Wetherby Skip Services Ltd

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Quarry Works Deposit for Recovery Site

Conceptual Site Model Report

HOOPER-SARGENT LIMITED
Environmental Permitting Consultancy

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1 Introduction

1.1 Relevant Regulatory and Guidance Requirements

This Conceptual Site Model (CSM) Report 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 Works Site (the Quarry Works Site) located on Field Lane in 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 CSM report 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 gas risk on neighbouring properties of the site.

   Reason: *Whilst the waste material to be accepted at the site is intended to be inert, there remains the potential for gas to be generated through residual / contaminated loads. The development is in very close proximity to an existing housing estate without the benefit of any stated gas protection. Due consideration should be given to potential pathways at all stages of the development.*

2. 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.*

3. Please provide assessment of all stages of development.

   Reason: *The application states that it is the intention to develop the land for residential development. This end use will partially seal the surface of the waste deposit which must be taken into account with respect to the conceptual model for the long-term risks from the waste deposit to adjacent land.*

To address Questions 1 and 2 it is necessary to compile a representative CSM of the Site to understand what the possible impacts may be to groundwater receptors from potential emissions from the site and also how it may generate and influence ground gas behaviour in the locality. A CSM will also inform how the Operator may respond to other emissions from the DfR activity such as dust, noise or mud on the road. These components require an understanding of the historical development of the site and surrounds, as well as the DfR activity itself. The

Agency have issued online guidance[1] (the CSM Guidance) to support prospective waste Operators in preparing a CSM to demonstrate the design of their proposed site is suitable.

The CSM is the first step in a series of documents that characterises the potential **Source** of any pollutants associated with the DfR activity, the **Pathways** by which those pollutants can travel from the Site and the **Receptors** potentially sensitive to those pollutants. This process enables the Operator to generate risk assessments (Step 2) that can characterise and / or quantify the risk to receptors if there is a link between the source, pathway and receptor that pollution could follow. The outcome of the risk assessments enables the Operator to counter any potentially polluting aspects of the Site by incorporation of mitigation measures (Step 3). The mitigation and monitoring measures resulting from the risk assessments are detailed in the Environmental Setting and Site Design report (ESSD) which should be written with due regard to Agency Guidance (the ESSD Guidance)[2].

A Groundwater Risk Assessment referenced 2405-016/R/003 and Ground Gas Risk Assessment referenced 2405-016/R/004 accompany this CSM in the NDM response along with the ESSD report referenced 2405-016/R/006.

1.2 CSM Report Content

This CSM report incorporates the essential components listed in the Guidance as follows:

- 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 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 – 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.

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

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 are located within the southeastern	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
	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.

The exploratory holes and trial pits installed in the Quarry Works Site as part of the GI described in the ARP Report describes the presence of made ground across the entirety of the site. This includes the ground underneath the hardstanding at the site entrance and the access ramp that extends down into the site. Based on the progression of landfilling works at the much larger South Elmsall Quarries site to the south and the physical connection to it via the tunnel under Field Lane, it is possible similar material was placed in the two sites. Further details about the physical description of the deposited waste material and the tunnel are described in Section 3 - Pathways.

2.4 Proposed Infill Materials

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 Operator intends to import waste types which are geotechnically suitable for building a stable development platform which in turn can be built upon. The Operator proposes to import a mix of granular and cohesive construction, demolition and extraction wastes which will provide physical strength and stability to the platform. The final landform will be flush with the surrounding ground levels with a slight gradient (<1v:30h) falling toward the east. On completion there will be no raised features associated with the platform above surrounding ground levels which if they became unstable could result in a slip or collapse into neighbouring properties or jeopardise the development on the platform.

For practical purposes the Operator wishes to maintain site-wide access to HGVs for as long as possible to minimise movement of material by site plant. To achieve this they will place the material in shallow lifts over a wide area and create shallow access ramps onto each lift of material the HGVs can transit / reverse up and down safely. The sub-surface quarry faces will provide confinement of the material and enable a good level of compaction and consolidation. Material will be placed first in the south and southwestern area of the site (Phase 3), with deposit operations extending northwards into Phase 1), with Phase 2 being the last area of Site to be filled.

The use of shallow ramps to enable HGVs to safely access the active deposit areas means any slope faces will be significantly shallower than 1v:3h. When the deposit operations reach the toe of the current access ramp tying in Phase 1 and Phase 2, it is likely the material will be placed in near horizontal lifts. The stability of the deposited material is unlikely to be a significant issue.

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 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. This type of material has the potential to dry out and produce dust or particulates if disturbed mechanically or by the wind. This has the potential to create a dust nuisance or respiratory hazard to sensitive individuals, or, may adversely impact a sensitive ecological receptor. Substances associated with that material may also mobilise with the particulates. 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.

The types of waste proposed for use in the DfR activity will not contain readily biodegradable material that could potentially produce odours or attract pests at point of deposits. The restriction to import of inert waste only reduces the likelihood of biogenic gas being produced when material is buried in the DfR activity. This reduces the risk of odorous gas being produced under anaerobic conditions and adverse reactions with other substance e.g. sulphate that may produce odorous and harmful species e.g. Hydrogen Sulphide. It is also unlikely to include materials which could cause a litter nuisance and the activity as a whole will not cause visible plumes from point sources or similar.

A discussion of the potential soluble pollutants associated with this type of material is discussed in Section 2.4.2 of the accompanying Groundwater Risk Assessment. The potential for the proposed waste deposits to produce biogenic gas is discussed in Section 2.4.2 of the Ground Gas Risk Assessment.

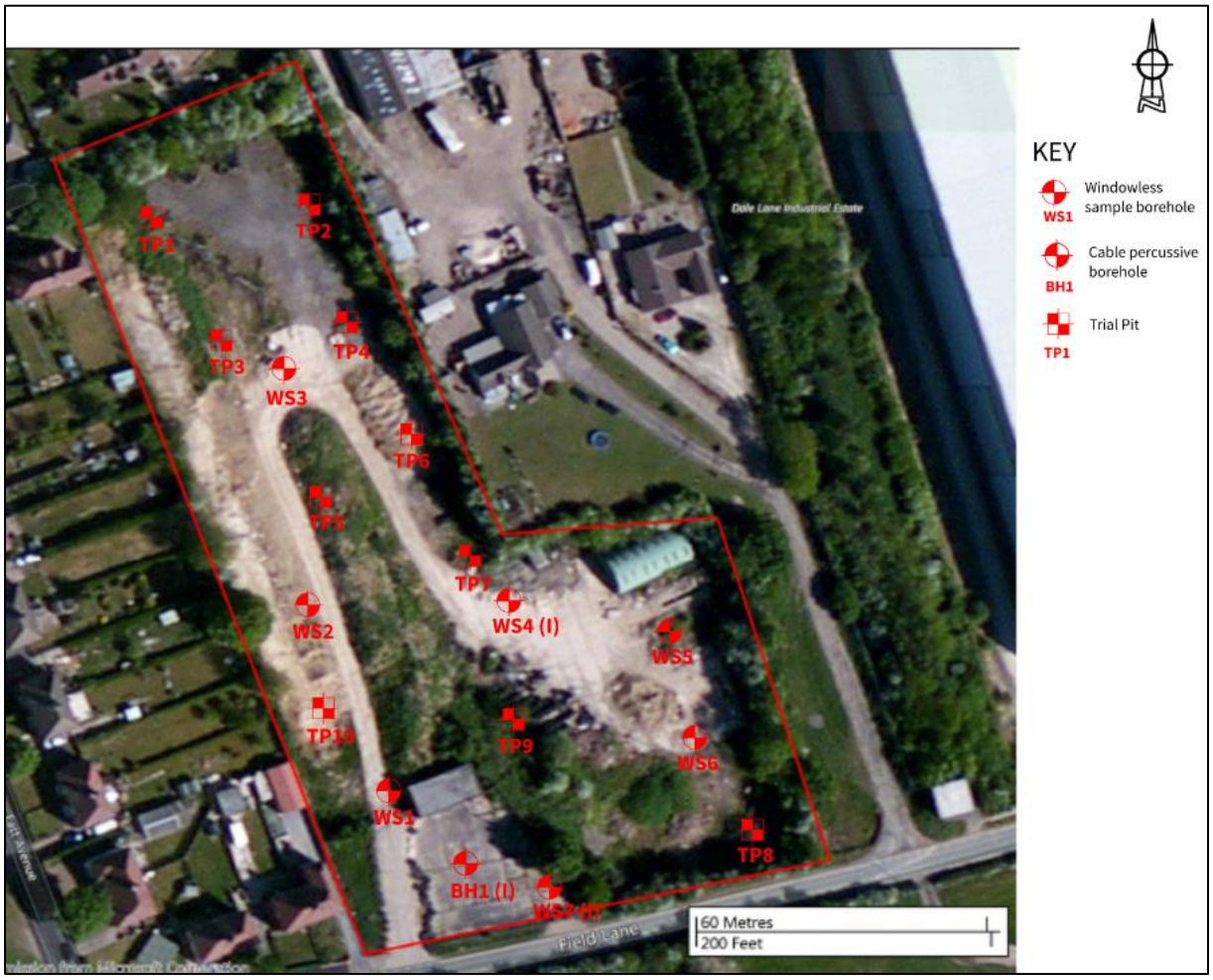
2.5 Other Pollution Sources

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. 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. Made ground was encountered at all locations and the physical ground conditions are discussed in Section 3.

Figure 1 – GI Location Plan



2.5.2 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 moderately 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.

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 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[3] 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 Made Ground Water Levels

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.

[3] Total Organic Carbon | Fact Sheets | soilquality.org.au

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 ~ 5m higher in elevation compared to BH1 and WS4. It is assumed this represents a perched water body in the waste deposits at a higher elevation. A standing head of water in BH1 and WS4 in granular made ground, suggests that water does not drain freely into the underlying Dolostone and is reflective of the low hydraulic conductivity values referenced above. It is assumed this water may eventually drain away vertically, but may also find a lateral pathway through the backfilled former tunnel (see below) and into the neighbouring landfill site.

2.5.4 Ground Gas Composition

Pipework was installed into GI locations BH1, WS4 and WS7 which were excavated into the existing made ground deposits at the Site. All other GI locations were backfilled with their arisings after soil samples and logging had been undertaken. The installation logs of all sampling points described the presence of organic material such as coal, with wood fragments noted in BH1 and WS4. Up to 1.7 %v/v methane was detected in BH1, 4.5 %v/v methane in WS4 and 0 %v/v in WS7. Carbon dioxide was recorded up to 8.7 %v/v in BH1, 11.2 %v/v in WS4 and 9.4 %v/v in WS7. Only BH1 recorded a flow rate above the instrument limit of detection (positive and negative flows). The highest methane concentrations did not necessarily correspond with the highest carbon dioxide readings.

2.5.5 Off-site Sources of Pollution

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[4]. The boreholes appeared to be drilled after the former quarry had been partially landfilled. This assumption is based on the 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

[4] 107249 (bgs.ac.uk)

registered borehole referenced SE41SE/50[5] 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. This waste has the potential to produce landfill gas albeit at significantly lower quantities compared to a non-hazardous landfill accepting biodegradable wastes.

Askew Aggregates operate a landfill site 515 m to the south-southeast of the Site in a former brickworks quarry. The planning consent[6] 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[7] 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[8].

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 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

[5] 107244 (bgs.ac.uk)
[6] 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
[7] 09_02426_FUL-0-2076071.pdf (wakefield.gov.uk)
[8] 09_02426_FUL-Site_Plans_full_scheme_HI-02_rev_B-396035.pdf (wakefield.gov.uk)

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 and produce landfill gas. The deposit of LFD inert WAC-compliant waste in the void and above the existing waste deposits 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[9] 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.

Medici et al (2019)[10] describe the hydraulic conductivity of the Dolostone in the unfaulted Cadeby Limestone as being within a range of 3.35×10^{-9} m/s to 1.08×10^{-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

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

[10] 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

persistent bedding planes. The intervening rock matrix is described as relatively impermeable reflected by the low hydraulic conductivity values detailed above.

3.2 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 [11] 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[12]. Made ground 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[13] and the trial pit summary[14]. No standing water has been observed within the

[11] SE3_locaccess.pdf (geohubliverpool.org.uk)
[12] 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)
[13] 07_00921_OUT-Site_Plans-371623.pdf (wakefield.gov.uk)
[14] 07_00921_OUT--1872237.pdf (wakefield.gov.uk)

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.

3.3 Anthropogenic Pathways

3.3.1 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 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 reasonably 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.

3.3.2 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. 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 was 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. During post installation monitoring in 2018 0.75 m of standing water was measured at the base of WS4 and 0.25 m in the base of WS7. This equates to an approximate water level of 55.75 mAOD in WS4 and 60.75 mAOD in WS7. No water was measured in BH1 which is located immediately to the west of WS7 with a comparable ground level. The absence of water in BH1, the shallower installation depth of WS7 (5m) and higher elevation than WS4 suggests the water may be perched in the previously imported fill.

The presence of the concrete slab will act as a barrier to vertical transmission of water. The retention of water in the granular backfill may be due to the underlying lower permeability dolostone beneath the site fill.

3.3.3 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.

3.3.4 Boreholes

BGS registered borehole referenced SE41SE/50[15] 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 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 for liquid to the lower strata or a pathway for mines gar generated in the coal measures out of it.

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.

3.4 Atmospheric Pathways

The transit of airborne pollutants or nuisances such as odour, particulates, dust and litter will be influenced primarily by wind direction. Noise can also be influenced by wind direction. The prevailing wind direction in the locality is from the west-southwest[16], with the wind blowing from that direction 23.4% of the time. The wind blows from the southwest, south, southwest or south collectively 32% of the time.

The typical depth of the quarry is 7 to 8 m relative to surrounding ground levels. This will afford a degree of shelter to any activities carried out in the void. The site is also surrounded by mature trees, shrubs and hedgerows which will also provide shelter from the wind. and Wind will have an increasing influence with rising ground levels in the quarry as works progress.

4 Receptors

4.1 Human Receptors

4.1.1 Pre-development

The Site is bounded on its immediately to the west by the gardens of residential housing. The houses themselves are approximately 50 m away, although some have sheds or other outbuildings in their gardens. Toward the north of the Site and on the northern boundary, the houses are significantly closer with one building < 3 m from the Site boundary. On the immediate eastern boundary is the Askew Aggregates compound which appears to include various sheds along with a residential property or office building. Approximately 40 m east of the boundary is the Montessa lodging house. It is also noted a planning application has been submitted for the construction of a bungalow immediately adjacent to the eastern boundary of the Site. The Next Stadium 2 Warehouse is 50 m from the Site at its closest point and is of

[15] 107244 (bgs.ac.uk)
[16] Wakefield Wind Forecast, West Yorkshire WF1 2 - WillyWeather

similar length (north to south) as the Site. There are no residences or occupied buildings within 100 m of the southern boundary of Site. The houses on Valley Avenue are approximately 115 m from the southwest corner of Site.

There is a small area of remaining void associated with the former South Elmsall Quarries site located to the southwest of Site. The houses on Valley Avenue are located on its southern and western boundary and the western flank of the landfill on the eastern boundary. Field Lane abuts the northern boundary. The South Elmsall Quarry geological SSSI located at the eastern extent of the landfill is another remaining area of quarry void. The SSSI and void to the west is situated below ground levels and their sub-surface elevation may be vulnerable to accumulation of gases during temperature inversion events, however the landfill is the more immediate source.

4.1.2 Post-built development

The objective of the DfR activity is to facilitate built development on the site which will likely comprise the construction of residential housing. The construction of the housing will seal the ground surface where foundations are laid, along with the construction of the driveways, roads, footpaths and any surface water management features. The residences will need to be connected to buried utilities which will be excavated into the DfR deposits. The construction of the buildings and associated infrastructure may therefore alter the pathways that any emissions associated with the DfR deposits or the magnitude of impacts on potentially sensitive receptors.

4.2 Groundwater Receptors

4.2.1 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.*"[17] 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[18] 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.

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

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.

4.2.2 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.

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

4.3 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[19] 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.

[19] Ea Beck from Frickley Beck to the Skell | Catchment Data Explorer | Catchment Data Explorer

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.

4.3.1 Surface Water Abstractions

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

4.4 Sensitive Habitats

Part of the eligibility criteria for a standard rules waste recovery permit is the proposed site's location relative to sensitive habitats. The proposed site must be:

- > 500 m from a European Site or Site of Special Scientific Interest (SSSI)
- > 250 m from the presence of Great Crested Newts where the site is linked by good habitat to the breeding ponds of the newts
- > 50 metres of a site that has species or habitats protected under the Biodiversity Action Plan that the Environment Agency considers is at risk from this activity
- > 50 metres of a National Nature Reserve (NNR), Local Nature Reserves(LNR), Local Wildlife Site (LWS), Ancient woodland or Scheduled Ancient Monument.

According to the Magic Map website[20] 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[21] 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."

There are no other potentially sensitive habitats, ancient woodland or ancient monuments within 500 m of the Site. The nearest potentially sensitive habitat is the Upton Country Park LNR approximately 1.3 km to the north. The nearest scheduled monuments are > 3km away.

4.5 Noise and Air Quality Receptors

The proximity of the Site to residential housing and commercial activities makes those receptors susceptible to potential air-borne emissions associated with the proposed activities i.e. dust and noise from vehicle movements and materials management. The Site is not located in an Air Quality Management Area (AQMA).

[20] Magic Map Application (defra.gov.uk)
[21] 1004301.pdf (naturalengland.org.uk)

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 gas or 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. The surface of this material will dry out in period of dry weather and may be susceptible to dust generation when disturbed by vehicles. Surface water run-off may mobilise solids from its surface also.

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 imported material 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. 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 has been noted on the concrete hardstanding external to and inside a former workshop.

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 (or gas if unsaturated) 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 in the immediate vicinity of the site, through which water flow rates are normally significantly higher. No water levels are available for the Dolostone, however the presence of

springs and wells to the south of Site which is topographically lower, indicate groundwater may be issuing at those locations.

The historical imported and quarry waste deposits are granular in nature and likely to have a higher vertical permeability than the underlying Dolostone and the likely more cohesive DfR deposits placed above them. The subsurface nature of the Site means that any precipitation-derived surface water is 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 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 surface water collected in the Quarry Works Site or landfill gas from the historical waste deposits to enter the the landfill to the south. The reverse could also be the case.

An exploratory borehole was drilled through the 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 will be 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.

The prevailing wind direction is from the west-southwest. The Site will retain where possible the semi-mature trees and shrubs that fringe the edge of the quarry void. This will afford some shelter to Site activities from wind crossing the Site.

5.1.3 Receptors

The Site is bounded on its immediate west and north boundary by residential housing. On the immediate eastern boundary is an aggregates distributor along with residential housing and offices. Close to the southeastern boundary is a large commercial warehouse which is part of the much Dale Lane Industrial Estate that extends north and east of the Site. To the immediate south is the restored landfill which currently has not been subject to further development. Southwest of the Site and the landfill is a housing estate.

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. This water may continue to flow toward the Frickley Beck further to the south.

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 therefore be no direct discharges to surface water receptors.

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 and 3a to 3c below 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 purely illustrative.

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 leachate from the existing waste deposits through the lower permeability Dolostone. This 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 or issuing mines gas from the Coal Measures beneath the Site. The green arrows represent gas produced by the existing waste deposits which may travel laterally into the Dolostone directly or potentially be exchanged with the adjacent landfill via the former tunnel.

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 likely more cohesive, low permeability fill above the existing more permeable waste deposits and the enhanced capacity for surface drainage. 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.

Figures 2c and 3c depict the Site during the deposit of waste has been completed with the DfR activity. The additional height of fill does increase the contact between the sides of the quarry and the waste which may influence the movement of gas from the existing and DfR deposits and air ingress into the rock.

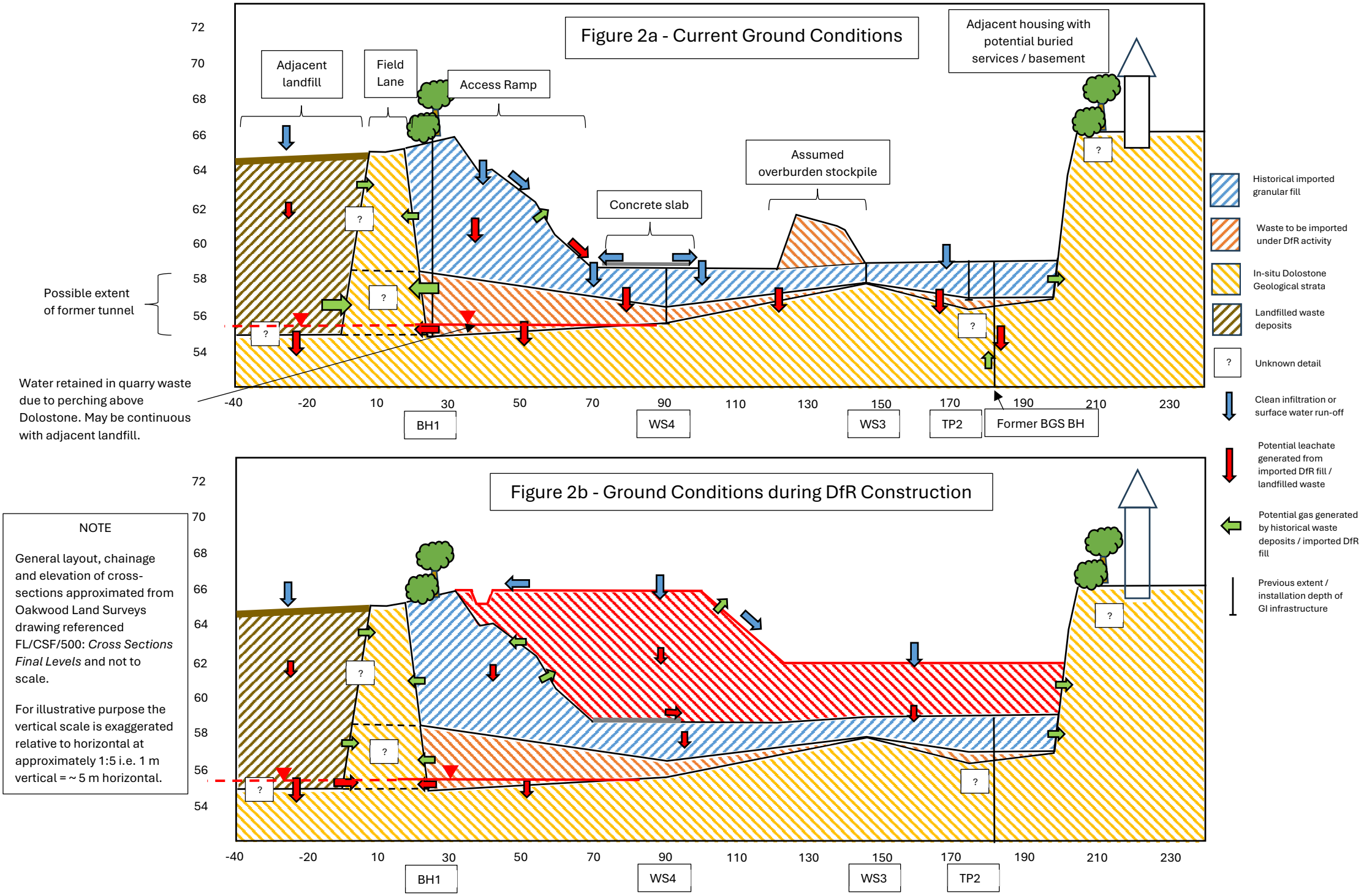


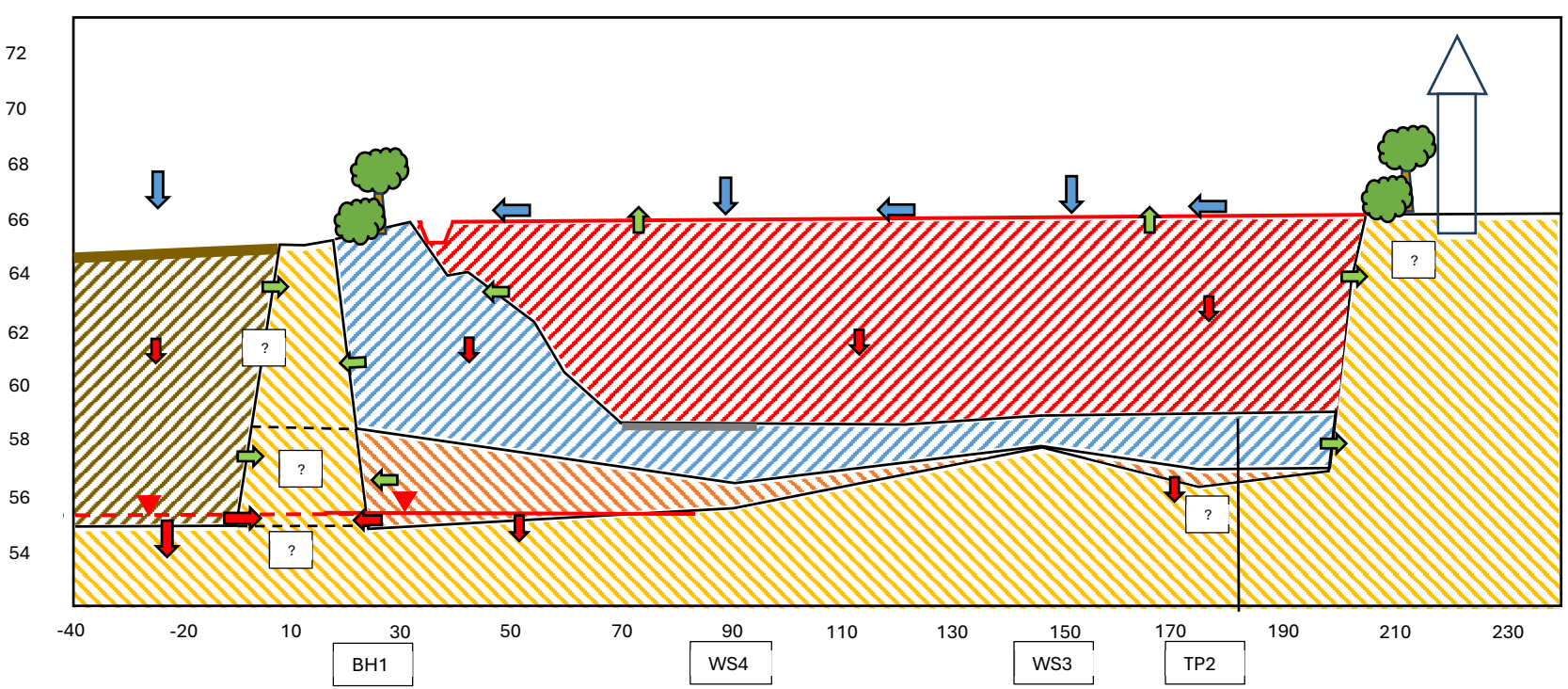
Figure 2a - Current Ground Conditions
Adjacent landfill
Field Lane
Access Ramp
Adjacent housing with potential buried services / basement
Assumed overburden stockpile
Concrete slab
Possible extent of former tunnel
Water retained in quarry waste due to perching above Dolostone. May be continuous with adjacent landfill.
BH1
WS4
WS3
TP2
Former BGS BH
Historical imported granular fill
Waste to be imported under DfR activity
In-situ Dolostone Geological strata
Landfilled waste deposits
Unknown detail
Clean infiltration or surface water run-off
Potential leachate generated from imported DfR fill / landfilled waste
Potential gas generated by historical waste deposits / imported DfR fill
Previous extent / installation depth of GI infrastructure
Figure 2b - Ground Conditions during DfR Construction
NOTE
General layout, chainage and elevation of cross-sections approximated from Oakwood Land Surveys drawing referenced FL/CSF/500: *Cross Sections Final Levels* and not to scale.
For illustrative purpose the vertical scale is exaggerated relative to horizontal at approximately 1:5 i.e. 1 m vertical = ~ 5 m horizontal.

Figure 2c - Ground Conditions post-completion DfR

NOTE

General layout, chainage and elevation of cross-sections approximated from Oakwood Land Surveys drawing referenced FL/CSF/500: *Cross Sections Final Levels* and not to scale.

For illustrative purpose the vertical scale is exaggerated relative to horizontal at approximately 1:5 i.e. 1 m vertical = ~ 5 m



Historical imported granular fill

Waste to be imported under DfR activity

In-situ Dolostone Geological strata

Landfilled waste deposits

? Unknown detail

Clean infiltration or surface water run-off

Potential leachate generated from imported DfR fill / landfilled waste

Potential gas generated by historical waste deposits / imported DfR fill

Previous extent / installation depth of GI infrastructure

Adjacent housing with potential buried services / basement

Figure 3a - Current Ground Conditions

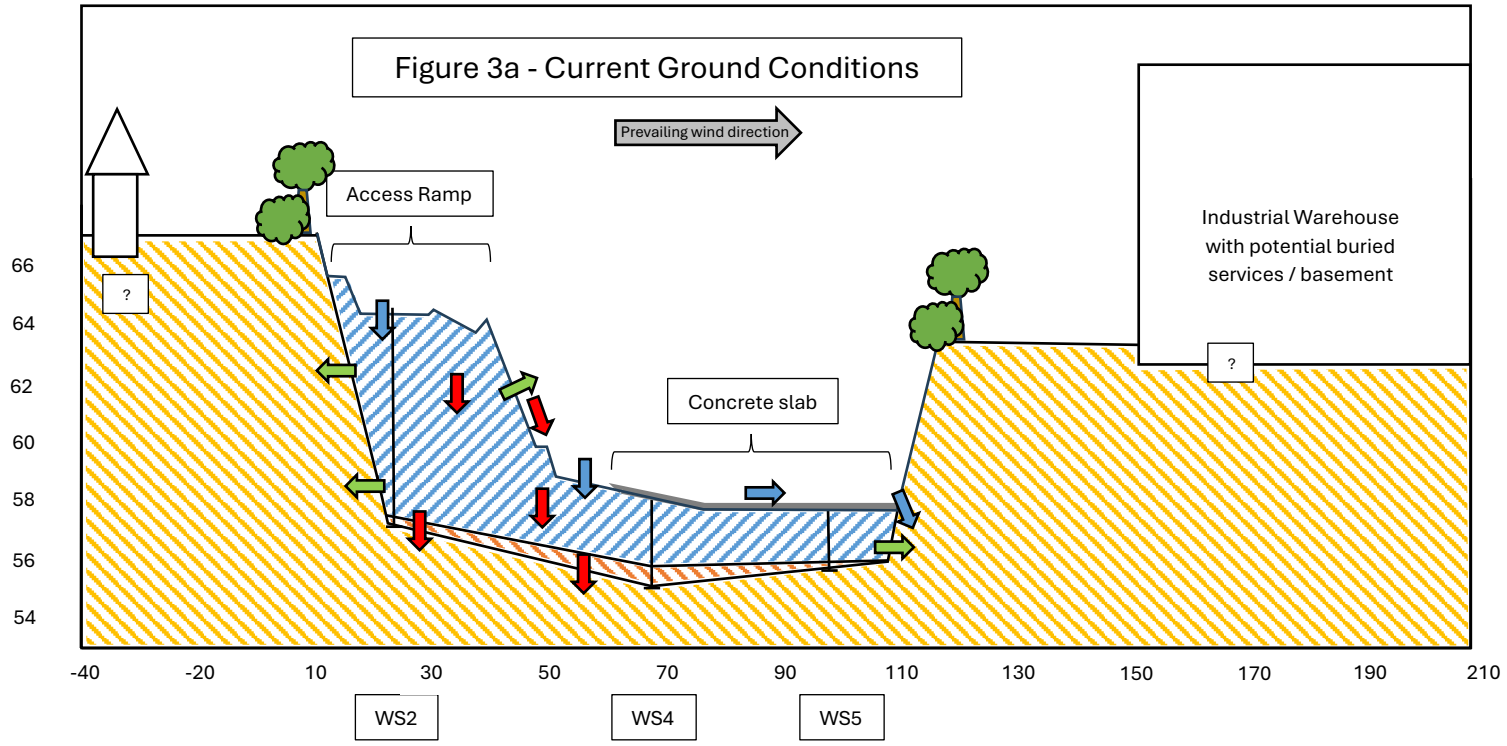
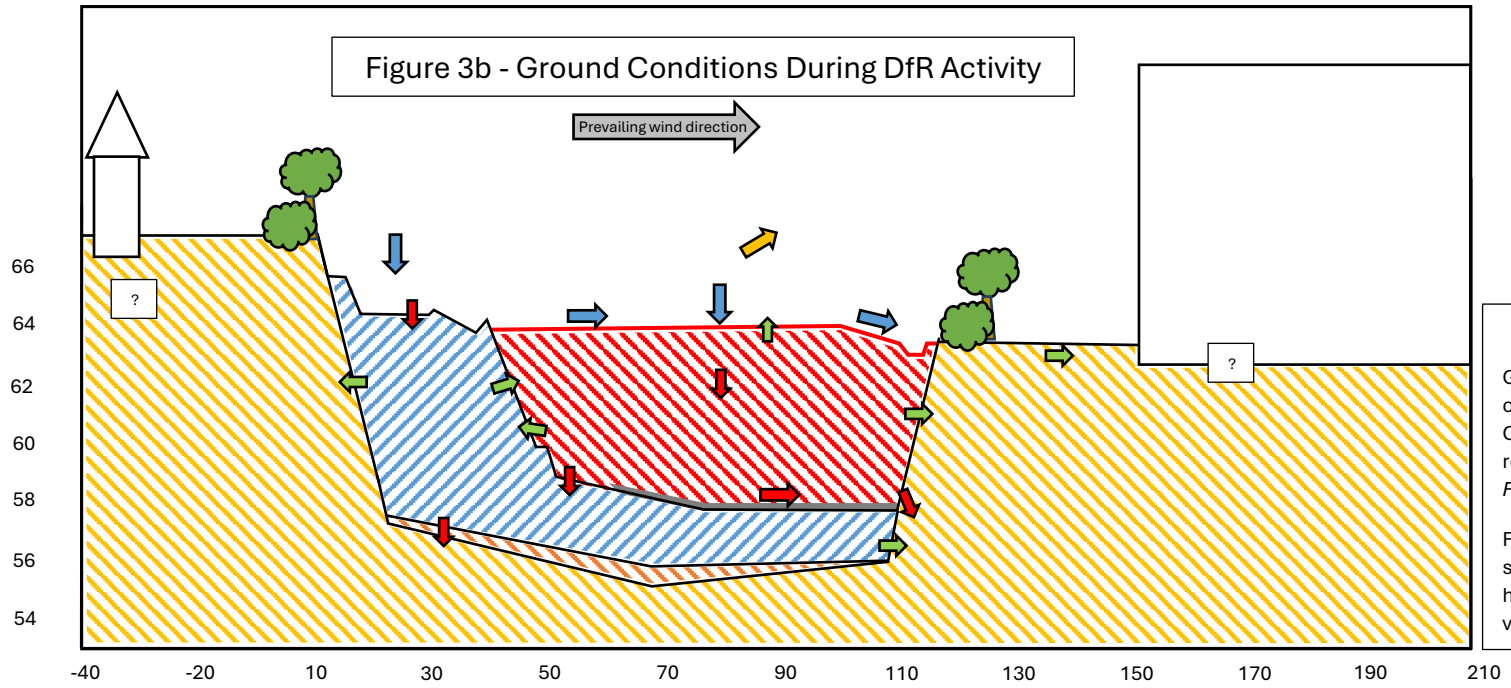


Figure 3b - Ground Conditions During DfR Activity

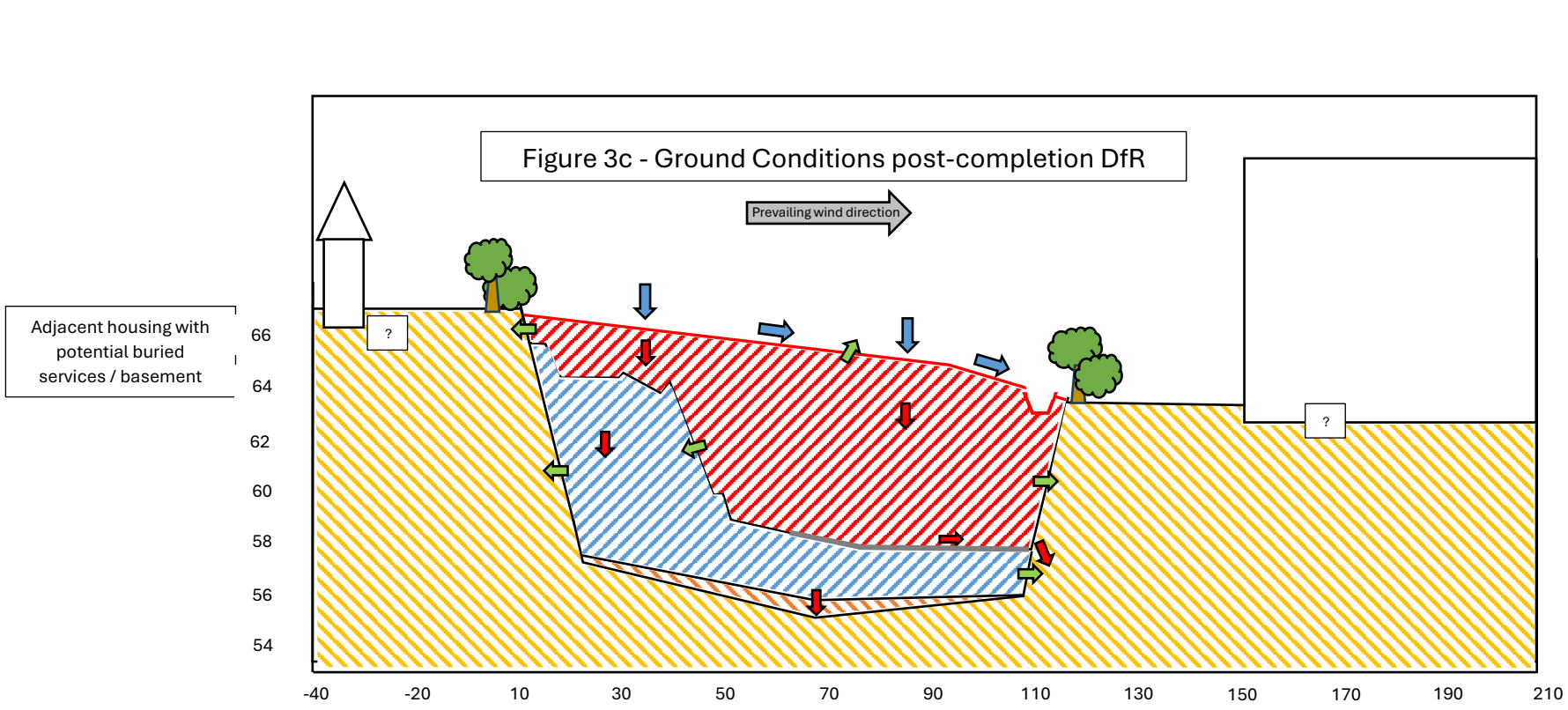


- Historical imported granular fill
- Waste to be imported under DfR activity
- In-situ Dolostone Geological strata
- ? Unknown detail
- Clean infiltration or surface water run-off
- Potential leachate generated from imported DfR fill / landfilled waste
- Potential gas generated by historical waste deposits / imported DfR fill
- Potential dust generated by vehicle activity.
- Previous extent / installation depth of GI infrastructure

NOTE

General layout, chainage and elevation of cross-sections approximated from Oakwood Land Surveys drawing referenced FL/CSF/500: *Cross Sections Final Levels* and not to scale.

For illustrative purpose the vertical scale is exaggerated relative to horizontal at approximately 1:5 i.e. 1 m vertical = ~ 5 m horizontal.



Historical imported granular fill

Waste to be imported under DfR activity

In-situ Dolostone Geological strata

? Unknown detail

Clean infiltration or surface water run-off

Potential leachate generated from imported DfR fill / landfilled waste

Potential gas generated by historical waste deposits / imported DfR fill

Potential dust generated by vehicle activity.

Previous extent / installation depth of GI infrastructure

NOTE

General layout, chainage and elevation of cross-sections approximated from Oakwood Land Surveys drawing referenced FL/CSF/500: *Cross Sections Final Levels* and not to scale.

For illustrative purpose the vertical scale is exaggerated relative to horizontal at approximately 1:5 i.e. 1 m vertical = ~ 5 m horizontal.