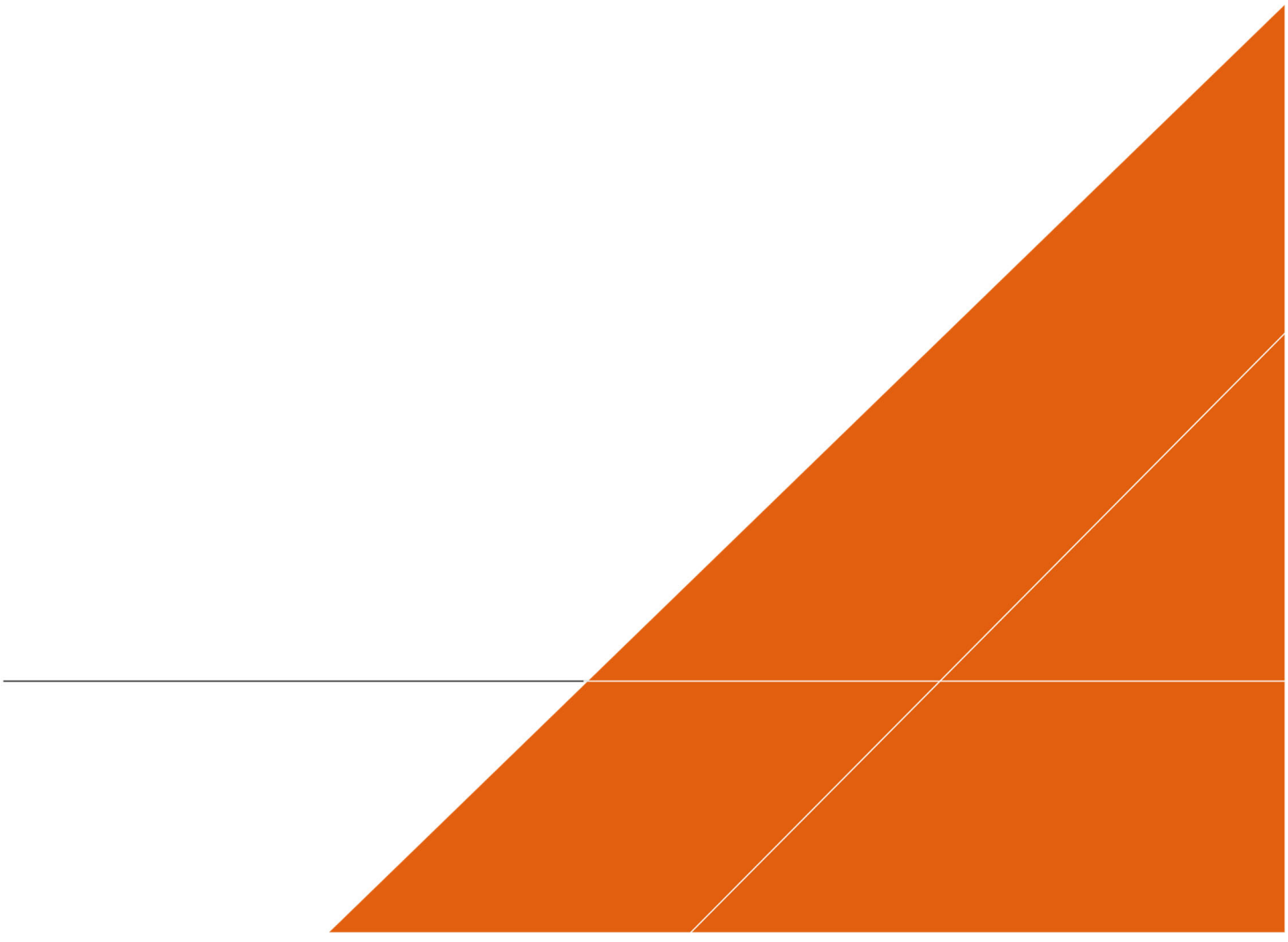
ARCADIS Design & Consultancy for natural and built assets

ENVIRONMENTAL SENSITIVITY AND SITE DESIGN REPORT

Waste Recovery Permit - Deposit for Recovery

Reclamation of the former British Sugar Refinery Site, York

SEPTEMBER 2022



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1 Introduction

Arcadis UK Ltd (Arcadis) has prepared this report in order to summarise the environmental sensitivity and potential environmental risks as well as present the Conceptual Site Model (CSM) in relation to the Former British Sugar Factory, Millfield Lane, York, YO26 6AY (the 'site'). A site location plan is presented as Figure 1.

1.1 Report Context

The site is currently subject to an Environmental Permit (EP) (EPR/QP3593NF) which has been in a state of Definitive Closure since October 2009 until EP variation consolidation in October 2015, when the period of aftercare monitoring & maintenance was commenced.

British Sugar now wish to vary the EP in order to enable waste recovery and remediation activities required to create a development platform for a residential development for which planning permission has been granted (ref: 14/02798/FULM, 15/00523/FULM and 15/00524/OUTM).

A summary of the proposed EP variation is provided below.

1. **Adding land** to the current EP by extending (and including) the current EP boundary. The current and proposed EP boundaries are shown on Figure 2;
2. **Addition of a Bespoke Waste Operation** – specifically a Deposit for Recovery (DfR) waste operation to enable recovery of waste material present within the current EP boundary followed by reuse / deposit of recovered waste across the proposed extended EP boundary as fill to create the development platform;
3. **Adding a R11 recovery code** activity to the permit to allow the 'use of wastes obtained from any of the operations numbered R1 to R10', in this case as fill to create the development platform; and
4. **Changing the Operating Techniques (Table S1.2)** such that aspects of the EP Working Plan (URS, 2015) that were previously excluded and not agreed by the Environment Agency (covering monitoring and permit surrender) are superseded by the testing, monitoring, verification and remediation criteria associated with the waste recovery operation (remediation) and can be agreed.

This ESSD report has been prepared to support the application to vary the EP and the addition of bespoke (DfR) waste operation (DfR) for which a Waste Recovery Plan (WRP) (Arcadis Report Ref: 10024487-AUK-XX-XX-RP-GE-0034-P6-Waste Recovery Plan, September 2022) has been prepared.

2 Environmental Setting and Sensitivity

This section sets out the current and historical context of the site, followed by its environmental setting and sensitivity. The environmental setting is important because the topography, geology, hydrogeology and hydrology of the site are the main factors that influence the way in which contaminants in the soil or groundwater may potentially impact upon receptors.

A review of any previous contamination or ground related assessments, together with details of any existing remedial measures in place across the British Sugar (BS) site then follows.

2.1 Site Details and Development

The site covers an area of 39.7 Ha and the location, boundary and layout is shown on Figures 1 and 2. The approximate centre of the site is located at National Grid Coordinates E 457561 N 453095 (Grid Ref SE 57561 53095). The primary access to the site for the waste recovery works will be from the existing Millfield Lane entrance to the former works or from the newly created road off the A59 through the former school grounds. A secondary access point will be via Plantation Drive although

The site was formerly occupied by the BS refinery which ceased operations in 2007. The site is currently unoccupied, except for personnel managing site security in its closed state. The majority of buildings associated with the site have been demolished. The embankments enclosing the wastewater treatment and the soil settlement ponds and a small number of buildings remain including;

- a building used for site security;
- National Grid electricity substation remaining in the south west end of the site;
- a small meter building in the south west end of the site;
- a small building next to the gas skid where the natural gas came into site; and
- a small store building on the edge of the beet roadway near the settling ponds, currently used for salt storage, in the northern area of the site.

The site now comprises the following main areas;

- The former Northern Wastewater Treatment Plant (NWWTP) area including the Sugar Factory Lime (SFL) (marketed as LimeX) storage area and the Soil Conditioning Area (SCA);
- The former Central Tank Farm area;
- The former Main Factory area;
- The former Southern Wastewater Treatment Plant (SWWTP) area; and
- Additional Areas including the sports field, the former Manor School (FMS) site and the entrance area to the NWWTP, which includes a surface water pond.

The former NWWTP, SFL storage area, SCA and central tank farm areas are located within the boundary of the EP. The former main factory area, SWWTP and Additional Areas are located outside of the permitted area. Figure 2 also shows the extent of the Environmental Permit boundary and location of the main site areas.

It is understood that the demolition works in relation to the FMS were undertaken between March and June 2018 and that the works were undertaken on behalf of CYC (City of York Council) by appropriately qualified contractors.

There are sixteen contemporary trade directories recorded within 500m radius from the site. A further 40 contemporary trade directories are recorded within 500m and 1km radius. The location of relevant environmental and human health receptors to the site are described within this section with active Source Pathway Receptor linkages identified in Section 3.10.

2.2 Historical Development

Reviews of the available historical maps for the BS site have yielded the following information and are presented in the table below:

Review of Historical Maps for BS site

Date	Scale	Description	
		Within Site Boundary	Outside Site Boundary
1850 1855	1:10,560	The BS site appears to be covered with vegetation. The BS site is within the Millfield and Far Field area of York.	The railway line is present along the eastern boundary. Poppleton Lodge is present to the west, York Boroughbridge to the far north-west and Acomb Park to the south-west.
1893	1:10,560	No significant changes are noted	A Post Office is situated to the west and a plantation farm to the south. The Poppleton Lodge is now named the Poppleton Villa. All other features remain unchanged
1910	1:10,560	No significant changes are noted.	The Post Office to the west of the site is no longer present. No other significant changes are noted.
1932	1:10,560	Poppleton Sugar Beet Factory is located in the southern part of the BS site. The Far Field is still located in the northern part. The Ing Cliffs Drain can be seen around the southern boundary of the BS site	A plantation cottage and the Carr Grange is now located to the far south of the site. Millfield Garth located at the northern boundary. No other significant changes are noted.
1952	1:10,560	Two ponds can be seen in the northern part of the BS site. No other significant changes are noted.	Few buildings are now located to the south-west of the site. Yorkshire waterworks and Ouse Acres are now located to the south of the site.
1958	1:10,000	More factory buildings in the southern part of the BS site. No other significant changes are noted.	More buildings located to the southwest and south of the site.

1972	1:10,000	More ponds can be seen in the northern part of the BS site. A tank and other structures present in the centre of the BS site, and more buildings located in the southern area of the BS site.	More structures can be seen outside the western boundary of the site. This includes works, sports ground, bowling green, a school (FMS), tennis court and a hospital. More residential buildings are now located outside the south-west boundary. A garage and works located outside the northern boundary.
1985	1:10,000	Additional ponds can be seen in the northern area of the BS site. Several tanks are present in the centre of the BS site and more factory buildings to cover the southern area.	The number of structures to the west of the site has reduced, although it is still referred to as works. A structure which may have been part of the Creosote works is still present to the south-west of the site.
1992	1:10,000	No significant changes are noted.	No significant changes are noted.
1999	1:10,000	No significant changes are noted.	No significant changes are noted.
2006	1:10,000	No significant changes are noted.	No significant changes are noted.
2014	1:10,000	The BS site is now shown to be without buildings (following the demolition works at the BS site).	No significant changes are noted.

Table 1 Summary of Historical Development

2.3 Proposed Development / Waste Recovery Operation

The waste recovery activities proposed are to be undertaken in accordance with the Remediation and Reclamation Strategy (RRS) (URS, February 2015) which has been reviewed and accepted by the EA Groundwater and Land Contamination (GWCL) Team and is an Approved Plan within the full planning permission granted in relation to the construction of the development platform. An addendum to the 2015 RRS has been produced by Arcadis to incorporate the latest site data (Remediation and Reclamation Strategy Addendum (RRSA), 2020). The scope of works within the RRS (URS, 2015) and RRSA (Arcadis, 2020) which is relevant to the waste deposited within the EP boundary is provided in the Waste Recovery Plan (WRP) and summarised below.

The objective of the RRS (URS, 2015) and RRSA (Arcadis, 2020) is to excavate the deposited waste material and to undertake remediation such that potential risks to future site users and the environment from contaminants in soil, soil pore water and soil gas are mitigated to an acceptable level.

2.3.1 Waste Characteristics

Desk-based studies and investigations indicate that the bulk of the waste is primarily soil derived having been brought to the refinery as farmland soils adhered to the sugar beet. Consequently, the materials are predominantly mixtures of natural clays, silts, sands and gravels with varying proportions of organic matter. The organic matter derives from both the original soil and also from the processing of the beet whereby the vegetation and fibre are separated from the sugar beet.

Also entrained in the waste is “spent lime” in the form of re-precipitated calcium carbonate. Limestone aggregate, comprised essentially of calcium carbonate in mineral form, was brought to the refinery and burnt in a kiln to produce calcium oxide [burnt lime] and carbon dioxide gas. The burnt lime was then slurried in combination with the raw beet juice in solution to balance pH and to clarify the juice. The carbon dioxide gas was then re-combined with the juice so that calcium carbonate re-precipitated out of the mixture along with unwanted impurities. The precipitate was then settled out and filtered from the juice, forming a useful friable particulate by-product known as Sugar Factory Lime (SFL) and marketed as LimeX. The bulk of the SFL was sold as a soil improver. Surplus SFL was also used in combination with soils in landscaping and bund construction on the site. Some of the exploratory hole records from the permitted area indicate that the waste contains “lime” but the material is generally considered to be SFL residue.

Other frequently observed secondary constituents of the waste include fragments of ash, coke / clinker, lime, masonry, sandstone, limestone, concrete, brick, ceramics, wood fragments and metal.

Identified contamination associated with waste types, along with a description of the material is detailed in Section 2.3.2 below.

2.3.2 Waste Types and Volumes

The types of waste deposited within the EP boundary identified during previous site investigations and to be recovered during the reclamation works are listed in the table below which provides a general soil description used within the reclamation strategy, the List of Wastes (LOW) / European Waste Catalogue (EWC) waste code and the EWC description (Guidance on the Classification and Assessment of Waste (1st edition 2015) Technical Guidance WM3'). All wastes listed below are generated entirely from within the site.

General Description	EWC Waste Code	EWC Description	Comments
Granular Made Ground	17 05 (03 / 04)	Soil and stones	Asbestos has been identified in 3 samples in EP boundary
Cohesive Made Ground			
Organic Rich Material	02 04 01	Soil from cleaning and washing beet	Includes current and historic lagoon sediments. Plant remains observed historically in some locations.
Sugar Factory Lime Material	02 04 02	Off-specification calcium carbonate	
Oversized Material	17 01 07	mixtures of, or separate fractions of concrete, bricks, tiles and ceramics	
Recovered Material	19 13 02	solid wastes from soil remediation	soils subject to a remediation process, meeting risk-based criteria and then suitable for re-use in the works, and generated entirely from within the site

Table 2 Waste Types and European Waste Catalogue (EWC) codes

The total quantity of the waste located within the EP boundary requiring excavation and recovery has been modelled and calculated using Geographic Information System (GIS) software based on the 2019 topographical survey and previous site investigation data. This volume is estimated at **746,800m^3** based on the excavation to the base of the Made Ground (i.e. excavation of the entire thickness of waste).

The bulk density of the waste in situ, i.e. including entrained moisture, is variable broadly ranging from about 1.7 – 2.1 tonnes per cubic metre. Using an average of 2.0 tonnes per cubic metre gives an estimated total tonnage of 1,493,600 tonnes.

The reclamation works and WRP rely on a cut-fill balance as a sustainable approach to providing the development platform needed to enable residential redevelopment. Therefore, GIS modelling software has also been used to determine the volume of material required to construction the development platform within the EP Boundary and across the entire site using the elevations and contours defined within 'Proposed Contours -DR-CE-00602 P5' Approved Plan 14/02798/FULM, (presented as Figure 11). The volume of material required to construct the development platform within the EP boundary is estimated to be 513,500m^3 with 446,100m^3 required to construct the development platform outside the EP boundary.

Therefore, in order to construct the required development platform across the site, it is proposed to permanently deposit **513,500m^3** of recovered waste within the current EP boundary with the remaining **233,300m^3** of recovered waste proposed to be permanently deposited on site outside the current EP boundary. Made Ground soils located outside the current EP boundary are proposed to be reused under the CL:AiRE DoWCOP framework to make up the remaining volume of required construction fill (212,800m^3).

3 Pathway and Receptor

3.1 Previous Investigations

A large number of previous Arcadis and third-party site investigation, monitoring and assessment activities have been undertaken at the site which are listed below and summarised within this section.

- Additional Ground Investigation Factual Report, 10024487-AUK-XX-XX-RP-GE-0032-01, Arcadis, March 2020;
- Updated Hydrogeological Risk Assessment Report, 10024487-AUK-XX-XX-RP-GE-0020-01, Arcadis, January 2020; and
- Ground Investigation Factual Report, 10024487-AUK-XX-XX-RP-GE-0015-01, Arcadis, August 2019.
- British Sugar Stabilisation Trials, Laboratory Bench Scale Mix Design Study, CE Geochem, Report A190504, November 2019;
- Quarter 2 2019 Gas and Groundwater Permit Monitoring Factual Report, Golder Associates (UK) Ltd, 2019;
- EP Annual Monitoring Reports, Golder Associates, 2015 to 2019;
- Outline Construction Environment Management Plan (Version 1.1), June 2017;
- Remediation and Reclamation Strategy – Final, URS (AECOM) February 2015;
- Surrender Pre-Application Advice Letter (EAWML68681), EA, 28th August 2015;
- Notice of Variation and Consolidation Document (EPR/QP3593NF/V002), 14th October 2015;
- Environmental Permit Variation: Working Plan (47068825), URS, August 2015;
- URS (2013) Summary Report for Ground Gas and Groundwater Data, 2006 – 2012, British Sugar Former Factory site, York for ABF;
- Factual Report on Ground Investigation: Ian Farmer Associates Limited (2010) Associated British Foods - British Sugar York site - August 2010: Contract No:W10/40642;
- British Sugar Factory York: Factual Vendor Due Diligence Report: Golder Associates (UK) Ltd, April 2010: Ref. 09514540114.500/A.0;
- Definitive Closure Management Plan – Annual Reports, Golder Associates, 2010 to 2014;
- Phase II Geotechnical and Geo-environmental Assessment report (Scott Wilson, 2010);
- Phase III Geoenvironmental Remediation Options Appraisal, Scott Wilson, December 2010;
- Geotechnical and Geo-environmental Audit of Available site Information: Scott Wilson Ltd, August 2009;
- Definitive Closure Report for Waste Management Licence NYCC/028, Golder Associates, July 2009;
- Preliminary Geotechnical Considerations Non-Technical Summary: Golder Associates (UK) Ltd , December 2008: Ref.08514540111.504/B.1;
- Preliminary Report on Intrusive site Investigation of Northern and Southern Waste Water Treatment Plant Areas: British sugar Factory, York: Golder Associates (UK) Ltd, October 2008: Ref. 08514540111.500;
- York Sugar Factory: SPMP Reporting: Assessment of Groundwater and Gas Reference Data - Final: Enviros Consulting Ltd, March 2008;
- Further Assessment of Potential Risks Posed by Soil Gas to Residential Properties on the Western Boundary of the York Sugar Factory: Enviros Consulting Ltd, October 2007; and
- York Sugar Factory: SPMP First Phase Reporting: Assessment of Reference Data: Enviros Consulting Ltd, August 2006.

3.2 Geology

3.2.1 Descriptions of Waste / Made Ground within the EP Boundary

Made Ground in the former NWWTP generally comprises clayey/silty gravelly sand and (occasionally clayey sandy) gravel (with occasional cobbles), with occasional soft to firm (locally very soft) silty, sandy and gravelly horizons of silt and clay. Deposited waste of this description was primarily associated with lagoon bund material and other raised areas across the NWWTP.

Notable variations are evident in the boreholes and trial pits undertaken in the SCA and bases of the existing and historical ponds where Made Ground generally comprises of very soft and soft (occasionally firm) dark brown and black clayey/silty, sandy, occasionally gravelly, organic rich clay or silt with infrequent clayey/silty sand and gravel bands. Plant remains and rootlets have been observed in these areas. This organic rich material is a significant focus for the remediation strategy.

Discrete horizons of SFL residue described as “creamy white chalky silt” or “weathered chalk/silt” were also identified within the SCA and other localized areas of bund material across the NWWTP.

Made Ground in the central tank farm generally comprises of grey and brown (locally black, orange, red, yellow/white/cream), (occasionally clayey/silty gravelly) sand and (occasionally clayey/silty sandy) gravel (with occasional cobbles and boulders), with occasional very soft and soft (locally stiff, firm and very stiff) silty, sandy and gravelly clay (locally silt) horizons.

3.2.2 Solid and Drift Geology

The BGS solid and drift geological map for York (Sheet 63) 1:50,000 indicates that the site is underlain by Glaciofluvial Deposits (Sand and Gravel). A small fraction of the BS site in the southeast area is underlain by Alluvium, Lacustrine clay (lake derived) and Warp (sediments allowed to settle out of estuarine water to produce agricultural land) formations.

The Scott Wilson (2010) ground investigation indicates that the thickness of the superficial deposits of the BS site varies between 12.9m and 29.0m. These strata are referred to collectively as the natural superficial deposits in the Remediation and Reclamation Strategy Addendum (Arcadis, April 2020).

The borehole logs from BS site investigations show that the natural superficial deposits beneath the Made Ground was generally found to be consistent with the published geology of the area and included generally firm (locally soft) sandy clay, or loose to medium dense granular deposits of sand, gravel, or combinations of both. The exception to this was an area of very soft organic rich clay or fibrous peat which was encountered at the southernmost area of the site.

The previous ground investigation by Scott Wilson (2010) indicated that the upper section of the natural superficial deposits are often cohesive and this suggests that the Warp layer is most likely at the top of the deposits underlain in turn by the lacustrine clay and glacial drift deposits. Granular and cohesive deposits are inter-bedded as sand and gravel and clay.

The BGS drift geological map for York (Sheet 63) 1:50,000 indicates that the underlying solid geology for the site, is comprised of Sherwood Sandstone Group (Sandstone). This formation was described as Sandstone, red, yellow and brown, part pebbly, subordinate red mudstone and siltstone.

3.3 Hydrology

3.3.1 Surface Water Features

The hydrological features within the site boundary are the soil settling ponds and the wastewater treatment ponds located in the NWWTP area of the site. The main surface water features in the vicinity of the site is the River Ouse, which ranges between 200m and 550m to the east, and the Ing Cliffs Drain, which is currently

culverted where it crosses the site. The River Ouse is also the closest watercourse monitored by the EA. The Ing Cliffs Drain, which runs through the site, is not monitored by the EA.

The Historic River Quality Scheme used by the EA classifies this watercourse as Chemistry Grade A and Biology Grade B under the General Quality Assessment (GQA). However, under the River Basin Management Plan (RBMP), the Current Ecological Quality of the River Ouse from River Nidd to Stillingfleet Beck has been classified as 'Moderate' (latest classification available from 2016). Whilst the Current Chemical Quality has been classed as 'Fail'. The 'fail' classification is due to presence of 'Priority Hazardous Substances' tributyltin compounds.

The Envirocheck report indicates that there are three surface water abstraction points from the River Ouse identified within 500m of the site. These abstractions are licensed to Yorkshire Water Services Ltd for potable public water supply. These abstraction licences are associated with the Yorkshire Water Treatment Works at Acomb Landing.

Water treatment at Acomb Landing has been carried out since the nineteenth century. This section of the river is in a Surface Water Drinking Water Protected Area and it is said to be 'at risk'. The term "at risk" in this case refers to the risk of deterioration of the raw river water resulting from the land use through which the river flows including land upstream of the abstraction point. The land at and upstream of the abstraction is currently used for a variety of uses including agriculture and, railways. The point of abstraction and the river banks along the stretch of river both upstream and downstream are prone to periodic flooding which could also lead to deterioration of the quality of river water.

The site is not located within a nitrate vulnerable zone.

3.3.2 Ecological Importance of Watercourses

The Current Ecological Quality of the River Ouse from River Nidd to Stillingfleet Beck has been classified as 'Moderate' (latest classification available from 2016).

The Clifton Ings and Rawcliffe Meadows site of Special Scientific Interest (SSSI) is located adjacent to the opposite bank of the River Ouse to site approximately 240m east from the site boundary. This SSSI area is also identified within the Priority Habitat Inventory as a Coastal and Floodplain Grazing Marsh

3.3.3 Surface Water Quality

The EA River Basin Management Plans for Humber River Basin District (December 2015) classifies the current quantitative status of 38/51 the district's underlying bedrock groundwater bodies as 'good' (13/51 'poor') and the current chemical status of 26/51 groundwater bodies to be 'good' (25/51 'poor'). The poor groundwater chemical status is a result of the Drinking Water Risk Status for the groundwater which is designated as "At Risk". The quantitative and chemical status objectives set for the 51 groundwater water bodies in the river basin district include 44 water bodies have an objective of maintaining or aiming to achieve good quantitative and chemical status between 2015 and 2027 (or beyond) and 7 water bodies have already achieved their objective of poor quantitative status (a less stringent objective).

Potential sources of contamination to surface water are discussed in Sections 3.7 and 3.8.

3.3.4 Flood Risk

A Flood Risk Assessment and Drainage Strategy Report (Report Ref: 60470111(47068101), AECOM, January 2017) was produced to support planning permissions listed in Section 1.1. The residential area of the site is within Flood Zone 1 – Low Risk and the type of development was considered appropriate for the site. Only areas of public open space will fall within the small area of Flood Zone 2 – Medium Risk on the site, and the type of development was considered appropriate in these areas. Modelling of the watercourse demonstrates that the additional discharge from the development will have an insignificant impact on the risk of flooding to properties off site. Therefore, it was considered the proposed rate and discharge location is appropriate for the development.

3.4 Hydrogeology

3.4.1 Aquifer Characteristics

The Glaciofluvial Deposits present beneath the site are classed by the EA as a Secondary A aquifer. Secondary A aquifers are defined as “permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers”. The groundwater vulnerability for the site is shown mainly as Minor Aquifer High.

The underlying bedrock of the Sherwood Sandstone Group is classified as a Principal aquifer. According to the EA, Principal aquifers are defined as “layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifers.”

It is noted that there are no potable groundwater abstractions within 1km of the site, there are no SPZ located within 5km of the site and groundwater ultimately discharges into the River Ouse. Based on this, SPZs will not be considered as potential receptors within this assessment. Two historical groundwater water abstractions are recorded within the BS site boundary in the Landmark Envirocheck Report and were both licensed to British Sugar. These have been revoked and the boreholes decommissioned and capped off.

The Ings Drain and the Principal Aquifer (Sherwood Sandstone) are not considered to be in hydraulic continuity with groundwater in the shallow Secondary A Aquifer and as such, are not considered to be significant receptors. In addition the SSSI located on the adjacent side of the River Ouse has not been considered a significant receptor in relation to the site as it is anticipated that groundwater will discharge into the River Ouse.

Key hydrogeological parameters are considered within the Hydrogeological Risk Assessment (HRA) provided within Appendix 4 of the B4 application form in support of the Waste Recovery Permit application.

3.4.2 Groundwater Flow

During previous intrusive investigations (Enviros 2008, URS 2015 and Arcadis 2019), groundwater has generally been encountered within the superficial deposits, with an additional groundwater strike encountered where intrusive holes were progressed into the bedrock (URS 2015). The depth to groundwater across the site varies due to the differing topography, while groundwater is indicated to flow towards the River Ouse in a north-easterly direction.

The most recent groundwater monitoring programme available at the time of review was undertaken by Golder Associates in 2018 and 2019 (Quarter 3). The Golder Associates environmental monitoring activities are to continue until the remediation and reclamation works commence.

Recovered waste will be permanently deposited above the resting groundwater table which is within the underlying superficial deposits.

3.4.3 Groundwater Quality

Data provided as part of the 2018 EP Annual Monitoring Report (Golder Associates, 2018) showed that groundwater levels recorded ranged from 9.97 to 17.97m AOD and 1.18 to 16.25m bgl with this representing more variance than observed in previous years. Long term trends in the ammoniacal nitrogen concentrations in groundwater sampled from wells located on-site were generally stable with trends in down gradient wells generally stable or decreasing (with the exception of GA-GW04 which showed an upwards trend although this has been decreasing since September 2018).

Further discussion of groundwater quality is provided in Section 3.10.4.1 with respect to Nickel.

No previous remediation works have been undertaken at the site.

3.5 Manmade Subsurface Pathways

The majority of buildings associated with the site have been demolished. The embankments enclosing the wastewater treatment and the soil settlement ponds and a small number of buildings remain as listed in Section 2.1. It is understood that the demolition works in relation to the FMS were undertaken between March and June 2018 and that the works were undertaken on behalf of CYC by appropriately qualified contractors. The majority of above ground infrastructure associated with former site operation is understood to have been removed. Demolition reports indicate that while asbestos cable ducts were removed in several locations it is anticipated that the majority of subsurface site drainage remains present. It is noted that drainage runs are likely to be located within the Made Ground above the resting groundwater present within the underlying superficial deposits and therefore not likely a significant pathway for contaminant migration.

The Ing Cliffs Drain is currently culverted where it crosses the site.

3.6 Current Geotechnical Condition

The geotechnical properties of the shallow soil is described in detail in multiple previous reports, including the 2015 RRS, and so a concise summary of the additional information gathered by Arcadis is provided below.

3.6.1 Moisture Content

A key factor determining the geotechnical properties of a soil is related to the soil's moisture content. For a given soil, a maximum degree of compaction can be achieved by compacting the soil at the Optimum Moisture Content (OMC). If the soil is compacted at lower or higher moisture content than the OMC, it will not be possible to adequately compact the soil, and issues such as long term settlement may occur. Typically soils with a natural moisture content of more than 4% above OMC require some form of improvement before they can be reused as earthworks fill.

For this reason OMC and natural moisture content testing data was obtained for a further 20 samples from across the site. OMC for the main soil types tested showed little variation and ranged from 11 to 15%, however natural moisture content ranged widely from 14 to 94%, with the higher moisture contents all being recorded within the soil conditioning area mound.

A sample of lagoon sediment (considered atypical of the main soil types on site) was found to have a natural moisture content of 133% and an OMC of 13%. The moisture contents are calculated on a % dry weight basis and so moisture contents >100% are possible.

3.6.2 Subsurface Obstructions

A number of subsurface obstructions were recorded on the demolition plans for the site, and Arcadis undertook trial pitting and trenching to target a number of these locations to confirm the current condition of these structures. The following significant features were encountered:

- Beet Reception Building basement- concrete base slab and basement walls encountered beneath main factory area. The location and extent were consistent with the demolition records.
- Central Tank Farm- redundant piles were encountered at the location of three of the former tanks. The locations were consistent with the demolition records

The following obstructions were also encountered at locations not identified within the demolition records:

- Former tank base west of weighbridge building. An extensive concrete foundation was encountered at approximately 1m depth, west of the current weighbridge. Ordnance Survey maps from 1957 suggest this may be associated with a former above ground storage tank, the date of demolition of which is unknown. The records indicate that the tank base may be in the order of 35m metres diameter.

- Former Manor School site. Concrete slab and shallow strip foundations encountered at location of former school building (outside of area covered in demolition records.
- Localised minor structures (strip footings/masonry walls) were encountered beneath the main factory site- these are assumed to be related to early phases of development at the site.

3.7 Soil Contamination

A number of detailed site investigations have been undertaken between 2006 and 2019. The combined exploratory hole locations from all summarised ground investigation reports are presented on Figure 3. The scopes of the respective investigations are summarised in Table 1.1 of the 2015 RRS.

Based on the information obtained on ground conditions and soils chemistry provided by the previous ground investigations, sources of contamination in soils, soil leachates and ground gas have been identified. Arcadis have undertaken additional ground investigation works since the production of the 2015 RRS (Arcadis Report Ref: 10024487-AUK-XX-XX-RP-GE-0015-01, August 2019).

The results of all previous third party investigations and recent works undertaken by Arcadis have been digitised and imported into an ESdAT database system which enables more effective data management and automated comparison to selected threshold values as well as supporting a Geographical Information systems (GIS) model created to visualise and conceptualise environmental data and material volumes for remediation.

3.7.1 Total Petroleum Hydrocarbons

The distribution of Sum Total Petroleum Hydrocarbons (TPH) concentrations (C_5 to C_{35}, aliphatic and aromatic hydrocarbons) measured within site soils during previous phases of investigation, as well as during the 2019 Arcadis Site Investigation, are shown on Figure 4.

Measured concentrations were compared against the Soil Remedial Target Value (RTV), provided within the 2015 RRS and reproduced for reference in the Table 7 of the Arcadis updated 2020 RRSA, in order to assess the requirement for remediation of identified TPH contamination.

The RTV for certain aliphatic and aromatic TPH fractions also include theoretical soil saturation limits which indicate where a measured soil concentration, if above this limit, may be indicative of the presence of free phase hydrocarbon (i.e. oil or fuel present within soil pores). Therefore, where soil concentrations were measured above the soil saturation limit additional review of visual and olfactory evidence of free phase hydrocarbons (recorded on exploratory trial pit and borehole logs) was undertaken to assess whether free phase hydrocarbons were indeed likely to be present. If there were no observations indicative of free phase liquid and TPH concentrations in soil were measured below the RTV then soil at this depth / location was not considered to require remediation for TPH.

Hydrocarbon compounds defined as volatile or non-volatile are listed in Table 5.8 of the 2015 RRS. Three exceedances of a ‘volatile’ (<C16) petroleum hydrocarbon were identified within soil sampled from GA-GW11, GP-TP02A and GA-TP03A.

Additional site investigation works undertaken by Arcadis in 2019 were specifically designed to address data gaps identified within the available site data and, therefore, further delineation of the six previously identified hotspots was undertaken. Locations of exceedances of RTVs as well as locations were free phase hydrocarbons were likely to be present (also marked as an exceedance) were used to further delineate TPH hotspots as shown on Figure 4.

The petroleum hydrocarbon fractions identified within site soils generally comprised C_{12} to C_{35} range hydrocarbons corresponding with relatively low volatility, diesel range and heavier hydrocarbon fuels rather than gasoline with more volatile hydrocarbon compounds such as benzene, toluene, ethylbenzene and xylenes (BTEX) rarely measured above laboratory method detection limits.

3.7.2 Polycyclic Aromatic Hydrocarbons

The distribution of Sum Polycyclic Aromatic Hydrocarbons (PAHs) (USEPA 16 compounds) concentrations measured within site soils during previous phases of investigation, as well as during the 2019 Arcadis Site Investigation are shown on Figure 5.

Measured concentrations were compared against the RTVs, provided within the 2015 RRS and reproduced for reference in Table 7 of the 2020 RRSA in order to assess the requirement for remediation of identified PAH contamination. The RTV for individual PAH compounds are dependent on the organic matter content of the soil sample collected and so, where available the Total Organic Carbon (TOC) and Fraction of Organic Carbon (foc) data has been reviewed to determine the appropriate RTV.

This comparison identified isolated exceedances of individual PAH compounds within shallow (<1m bgl (below ground level)) soils collected from 5 locations located across the Main Factory area (SW-TP24, SW-TP31, SW-WS01, GA-TP26C, and GA-GW12). A review of soil descriptions associated with these exceedances recorded on third party exploratory logs indicates these PAH exceedances were frequently associated with sand and gravel Made Ground where ash and bituminous material were noted to be present.

Exceedances of RTVs were previously (2010) measured for Benzo(a)pyrene, Dibenzo(a,h)anthracene and Indeno(1,2,3-cd)pyrene in two sediment samples obtained from the north western pond (SW-GS1 and SW-GS2), however, PAHs concentrations in sediment samples collected by Arcadis in 2019 were below laboratory Method Detection Limits (MDL).

3.7.3 Asbestos

The 2015 RRS noted that asbestos (chrysotile / amosite) was recorded in samples from two locations in the southern half of the site. Further data review by Arcadis identified that these samples were SW-WS23b (1.0m bgl, Chrysotile asbestos) located in the Southern WWTP (AA4a) and SW-WS01 (shallow, Amosite asbestos) located in the southern west of the Main Factory area.

Further investigation undertaken by Arcadis in 2019 identified Asbestos Containing Material (ACM) (Amosite asbestos) within two locations; AUK_TP04 located in the Playing Fields area and AUK_TP24 located in Historic Pond 7. In addition, free asbestos fibres in soil (Chrysotile) were detected in AUK_BH04 located in the SCA as well as in AUK_TP33 (Amosite, Chrysotile and Crocidolite) located in the Northern WWTP area.

In addition, asbestos, present as free fibres, was identified in soil sampled from AUK_BH202 at depths of 1.0-1.5m bgl and 4.0-4.5m bgl during additional ground investigation works to install two perimeter wells undertaken by Arcadis in March 2020.

3.8 Soil Leachate Contamination

3.8.1 Ammoniacal Nitrogen

The distribution of ammoniacal nitrogen (reflective of both ammonia and ammonium) concentrations measured within site soil leachates during previous phases of investigation, as well as during the 2019 Arcadis Site Investigation, are shown on Figure 6.

The derivation of the ammoniacal nitrogen RTV for soil leachates using the Remedial Target Methodology (RTM) has been described within the 2015 RRS with a Tier 3 assessment undertaken to assess the fate of ammoniacal nitrogen in leachate and groundwater under the aerobic conditions identified to be present.

Additional sensitivity analysis was conducted in response to previous EA comments and included within the revised 2015 RRS. A review of these RTVs was undertaken by Arcadis as part of the updated Hydrogeological Risk Assessment (HRA) (Report Ref: 10024487-AUK-XX-XX-RP-GE-0020-01, 2020) which considered these RTVs to be supportive of achieving the Site Specific Assessment Criteria (SSAC) for the protection of groundwater and thus provide an appropriate level of source reduction.

Measured concentrations were therefore compared against the soil pore water RTVs provided within the 2015 RRS which were defined based on Averaging Areas shown in the table below and on Figure 6.

Averaging Area	RTV for Leachate* (mg/L)
AA1a	46
AA1b	12
AA2	3
AA3a	5
AA3b	2
AA4a	2
AA4b	26

* the variation in RTV values is due to the differing distances to the receptor (River Ouse) and the variation in the length of each area.

Table 3 Soil Pore Water (Leachate) Remediation Target Values (RTV) for Ammoniacal Nitrogen

The distribution of elevated ammoniacal nitrogen concentrations, the locations of soil pore water RTV exceedances and well as soil descriptions and observations recorded within exploratory logs indicate that ammoniacal nitrogen contamination is strongly associated with Organic Rich Material historically deposited within the North West area (including the northern WWTP) and the southern WWTP. The average and maximum concentrations of ammoniacal nitrogen in soil leachate from Averaging Areas AA1a and AA1b (corresponding to the majority of the NWWTP area) are 27.8mg/L and 125mg/L (AA1a) and 22.2 mg/L and 67.2mg/L (AA1b), respectively.

Isolated exceedances of the soil pore water RTV were identified within Made Ground outside the NWWTP and SWWTP and these locations have been identified as ‘hotspots’ on Figure 6.

3.8.2 Metals and Metalloids

Localised exceedances of Environmental Quality Standard (EQS) values of a number of metals and metalloids have been recorded within a small number of soil leachate samples. The contaminants noted include arsenic, copper, manganese and zinc. However, these contaminants are not considered to present any unacceptable risk to environmental receptors due to their localised nature as well as the fact that the mean concentrations of these contaminants were all below their corresponding EQS value. Arsenic, copper, manganese and zinc in soil leachate are, therefore, not considered to require remediation. Additional assessment of Nickel has been undertaken by Arcadis as part of the Updated HRA (Report Ref: 10024487-AUK-XX-XX-RP-GE-0020-01, January 2020) as described in Section 3.10.4.1 and also is not considered to require active remediation.

3.9 Ground Gas Regime

Ground gas monitoring from a network of borehole standpipes across the site has been conducted since September 2008 and remains ongoing at the time of writing. Ground gas monitoring has comprised the measurement of carbon dioxide (CO_2), methane (CH_4), oxygen (O_2), carbon monoxide (CO), hydrogen sulphide (H_2S) and gas flow rate during the monitoring period. Based on the results of this monitoring it is considered that methane and carbon dioxide are the principal gases of concern in relation to the proposed development.

Additional ground gas data has been collected on a monthly basis and reported quarterly since the 2015 RRS was produced which has been reviewed to update the previous assessment of the ground gas regime detailed within the 2015 RRS report (as well as fulfil Environmental Permit monitoring requirements).

For the 2020 RRSA, the borehole flow rate and gas concentrations for carbon dioxide (CO_2) and methane (CH_4) have been compared to guidance values given in the following documents:

- BSI Standards Publication "Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings", BS 8485:2015+A1:2019
- CIRIA Report C665 "Assessing Risks Posed by Hazardous Ground Gases to Buildings", 2007; and
- NHBC "Guidance on Evaluation of Development Proposals on Sites where Methane and Carbon Dioxide are Present" 2007.

Reference has also been made to the following UK publications;

- Contaminated Land: Applications in Real Environments (CL:AIRE) Research Bulletin RB17 (RB17) – A Pragmatic Approach to Ground Gas Risk Assessment, 2012; and
- NHBC Technical Extra, Issue 20, April 2016.

3.9.1 Assessment of Current Ground Gas Conditions

Ground gas data collected by Golders as part of the monthly EP monitoring undertaken between 2010 and 2019 has been collated, digitised and reviewed within a Power BI Dashboard to facilitate data and trend analysis. Full details of this assessment are provided in the 2020 RRSA and summarised below.

- Assessment of the ground gas regime demonstrates a significantly improved situation compared with the previous assessment during production of the 2015 RRS.
- A wide range of ground gas monitoring results have been obtained at the site. Some areas on the site (especially in the northern half) contain elevated concentrations of methane and carbon dioxide, whereas others contain low concentrations. The distribution of higher concentrations is highly variable;
- The elevated gas concentrations are present as a result of the presence of relatively higher concentrations of Organic Rich Material in the Made Ground;
- Based on data available at the time of review (January 2018 to April 2019) a Characteristic Situation of CS2 is considered appropriate in relation to both methane and carbon dioxide. NHBC classification based on the same data set and including further consideration of elevated gas concentrations determined two locations classified an Amber 2 and a further three locations classified as Amber 1. These were located within Historic Pond 7 and the SCA. All other ground gas monitored location monitored were classified as Green, with no locations classified as Red under the NHBC traffic light classification; and
- Trend analysis shows that since 2015, maximum concentrations of methane and carbon dioxide have remained generally stable while total gas flow rates have significantly decreased (maximum 0.4L/hr). This is considered to reflect continued degradation of organic matter within deposited materials and associated reduction in the quantity of ground gas generated;

The distribution of NHBC traffic light ground gas classifications are shown on Figure 7.

3.10 Receptors and Compliance Points

3.10.1 Conceptual Site Model

Figure 8, originally presented within the 2015 RRS, shows the figurative Conceptual Site Model for the pre remediation works scenario. Figure 9, presents the figurative CSM for the post remediation works scenario (2015 RRS).

The CSM for the site has not significantly changed following additional phases of work by Arcadis and these CSM drawings are considered to remain appropriate.

An updated CSM was produced as part of the Update HRA (Arcadis, 2019) in relation to groundwater and water resource receptors which is presented in Figure 10 which complements previous CSMs which focus on contaminants within the Made Ground.

3.10.2 Active Pollutant Linkages – Wastes / Soils

The following Source Pathway Receptor (SPR) pollutant linkages are considered active in relation to the site and, therefore, requirement management (e.g. via active remediation or other controls during earthworks) to address potential risks:

- PAHs in Made Ground identified in localised hotspots across the Main Factory area and Southern WWTP and the potential human health risks to future on-site residents associated with exposure by direct contact and/or plant uptake;
- TPHs in Made Ground identified in localised hotspots across the Main Factory area and Southern WWTP and the potential human health risks to future on-site residents associated with exposure by inhalation, direction contact and/or plant uptake;
- Asbestos present within ACM or free fibres in soil located in localised areas across the site and potential human health risks to future residents and/or construction workers due to inhalation of dust and/or free asbestos fibres;
- The degradation of Organic Rich Material within Made Ground located primarily within the Northern and Southern WWTP areas have the potential to generate ground gas (carbon dioxide and methane) representing a potential risk to future on-site residents and residential dwellings via inhalation and explosion;

The monitoring and management of potential odour and dust generation during works will be undertaken to protect construction workers and off-site residents.

3.10.3 Additional Pollutant Linkages Considered - Groundwater

The following SPR linkage is also proposed to be addressed as part of the remediation works

- Ammoniacal nitrogen, representative of ammonia and ammonium, associated with Organic Rich Material in Made Ground leaching from Made Ground to groundwater and subsequent migration within the Secondary (A) aquifer (superficial deposits) to the River Ouse.

The previous Tier 3 risk assessment and sensitivity analysis undertaken by AECOM as part of the 2015 RRS as well as the updated Hydrogeological Risk Assessment (HRA) (Arcadis, January 2020) both included detailed assessment of the potential environmental risks posed by ammoniacal nitrogen. The updated HRA concluded that measured concentrations of ammoniacal nitrogen in groundwater were not identified in excess of the updated SSAC derived for the protection of the Secondary A Aquifer or the River Ouse. As such, measured concentrations of ammoniacal nitrogen were not considered to represent a significant risk to water resources.

Therefore, while active remediation works will be undertaken with respect to Made Ground soils in order to reduce the concentrations and leachability of ammoniacal nitrogen this will be for the purposes of 'Source Reduction' and no active remediation of groundwater is considered to be required.

Within the HRA (Arcadis 2019). two compliance points were used to assess the risk to the River, reflecting the distance from the two identified source widths, Source 1 and Source 2:

- Source 1 compliance point: 400m
- Source 2 compliance point: 250m

For the assessment of the risk to the Secondary A Aquifer, a compliance point of 250m from the source has been selected. Ammoniacal nitrogen is considered to be a non-hazardous substance, based on a review of the Joint Agencies Groundwater Determinations Advisory Group's Confirmed Hazardous Substances List (published in 2018 and accessible https://www.wfduk.org/resources/groundwater-hazardous-substances-standards). Review of the EA guidance indicates the a compliance point of up to 250m can be adopted for non-hazardous substances in groundwater with local resource potential (rather than strategic resource potential), (ref: https://www.gov.uk/guidance/land-contamination-groundwater-compliance-points-quantitative-risk-assessments). A compliance point of 250m is considered appropriate in the context of the environmental site setting, given that there are no potable groundwater abstractions within 1km of the site, there are no SPZ located within 5km of the site. The sensitivity of the compliance point distance over a range of 50m to 400m, was assessed within the HRA.

3.10.4 Metals and Metalloids

Concentrations of metal and metalloid determinants recorded within samples from the site are not considered to present a risk to human health for a residential with plant uptake end-use. Therefore, these determinants are not considered further in relation to potential human health risks.

Localised exceedances of Environmental Quality Standard (EQS) values of a number of contaminants have been recorded within a small number of soil leachate samples. The contaminants noted are as follows: arsenic, copper, manganese and zinc. However, these contaminants are not considered to present any risk because of their localised nature and that the mean concentrations of these contaminants were below their corresponding EQS value. Arsenic, copper, manganese and zinc in soil leachate are, therefore, not considered to require mitigation.

3.10.4.1 Nickel

Measured concentrations of nickel in groundwater were measured in excess of Drinking Water Standards (DWS) and EQS following the water standard quality screening undertaken as part of the updated HRA (January 2020) which provided a detailed discussion in relation to nickel in groundwater.

The conclusions of this review was that elevated nickel concentrations in groundwater beneath the site are associated with naturally occurring nickel. The presence of localised "highs" were considered to be associated with changes in aquifer hydrogeochemical conditions immediately beneath the organic waste mass (such as increased dissolved organic carbon and change from oxidising to reducing conditions), which may affect the partitioning and mobilisation of the naturally present nickel. The presence of nickel in selected locations on the hydraulic down gradient boundary at what would be considered background concentrations, suggests that the mobilisation of nickel is likely to be localised to beneath the organic waste mass. On this basis, nickel was not included for further assessment within the HRA and is not considered to require active remediation.

It is noted that the above conclusion is broadly in line with the considerations within the 2015 RRS which, following review of site investigation results and a detailed assessment of nickel in the surrounding area, suggested that the concentrations of nickel in soil were low and that the concentrations of nickel measured in groundwater beneath the site were likely to have originated from natural soil minerals. The 2015 RRS ultimately concluded that nickel concentrations were representative of background concentrations and did not include nickel as a potential contaminant requiring modelling or further consideration.

It is noted that the proposed remediation strategy will involve aerobic bioremediation which will reduce levels of organic matter within deposited waste and thus reduce the source of dissolved organic matter and associated reducing conditions within the underlying aquifer. Furthermore, it should be noted that during the remediation works all the Made Ground at the will be re-engineered and reinstated which will reduce infiltration rates through the recovered material. It is anticipated that these activities will further reduce the occurrence of localised concentrations of elevated nickel in groundwater beneath remediated / recovered material.

3.10.5 Amenity (Nuisance and Health Issues)

The principal potential nuisance issues associated within the waste recovery operation are as follows:

- Airborne Dust – associated with waste excavation, handling and transport, stockpiled material and access roads;
- Odour – associated with wastes (notably ammoniacal nitrogen impacted waste) and their excavation, transport, handling (including recovery via ex situ bioremediation and stabilisation) and stockpiling;
- Noise – associated with plant, waste handling (including physical processing), generators and other equipment as well as vehicle movements to and from site.

The key potential receptors identified in relation to nuisance issues are as follows (shown on Figure 2):

- Neighbouring residents located adjacent to the south, southeast and southwest site boundaries;
- The Tangerine Confectionary York premises located adjacent to the playing field on the southwest site Boundary;
- Various other commercial premises, including York Business Park, located adjacent to the northeast and northwest site boundaries.

There are no safeguarded aerodromes within 4km of the site (nearest active airfield is RAF Rufford located ~4.8km to the west).

The Clifton Ings and Rawcliffe Meadows site of Special Scientific Interest (SSSI) is located adjacent to the opposite bank of the River Ouse to site approximately 240m east from the site boundary. This SSSI area is also identified within the Priority Habitat Inventory as a Coastal and Floodplain Grazing Marsh but is not considered to be a significant receptor in relation to amenity / nuisance issues.

4 Pollution Control Measures

The waste recovery activities proposed to address identified contaminants within waste material is detailed within the RRSA (Arcadis, April 2020) and summarised within the submitted Waste Recovery Plan (Arcadis, March 2020) associated with this permit application.

4.1 Site Engineering

4.1.1 Basal and Side Slope Engineering

The waste recovery operation includes the remediation of waste such that potential risks to future site users and the environment from contaminants in soil, soil pore water and soil gas are mitigated to an acceptable level protective of human health and environmental receptors. Geotechnical improvement will also be undertaken, as required, via stabilisation and compact such that the development platform is suitable to enable residential development.

Therefore, as waste recovery activities will be undertaken, no engineered basal or side barriers are required.

A Slope Stability Plan (Arcadis, May 2020) has also been prepared and submitted as part of permit application form B4 Appendix 4 requirements.

4.1.2 Capping

The proposed waste operation will recover deposited wastes such that they are suitable for use as general fill for construction of a development platform to enable residential development All recovered waste used to construct this development platform will be screened, tested, remediated (as required) and placed such that contaminants are mitigated to an acceptable level protective of human health and environmental receptors.

The geochemical suitability of all earthworks materials to be used in the development within 1m of the anticipated formation level including garden areas and the footprint of buildings are to be assessed against site specific soil RTVs derived for risks to human health for a Residential with Plant Uptake end use. Where soil materials are identified as having elevated concentrations of non-volatile hydrocarbons, in respect to the RTVs, they are to be placed below to top 1m of the development platform to break direct contact and plant uptake exposure pathways.

During the remediation and reclamation works, excavated material which is considered potentially suitable for reuse as plant growth media (topsoil type material) within future residential gardens and/or within Public Open Space (POS) will be identified, segregated and assessed in order to maximise the reuse of this material and minimise offsite disposal. The specifications for multipurpose topsoil within BS 3882:2015 will be used as an initial screen to inform the suitability of site soils for reuse as plant growth media. However, the specific end use and location for deposit of plant growth media will also be considered with a view to maximising reuse of material which may fail some of the BS 3882:2015 specifications, this will ensure suitable topsoil material on site can be classified as suitable for a specific purpose.

The development platform will also include the construction of access roads and other areas of hard standing.

Therefore, as waste recovery activities will be undertaken to ensure that only recovered waste that is suitable for re-use is placed at the site then there is no requirement for any further engineered cap at the site.

4.1.3 Restoration

The current site topography, including within the EP boundary area, is shown on Figure 2 which was created based on the most recent topographical survey undertaken in April 2019 by Greenhatch Ltd and mapping the entire site area to a resolution of 0.5m and taking spot levels at 20m centres. This reflects the deposits of aged historically deposited waste.

The planning conditions and associated approved plans require specific volumes of bulk fill to construct the development platform for which equivalent volumes of waste are proposed to be recovered. The contours of the proposed development platform is shown on Figure 11 and is an Approved Plan ('Proposed Contours - DR-CE-00602 P5' Approved Plan associated with planning permission 14/02798/FULM. The proposed contours provide a suitable elevation and gradient for sustainable urban drainage and gravity drained surface water drainage network and the areas of public amenity have been designed to suitable and appropriate gradients and levels taking into account usage, visual impact and environmental requirements.

The waste types and volumes are described in Section 2.3.2.

As the waste recovery operation does not relate to the deposit of waste to provide a growing medium and/or nutrients to support plant growth (R10 for land treatment) for agricultural benefit or ecological improvement, no agricultural or ecological benefit statement is required.

4.1.4 Surface Water Management

Surface water mitigation measures aim at ensuring the surface water run-off from the site during construction does not have a detrimental effect on the receiving watercourses (River Ouse and Ing Cliff Drain) and the underlying aquifer. The surface water run-off would be controlled using appropriate drainage measures and infiltration into the ground would be minimised.

Treatment of run-off during construction may include the use of the following treatment processes: settlement, flocculation, air stripping, aeration, chemical oxidation, granulated carbon adsorption. It is envisaged that an on-site treatment plant may be required to ensure that the concentrations of key determinands in the effluent discharge are within consented discharge limits. However, the development platform will have been placed to comply with the remedial target values during the construction stage which is covered by the Detailed Application. The remedial target values are designed to mitigate risks to surface water and/or groundwater at the time of the engineering of the development platform. As such, the need for subsequent treatment of effluent discharge during the construction stage following remediation will be limited.

In order to manage the discharge from the site, a construction stage surface water management plan shall be developed. The following principal items shall be included: a series of temporary land drains as required around the development discharging to discharge point(s); a monitoring and sampling point constructed at the point(s) of discharge; settlement lagoons, if required, constructed upstream of the discharge point(s); cut-off ditches around the perimeter of the site to prevent water discharging at any location other than the aforementioned discharge point(s).

The construction stage surface water management plan shall be prepared in conjunction with the programme of works and reviewed regularly during the works to ensure that it meets the objectives above.

The location, quality and quantity of discharges will be confirmed by the waste recovery contractor once appointed as part of the Environmental Permit (Mobile Treatment License) deployment. Application for deployment of and the operation of the requisite mobile treatment plant(s) will be made in accordance with applicable legislative requirements.

4.1.5 Post Closure Controls (Aftercare)

4.1.5.1 Post Closure Use and Management

The proposed soil gas and groundwater monitoring associated within waste recovery, including aftercare (post remediation) is provided in Section 5.

The proposed after use of the site is for residential development comprises up to 1,100 residential units, and the associated public open space (landscaping and recreational spaces) for the use of the residents (as per planning permission (15/00524/OUTM).

Environment Agency guidance document RGN9 “Surrender” provides guidance on the regulatory requirements for holders of permits considering applications to surrender an environmental permit. A bespoke Deposit for Recovery permit has been applied for to enable waste recovery at the site given the volumes of waste for recovery are greater than 60,000m^3.

In the case of a waste recovery operation, Section 5 of RGN9 indicates that for this site, which holds a bespoke permit, the EA will require a report at the conclusion of the recovery process which confirms that the recovered and deposited waste is in a satisfactory state; i.e. it will not cause an unacceptable risk of pollution or harm to human health or the environment. Section 5.3b of RGN9 provides for a report which confirms that the recovered waste meets risk-based completion criteria developed for the site.

In accordance with section 5 of RGN9, a completion and validation report will be provided in line with the requirements of the reclamation strategy and guidance given in Land Contamination: Risk Management guidance (EA 2019), to confirm that risk-based compliance criteria have been achieved for the recovered and deposited waste.

Following regulatory acceptance of this completion and verification report it will have been demonstrated that waste has been successfully recovered such that it does not pose a significant risk to human health or the environment and no further post closure management would be considered required. Therefore, on this basis, it is not considered necessary to provide a Closure Plan for the site.

4.1.5.2 Subsidence and Settlement

The site is not located within an area of previous coal mining activity and so the likelihood of mining subsidence is considered low. Certain waste types present, principally the Organic Rich Material (EWC Code 02 04 01) are highly compressible and a key objective of the waste recovery is to provide a development platform suitable for supporting structural and pavement loads from the proposed development of the site.

Therefore, soils will be classified and compacted in accordance with the requirements of the Series 600 of the Specification for Highways Works. Compacted soils will be required to achieve at least 95% of the maximum dry density, with a maximum permissible air void of 5%.

Soils used for fill should reach at least firm consistency with a minimum undrained strength Cu of 60 kN/m2 if cohesive and/or be engineered to a relative density of at least medium dense if granular (may require stabilisation / modification; the extent of this will depend on the condition of the fill).

Where the natural formation is found to consist of compressible or highly plastic soils, additional earthworks, modification, or an alternate foundation solution will be adopted.

4.1.5.3 Waste Recovery Operation - Compliance Criteria

The overall approach to permit surrender will be in line with the EA guidance document RGN9 “Surrender” as described in Section 4.1.5.1. The DfR compliance criteria are outlined below.

<u>Soil and Soil Pore Water Compliance Criteria</u>
A set of compliance criteria, known as RTVs, for remediated Made Ground soils and soil pore water, have been established by means of risk assessment. The criteria for the protection of human health are based on relatively conservative assumptions as to the plausibility of the exposure pathways set out in the contaminant linkages above, and as to the duration and frequency of exposure of users of the site to contaminants in soils. The criteria are therefore protective of human health based on a residential end use scenario with plant uptake. The RTV defined within the 2015 RRS have also been adopted within the RRSA 2020 addendum.

The criteria for the protection of the water environment, specifically the protection of the River Ouse, are based upon the acceptable concentration of solute substances in the pore water of the Made Ground soils. These being appropriate in the context of potential migration of soil solutes towards the river; and for the status of the river as a surface water receptor with importance for abstraction and treatment for potable use.

A review of the RTV calculated for ammoniacal nitrogen in soil pore water (URS 2015) was undertaken by Arcadis within the updated HRA ((Report Ref: 10024487-AUK-XX-XX-RP-GE-0020-01, January 2020) which confirmed that the RTV were protective of groundwater and supported the SSACs derived.

Ground Gas Compliance Criteria

The compliance criterion in respect of ground gas for the built residential properties complies with the requirements of the NHBC and related published UK guidance. The objective of the remediation and reclamation works will be to reduce ground gas concentrations and flow to a level compliant with the Amber 1 level of the NHBC traffic light system, with the proviso that conditions following remediation and reclamation will be no greater than Amber 2.

At the objective level of Amber 1 and a level no greater than Amber 2 as measured by post-remediation ground gas monitoring, standard protective measures can be adopted for use, as necessary, in the built structures.

In addition, ground gas monitoring following remediation works will also be used to demonstrate that where methane and carbon dioxide concentrations exceed 1.5%v/v and 5%v/v respectively (Scenario 1, EPR 5.02, EA Guidance) hazardous gas flow rates (Qhgs) will be calculated in line with Scenario 2 (EPR 5.02) in accordance with the required permit surrender Completion Criteria provided by the EA in Pre-Advice Letter (EAWML68681, EA, 28th August 2015);

Groundwater Compliance Criteria

The previous Tier 3 risk assessment and sensitivity analysis undertaken by AECOM as part of the 2015 RRS as well as the updated Hydrogeological Risk Assessment (HRA) undertaken by Arcadis (Report Ref: 10024487-AUK-XX-XX-RP-GE-0020-01, January 2020) both included detailed assessment of the potential environmental risks posed by ammoniacal nitrogen in Made Ground soils. The updated HRA concluded that measured concentrations of ammoniacal nitrogen in groundwater were not identified in excess of the updated SSAC derived for the protection of the Secondary A Aquifer or the River Ouse and, therefore, that measured concentrations of ammoniacal nitrogen in Made Ground soils are not considered to represent a significant risk to water resources. On this basis, the strategy does not propose to remediate groundwater in the natural superficial deposits; rather the remediation and waste recovery efforts are to be focused on reducing the leaching of ammoniacal nitrogen from Made Ground soils.

Ground water assessment criteria may include assessment of trends or statistics, in combination with comparison with set values, and are as follows:

- **Post remediation** – to assess groundwater quality trends within replacement monitoring wells to demonstrate there are no significant sustained increases in concentrations of ammoniacal nitrogen and metal or metalloids contaminants listed in the EP Variation. Assessment of trends may include statistical analysis where appropriate, or comparison with simple descriptive statistics.
  - For replacement monitoring wells which are direct replacements for existing monitoring wells (listed within the EP Variation working Plan (URS, February 2015)) and for which representative data is likely available for pre remediation conditions, then reference will also be made to these pre remediation concentrations (including Control Levels) to demonstrate there is no significant deterioration in groundwater quality following remediation;
  - For replacement monitoring wells which are not direct replacements for existing monitoring wells and for which representative data is not likely available for pre remediation conditions then, if sustained increasing trend is observed, reference will also be made to the updated Site Specific Assessment Criteria (SSAC) (Updated HRA, Arcadis, 2019) provided these replacement wells are associated with identified Sources (Updated HRA, Arcadis, 2019). Where these wells are not associated

with a Source, then further risk assessment may be undertaken if deemed required, including reference to EQS and/or DWS standards, if relevant.

Earthworks Performance Criteria

The proposed performance criteria are summarised as follows.

- Materials placed as compacted fill should comply with the properties of Class 2A/B/C and / or Class 1A/B/C as defined in the Specification for Highways Works Series 600 Earthworks;
- It is intended that the density for compacted material should be a specified minimum of 95% of the maximum dry density (4.5 kg Procter compaction test); and should be a specified maximum of 5% air voids where the particle density has been measured. Extraneous non-mineral materials such as fragments of plastic, wood and textile fragments and the like should be removed from the material before compaction as far as practicable. Durable materials including brick, concrete and masonry may be retained within the fill provided their largest particle dimension is no greater than two-thirds of the layer thickness being compacted and, in any case, no greater than 200 mm. Particles larger than 200 mm will be segregated, crushed and used in the fill. Plate bearing tests on the completed formation using the 600mm diameter plate should be considered acceptable where settlement under a sustained load equivalent to 100 kN/m² is less than 25 mm;
- Hand shear vane tests shall be undertaken at formation level and at the bases of excavations in cohesive materials. The specified minimum hand vane strength in cohesive materials shall be 60 kN/m2.

5 Monitoring

The proposed monitoring activities are detailed within the Monitoring Report (Arcadis Ref: 10024487-AUK-XX-XX-RP-GE-0060-03) in support of application form B4 Appendix 4 with selected elements also provided below.

5.1 Weather Monitoring

The site manager will make reasonable efforts to foresee adverse weather conditions by accessing an appropriate source of weather forecast data. A weekly forecast will be made available for the weekly liaison meetings with relevant receptors to aid with planning of activities. This information should be used to schedule appropriate preventative action at times when there is an increased risk that site operations will give rise to significant off-site impacts. Alternatively, activities with the potential to generate significant amounts of dust will be postponed, if necessary, until there are more favourable meteorological conditions.

In addition to the forecasting of meteorological conditions, meteorological data that is representative of conditions at the site will also be required to substantiate potential complaints. This will be gathered by a meteorological station position at a suitable area within the site (possibly fixed to the site office) and will measure and electronically log parameters including wind speed, wind direction and precipitation.

5.2 Gas Monitoring Infrastructure

A programme of ground gas monitoring shall be carried out prior to the commencement of the remediation and reclamation works, during those works and post completion at the frequencies given in the Table below.

Scope of Monitoring	Test	Frequency of Testing
GROUND GAS MONITORING		
Ground gas monitoring prior to and during works will be taken from 36 wells currently monitored as part of the EP monitoring programme (tables S3.1 and S3.3 within the EP Variation (EPR/QP3593NF/V002). This includes 11 wells located within the EP boundary and 25 wells located outside the EP boundary. Locations shown on Figure 12. Ground gas monitoring following works will be taken from 36 replacement wells located within the EP boundary (listed within tables S3.2 and S3.4 in the EP (EPR/QP3593NF/V002). This includes 11 wells located within the EP boundary and 25 wells located outside the EP boundary. Locations shown on Figure 13.	Including peak and field stable measurements of carbon dioxide, carbon monoxide and methane concentrations, total gas flow, atmospheric pressure and conditions during monitoring.	Standpipe installations located around the site to be sampled prior to the works (3 monthly visits), then at monthly intervals during the works, then at monthly intervals post works completion for a period of 24 months. Post completion should 12 consecutive monthly monitoring visits indicate ground gas compliance criteria have been met then it is understood that this will be accepted by the EA (Pre-application Advice, August 2015) with no further ground gas monitoring required.

Table 4 Ground Gas Monitoring Scope and Infrstructure

Where the concentrations of ground gases (and flow rates) recorded during the programme of monitoring are substantially elevated above levels previously recorded additional monitoring / increased frequency may be required at selected locations. However, the Remediation and Reclamation Strategy is intended to mitigate the ground gas risk to Amber 1, with the proviso that it is no greater than Amber 2. Where monitoring locations are within areas of the development that will be subject to earthworks excavations, placement of materials or construction, the monitoring locations shall be preserved and monitored for as long as reasonably practicable.

5.3 Gas Monitoring

The current ground gas regime including historical and baseline ground gas concentrations and assessment is provided in Section 3.9.

6 Site Closure Plan

In support of the Part C4 application form, Appendix 2, Q7, as the proposed waste operation is deposit for recovery (DfR) the risk based criteria, testing and verification process is described with the Waste Recovery Plan (Arcadis Report Ref: 10024487-AUK-XX-XX-RP-GE-0034-P6-Waste Recovery Plan, September 2022) and the support remediation strategy documents (RRS, URS 2015 and RRSA, Arcadis, 2021). The verification process detailed within these documents will demonstrate successful waste recovery which leaves the recovered waste and the site in a satisfactory state, presenting no unacceptable risk to the environment or human health, and this process is also proposed to enable EP surrender.

The overall EP surrender strategy is discussed within the Proposed Variations to Environmental Permit and Waste Operations – Supporting Information document (Arcadis Report Ref: 10024487-AUK-XX-XX-RP-GE-0075-02, September 2022).

Therefore, no separate site closure plan is considered required.

FIGURES

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