	T27	A40			N.D.	N.D.	N.D.	N.D.	N.D.
Soil Organic Matter	T287	A40	0.1	%	**12**	**11**	**17**	**11**	**11**

Concept Reference: 764416
Project Site: Field Lane, South Elmsall
Customer Reference: NRP/01

Soil Analysed as Soil
ARP Geotechnical Standard Suite

				Concept Reference	**764416 036**	**764416 037**	**764416 039**	**764416 042**	**764416 043**
				Customer Sample Reference	**WS4**	**WS4**	**WS5**	**WS6**	**WS7**
				Bottom Depth	**1.70**	**2.60**	**1.50**	**3**	**0.40**
				Depth	**1.60**	**2.50**	**1.30**	**2.50**	**0.20**
				Date Sampled	**30-AUG-2018**	**30-AUG-2018**	**30-AUG-2018**	**30-AUG-2018**	**30-AUG-2018**
				Matrix Class	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Clay**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Arsenic	T6	M40	2	mg/kg	**4**	**3**	<2	**3**	**16**
Cadmium	T6	M40	1	mg/kg	<1	<1	<1	<1	<1
Chromium	T6	M40	1	mg/kg	**6**	**6**	**3**	**4**	**24**
Chromium VI	T6	A40	1	mg/kg	<1	<1	<1	<1	<1
Copper	T6	M40	1	mg/kg	**20**	**41**	**14**	**50**	**46**
Lead	T6	M40	1	mg/kg	**17**	**13**	**7**	**19**	**86**
Mercury	T6	M40	1	mg/kg	<1	<1	<1	<1	<1
Nickel	T6	M40	1	mg/kg	**6**	**5**	**3**	**3**	**27**
Selenium	T6	M40	3	mg/kg	<3	<3	<3	<3	<3
Zinc	T6	M40	1	mg/kg	**48**	**44**	**26**	**51**	**150**
SO4(Total)	T6	A40	0.01	%	**0.07**	**0.09**	**0.04**	**0.03**	**0.09**
(Water Soluble) SO4 expressed as SO4	T242	A40	0.05	g/l	**0.54**	<0.05	**0.06**	**0.26**	**0.07**
pH	T7	A40			**7.4**	**8.6**	**8.4**	**7.8**	**7.9**
Phenols(Mono)	T546	AR	1	mg/kg	<1	<1	<1	<1	<1
TPH (C8-C35)(Total)	T206	M105	1	mg/kg	**(13) 24**	**(13) 73**	**(13) 8**	**(13) 5**	**(13) 150**
Asbestos ID	T27	A40			N.D.	N.D.	N.D.	N.D.	N.D.
Soil Organic Matter	T287	A40	0.1	%	**11**	**14**	**16**	**12**	**6.6**

Concept Reference: 764416
Project Site: Field Lane, South Elmsall
Customer Reference: NRP/01

Soil Analysed as Soil
Sulphate (Total)

				Concept Reference	764416 028	764416 030	764416 033
				Customer Sample Reference	**TP10**	**WS1**	**WS2**
				Bottom Depth		**1.60**	**4.50**
				Depth	**1.50**	**1.50**	**4**
				Date Sampled	**31-AUG-2018**	**30-AUG-2018**	**30-AUG-2018**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**			
SO4(Total)	T102	A40	0.01	%	**0.06**	**0.21**	**0.03**

Concept Reference: 764416
Project Site: Field Lane, South Elmsall
Customer Reference: NRP/01

Soil Analysed as Soil
pH

				Concept Reference	764416 028	764416 030	764416 033
				Customer Sample Reference	**TP10**	**WS1**	**WS2**
				Bottom Depth		**1.60**	**4.50**
				Depth	**1.50**	**1.50**	**4**
				Date Sampled	**31-AUG-2018**	**30-AUG-2018**	**30-AUG-2018**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**			
pH	T7	A40			**8.6**	**8.7**	**8.2**

Concept Reference: 764416
Project Site: Field Lane, South Elmsall
Customer Reference: NRP/01

Soil Analysed as Soil
PAH US EPA 16 (B and K split)

				Concept Reference	764416 001	764416 002	764416 005	764416 008	764416 011
				Customer Sample Reference	**BH1**	**TP1**	**TP2**	**TP3**	**TP4**
				Bottom Depth		**0.30**	**0.20**	**0.15**	**0.60**
				Depth	**0.30**	**0**	**0**	**0**	**0.50**
				Date Sampled	**30-AUG-2018**	**31-AUG-2018**	**31-AUG-2018**	**31-AUG-2018**	**31-AUG-2018**
				Matrix Class	**Sandy Soil**	**Topsoil**	**Topsoil**	**Topsoil**	**Topsoil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Naphthalene	T207	M105	0.1	mg/kg	<0.1	(9) <1.0	(9) <1.0	(9) <1.0	(9) <1.0
Acenaphthylene	T207	M105	0.1	mg/kg	<0.1	(9) <1.0	(9) <1.0	(9) <1.0	<0.1
Acenaphthene	T207	M105	0.1	mg/kg	<0.1	(9) <1.0	(9) <1.0	(9) <1.0	<0.1
Fluorene	T207	M105	0.1	mg/kg	<0.1	(9) <1.0	(9) <1.0	(9) <1.0	<0.1
Phenanthrene	T207	M105	0.1	mg/kg	<0.1	**2.3**	(9) <1.0	(9) <1.0	**0.1**
Anthracene	T207	M105	0.1	mg/kg	<0.1	(9) <1.0	(9) <1.0	(9) <1.0	<0.1
Fluoranthene	T207	M105	0.1	mg/kg	**0.3**	**6.3**	(9) <1.0	**1.1**	**0.2**
Pyrene	T207	M105	0.1	mg/kg	**0.2**	**6.8**	(9) <1.0	**1.2**	**0.2**
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	**0.2**	**1.5**	(9) <1.0	(9) <1.0	**0.2**
Chrysene	T207	M105	0.1	mg/kg	**0.1**	**1.9**	(9) <1.0	(9) <1.0	**0.2**
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	**0.1**	**1.5**	(9) <1.0	(9) <1.0	**0.2**
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	**0.1**	**1.3**	(9) <1.0	(9) <1.0	**0.2**
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	**0.1**	**1.9**	(9) <1.0	(9) <1.0	**0.2**
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	<0.1	**1.0**	(9) <1.0	(9) <1.0	**0.1**
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	<0.1	(9) <1.0	(9) <1.0	(9) <1.0	<0.1
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	<0.1	(9) <1.0	(9) <1.0	**1.1**	**0.1**
PAH(total)	T207	M105	0.1	mg/kg	**1.2**	**25**	<1.0	**3.3**	**1.7**

Concept Reference: 764416
Project Site: Field Lane, South Elmsall
Customer Reference: NRP/01

Soil Analysed as Soil
PAH US EPA 16 (B and K split)

				Concept Reference	**764416 013**	**764416 015**	**764416 019**	**764416 023**	**764416 025**
				Customer Sample Reference	**TP5**	**TP6**	**TP7**	**TP8**	**TP9**
				Bottom Depth	**0.10**				
				Depth	**0**	**0.05**	**0.60**	**2.10**	**1.20**
				Date Sampled	**31-AUG-2018**	**31-AUG-2018**	**31-AUG-2018**	**31-AUG-2018**	**31-AUG-2018**
				Matrix Class	**Topsoil**	**Topsoil**	**Sandy Soil**	**Clay**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Naphthalene	T207	M105	0.1	mg/kg	**0.2**	(9) <1.0	(9) <1.0	<0.1	<0.1
Acenaphthylene	T207	M105	0.1	mg/kg	<0.1	(9) <1.0	(9) <1.0	<0.1	<0.1
Acenaphthene	T207	M105	0.1	mg/kg	<0.1	(9) <1.0	(9) <1.0	<0.1	**0.1**
Fluorene	T207	M105	0.1	mg/kg	<0.1	(9) <1.0	(9) <1.0	<0.1	**0.8**
Phenanthrene	T207	M105	0.1	mg/kg	**1.2**	**5.6**	**1.8**	<0.1	**2.2**
Anthracene	T207	M105	0.1	mg/kg	**0.4**	**1.8**	(9) <1.0	<0.1	<0.1
Fluoranthene	T207	M105	0.1	mg/kg	**2.5**	**19**	**3.6**	<0.1	**0.2**
Pyrene	T207	M105	0.1	mg/kg	**2.3**	(9) <1.0	**3.3**	<0.1	**0.3**
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	**1.1**	**8.7**	**1.6**	<0.1	<0.1
Chrysene	T207	M105	0.1	mg/kg	**1.1**	**8.9**	**1.7**	<0.1	**0.1**
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	**0.8**	**7.6**	**1.4**	<0.1	<0.1
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	**0.7**	**6.9**	**1.2**	<0.1	<0.1
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	**1.1**	**9.7**	**1.9**	<0.1	<0.1
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	**0.6**	**5.2**	**1.1**	<0.1	<0.1
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	**0.2**	**1.9**	(9) <1.0	<0.1	<0.1
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	**0.6**	**5.0**	**1.2**	<0.1	<0.1
PAH(total)	T207	M105	0.1	mg/kg	**13**	**80**	**19**	<0.1	**3.7**

Concept Reference: 764416
Project Site: Field Lane, South Elmsall
Customer Reference: NRP/01

Soil Analysed as Soil
PAH US EPA 16 (B and K split)

				Concept Reference	**764416 026**	**764416 027**	**764416 029**	**764416 032**	**764416 034**
				Customer Sample Reference	**TP9**	**TP10**	**WS1**	**WS2**	**WS3**
				Bottom Depth			**0.70**	**1.30**	**0.50**
				Depth	**1.80**	**1**	**0.60**	**1.20**	**0.40**
				Date Sampled	**31-AUG-2018**	**31-AUG-2018**	**30-AUG-2018**	**30-AUG-2018**	**30-AUG-2018**
				Matrix Class	**Clay**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Naphthalene	T207	M105	0.1	mg/kg	<0.1	(9) <1.0	<0.1	<0.1	<0.1
Acenaphthylene	T207	M105	0.1	mg/kg	<0.1	(9) <1.0	<0.1	<0.1	<0.1
Acenaphthene	T207	M105	0.1	mg/kg	<0.1	(9) <1.0	<0.1	<0.1	<0.1
Fluorene	T207	M105	0.1	mg/kg	<0.1	(9) <1.0	<0.1	<0.1	<0.1
Phenanthrene	T207	M105	0.1	mg/kg	<0.1	**2.2**	<0.1	<0.1	<0.1
Anthracene	T207	M105	0.1	mg/kg	<0.1	(9) <1.0	<0.1	<0.1	<0.1
Fluoranthene	T207	M105	0.1	mg/kg	<0.1	**5.1**	<0.1	<0.1	**0.1**
Pyrene	T207	M105	0.1	mg/kg	<0.1	**4.7**	<0.1	<0.1	**0.1**
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	<0.1	**2.3**	<0.1	<0.1	<0.1
Chrysene	T207	M105	0.1	mg/kg	<0.1	**2.4**	<0.1	<0.1	<0.1
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	<0.1	**1.8**	<0.1	<0.1	<0.1
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	<0.1	**1.8**	<0.1	<0.1	<0.1
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	<0.1	**2.5**	<0.1	<0.1	<0.1
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	<0.1	**1.4**	<0.1	<0.1	<0.1
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	<0.1	(9) <1.0	<0.1	<0.1	<0.1
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	<0.1	**1.4**	<0.1	<0.1	<0.1
PAH(total)	T207	M105	0.1	mg/kg	<0.1	**26**	<0.1	<0.1	**0.3**

Concept Reference: 764416
Project Site: Field Lane, South Elmsall
Customer Reference: NRP/01

Soil Analysed as Soil
PAH US EPA 16 (B and K split)

				Concept Reference	**764416 036**	**764416 037**	**764416 039**	**764416 042**	**764416 043**
				Customer Sample Reference	**WS4**	**WS4**	**WS5**	**WS6**	**WS7**
				Bottom Depth	**1.70**	**2.60**	**1.50**	**3**	**0.40**
				Depth	**1.60**	**2.50**	**1.30**	**2.50**	**0.20**
				Date Sampled	**30-AUG-2018**	**30-AUG-2018**	**30-AUG-2018**	**30-AUG-2018**	**30-AUG-2018**
				Matrix Class	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Clay**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Naphthalene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	**1.5**
Acenaphthylene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	**1.3**
Fluorene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	**1.6**
Phenanthrene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	**5.1**
Anthracene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	**2.2**
Fluoranthene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	**5.3**
Pyrene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	**5.0**
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	**2.5**
Chrysene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	**2.4**
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	**1.6**
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	**1.7**
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	**2.4**
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	**1.1**
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	**0.5**
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	**1.1**
PAH(total)	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	**37**

Concept Reference: 764416
Project Site: Field Lane, South Elmsall
Customer Reference: NRP/01

Soil Analysed as Soil
TPH (CWG)

				Concept Reference	**764416 025**	**764416 036**
				Customer Sample Reference	**TP9**	**WS4**
				Bottom Depth		**1.70**
				Depth	**1.20**	**1.60**
				Date Sampled	**31-AUG-2018**	**30-AUG-2018**
				Matrix Class	**Sandy Soil**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**		
TPH (C5-C6 aliphatic)	T209	AR	0.100	mg/kg	<0.100	<0.100
TPH (C6-C8 aliphatic)	T209	AR	0.10	mg/kg	<0.10	<0.10
TPH (C8-C10 aliphatic)	T209	AR	0.10	mg/kg	**0.29**	**0.20**
TPH (C10-C12 aliphatic)	T909	M105	1	mg/kg	**[13] 23**	[13] <1
TPH (C12-C16 aliphatic)	T909	M105	1	mg/kg	**[13] 260**	[13] <1
TPH (C16-C21 aliphatic)	T909	M105	1	mg/kg	**[13] 400**	[13] <1
TPH (C21-C35 aliphatic)	T909	M105	2	mg/kg	**[13] 480**	**[13] 2**
TPH (C6-C7 aromatic)	T209	AR	0.10	mg/kg	<0.10	<0.10
TPH (C7-C8 aromatic)	T209	AR	0.10	mg/kg	<0.10	<0.10
TPH (C8-C10 aromatic)	T209	AR	0.10	mg/kg	<0.10	<0.10
TPH (C10-C12 aromatic)	T909	M105	2	mg/kg	**[13] 12**	[13] <2
TPH (C12-C16 aromatic)	T909	M105	1	mg/kg	**[13] 120**	[13] <1
TPH (C16-C21 aromatic)	T909	M105	1	mg/kg	**[13] 260**	[13] <1
TPH (C21-C35 aromatic)	T909	M105	1	mg/kg	**[13] 31**	**[13] 3**

Index to symbols used in 764416-1

Value	Description
M105	Analysis conducted on an "as received" aliquot. Results are reported on a dry weight basis where moisture content was determined by assisted drying of sample at 105C

AR	As Received
M40	Analysis conducted on sample assisted dried at no more than 40C. Results are reported on a dry weight basis.
A40	Assisted dried < 40C
N.D.	Not Detected
13	Results have been blank corrected.
9	LOD raised due to dilution of sample
S	Analysis was subcontracted
M	Analysis is MCERTS accredited
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Notes

Asbestos testing was subcontracted to REC Asbestos.
These samples have been analysed exceeding recommended holding times for pH. It is possible therefore that the results provided may be compromised.

Method Index

Value	Description
T287	Calc TOC/0.58
T6	ICP/OES
T27	PLM
T207	GC/MS (MCERTS)
T209	GC/MS (Head Space)(MCERTS)
T2	Grav
T162	Grav (1 Dec) (105 C)
T206	GC/FID (MCERTS)
T909	GCxGC
T242	2:1 Extraction/ICP/OES (TRL 447 T1)
T7	Probe
T102	ICP/OES (HCl extract)
T546	Colorimetry (CF)

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	Concept References
Moisture @105C	T162	AR	0.1	%	N	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Retained on 10mm sieve	T2	M40	0.1	%	N	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Arsenic	T6	M40	2	mg/kg	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Cadmium	T6	M40	1	mg/kg	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Chromium	T6	M40	1	mg/kg	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Chromium VI	T6	A40	1	mg/kg	N	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Copper	T6	M40	1	mg/kg	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Lead	T6	M40	1	mg/kg	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Mercury	T6	M40	1	mg/kg	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Nickel	T6	M40	1	mg/kg	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Selenium	T6	M40	3	mg/kg	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Zinc	T6	M40	1	mg/kg	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
SO4(Total)	T6	A40	0.01	%	N	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
(Water Soluble) SO4 expressed as SO4	T242	A40	0.05	g/l	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
pH	T7	A40			M	001-002,005,008,011,013,015,019,023,025-030,032-034,036-037,039,042-043
Phenols(Mono)	T546	AR	1	mg/kg	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
TPH (C8-C35)(Total)	T206	M105	1	mg/kg	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Asbestos ID	T27	A40			SU	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Soil Organic Matter	T287	A40	0.1	%	N	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
SO4(Total)	T102	A40	0.01	%	M	028,030,033
Naphthalene	T207	M105	0.1	mg/kg	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Acenaphthylene	T207	M105	0.1	mg/kg	U	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Acenaphthene	T207	M105	0.1	mg/kg	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Fluorene	T207	M105	0.1	mg/kg	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Phenanthrene	T207	M105	0.1	mg/kg	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Anthracene	T207	M105	0.1	mg/kg	U	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Fluoranthene	T207	M105	0.1	mg/kg	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Pyrene	T207	M105	0.1	mg/kg	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Chrysene	T207	M105	0.1	mg/kg	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043

Determinand	Method	Test Sample	LOD	Units	Symbol	Concept References
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	M	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
PAH(total)	T207	M105	0.1	mg/kg	U	001-002,005,008,011,013,015,019,023,025-027,029,032,034,036-037,039,042-043
TPH (C5-C6 aliphatic)	T209	AR	0.100	mg/kg	N	025,036
TPH (C6-C8 aliphatic)	T209	AR	0.10	mg/kg	N	025,036
TPH (C8-C10 aliphatic)	T209	AR	0.10	mg/kg	N	025,036
TPH (C10-C12 aliphatic)	T909	M105	1	mg/kg	M	025,036
TPH (C12-C16 aliphatic)	T909	M105	1	mg/kg	M	025,036
TPH (C16-C21 aliphatic)	T909	M105	1	mg/kg	M	025,036
TPH (C21-C35 aliphatic)	T909	M105	2	mg/kg	M	025,036
TPH (C6-C7 aromatic)	T209	AR	0.10	mg/kg	N	025,036
TPH (C7-C8 aromatic)	T209	AR	0.10	mg/kg	N	025,036
TPH (C8-C10 aromatic)	T209	AR	0.10	mg/kg	N	025,036
TPH (C10-C12 aromatic)	T909	M105	2	mg/kg	M	025,036
TPH (C12-C16 aromatic)	T909	M105	1	mg/kg	M	025,036
TPH (C16-C21 aromatic)	T909	M105	1	mg/kg	M	025,036
TPH (C21-C35 aromatic)	T909	M105	1	mg/kg	M	025,036

ARP GEOTECHNICAL BOREHOLE MONITORING RESULTS

JOB NO: WSK/01 **CLIENT:** Wetherby Skip Services

SITE: Field Lane, South Elmsall

BH: BH1

Date	BH Steady Flow Rate (l/hr)*	Peak CH_4 %	Qhg CH_4 (l/hr)	Peak CO_2 %	Qhg CO_2 (l/hr)	Min. O_2 %	Depth to G Water (m)	Comment
20/09/2018	0.9	1.7	0.015	8.7	0.078	4.5	Dry	
10/10/2018	0.1	1.4	0.001	6.4	0.006	8.2	Dry	
05/11/2018	0.1	1.5	0.002	7.4	0.007	5.4	Dry	
03/12/2018	-0.3	1.5	-0.005	7.3	-0.022	4.7	Dry	
			0.000		0.000			
			0.000		0.000			

* Where no flow is detected, detection limit of 0.1l/hr should be inserted

Qhg = Hazardous gas flow rate, in accordance with BS8485:2007

ARP GEOTECHNICAL BOREHOLE MONITORING RESULTS

JOB NO. WSK/01 **CLIENT:** Wetherby Skip Services

SITE: Field Lane, South Elmsall

BAROMETRIC PRESSURES

Monitor Date	Weather on Day	Pressure on Day (mb)*	Pressure on day before (mb)*	Pressure 2 days before (mb)*	Pressure 3 days before (mb)*	Trend*
20/09/2018	Mild and dry	1004	1002	1003	1009	Falling
10/10/2018	Warm and dry	1011	1015	1021	1014	Falling
05/11/2018	Overcast	1003	1008	1016	1024	Falling
03/12/2018	Dry and cold	999	992	996	1004	Variable

FALSE

*Pressures at midday (EGNM) corrected to sea level.

https://www.timeanddate.com/weather/uk/leeds/historic

ARP GEOTECHNICAL BOREHOLE MONITORING RESULTS

JOB NO: WSK/01 **CLIENT:** Wetherby Skip Services

SITE: Field Lane, South Elmsall

BH: WS4

Date	BH Steady Flow Rate (l/hr)*	Peak CH_4 %	Qhg CH_4 (l/hr)	Peak CO_2 %	Qhg CO_2 (l/hr)	Min. O_2 %	Depth to G Water (m)	Comment
20/09/2018	0.1	1.5	0.002	11.2	0.011	4.5	2.25	HC odour to
10/10/2018	0.1	4.5	0.005	9.1	0.009	2.0	2.10	HC odour to water.
05/11/2018	0.1	1.8	0.002	9.1	0.009	4.6	2.28	
03/12/2018	-0.2	3.8	-0.008	6.6	-0.013	2.6	1.97	
			0.000		0.000			
			0.000		0.000			

* Where no flow is detected, detection limit of 0.1l/hr should be inserted

Qhg = Hazardous gas flow rate, in accordance with BS8485:2007

ARP GEOTECHNICAL BOREHOLE MONITORING RESULTS

JOB NO: WSK/01 **CLIENT:** Wetherby Skip Services

SITE: Field Lane, South Elmsall

BH: WS7

Date	BH Steady Flow Rate (l/hr)*	Peak CH_4 %	Qhg CH_4 (l/hr)	Peak CO_2 %	Qhg CO_2 (l/hr)	Min. O_2 %	Depth to G Water (m)	Comment
20/09/2018	0.1	0.0	0.000	5.5	0.006	12.1	4.75	
10/10/2018	0.1	0.0	0.000	7.1	0.007	6.0	4.60	Well flooded
05/11/2018	0.1	0.0	0.000	9.4	0.009	9.4	4.65	
03/12/2018	0.1	0.0	0.000	1.3	0.001	18.5	4.57	
			0.000		0.000			
			0.000		0.000			

* Where no flow is detected, detection limit of 0.1l/hr should be inserted
Qhg = Hazardous gas flow rate, in accordance with BS8485:2007