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LIGHTWATER QUARRIES LIMITED

APPLICATION FOR AN ENVIRONMENTAL PERMIT

GEBDYKES QUARRY LANDFILL

NON-TECHNICAL SUMMARY

APRIL 2023

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LIGHTWATER QUARRIES LIMITED

APPLICATION FOR AN ENVIRONMENTAL PERMIT

GEBDYKES QUARRY LANDFILL

NON TECHNICAL SUMMARY

APRIL 2023

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DRAWINGS	TITLE	SCALE
NT14621-003	Permit Boundary Plan	1:5,000 @ A3

1 INTRODUCTION

1.1.1 Lightwater Quarries Limited has commissioned Wardell Armstrong LLP to prepare an application to the Environment Agency for an Environmental Permit for a proposed inert landfill at Gebdykes Quarry, Halfpenny House Lane, Masham, North Yorkshire.

1.1.2 Gebdykes Quarry is an operational limestone quarry. Previous restoration proposals were for a low-level restoration scheme, however this is considered inappropriate for the elevated location. There is now a preference to restore the existing void to original ground level using inert wastes imported to the site and placed within the void, which will form the landfilling activity.

1.1.3 The site is located within a rural setting, with agricultural land and farms surrounding the majority of the site. The site location is discussed further in Section 2.

1.1.4 The site will be operated in accordance with all relevant legislation and Environment Agency guidance. Section 3 lists the documents that have been provided in support of the application.

1.1.5 Clean inert wastes only will be accepted at the site for landfilling. Site operations are detailed in Section 4.

1.1.6 The site is designed to provide comprehensive environmental protection. Further information on the environmental risks and mitigation measures is provided in Section 5.

2 THE SITE

2.1.1 Gebdykes Quarry is located at Halfpenny House Lane, Masham, North Yorkshire at national grid reference SE 23770 82304. The nearest postcode is HG4 4BT and the site is accessed via the site entrance road off Halfpenny House Lane (B5268). The site location and proposed permit boundary is provided in Drawing NT14621-003.

2.1.2 The nearest town to the site is Masham, located 1.5km to the southwest. There are also a number of other small settlements within the surrounding area, including Well approximately 2.5km to the east, Snape 3km to the northeast and Thornton Watlass 3km to the north.

2.1.3 The site is bound to the north and northwest by Limekiln Lane, agricultural land to the west and south, and Halfpenny House Lane to the east.

2.1.4 The site is located approximately 815m to the east of the River Ure. The nearest designated site is Mar Field Fen SSSI, located 1.2km to the west.

2.1.5 Two ancient woodlands are present within 1km of the site. Low Burton Wood is adjacent to the site to the west, and an unnamed ancient, replanted woodland is located 1km to the northwest.

2.1.6 The site is underlain by dolostone of the Cadeby Formation. The bedrock underlying the site forms a Principal aquifer.

3 ENVIRONMENTAL PERMIT APPLICATION

3.1.1 The proposed activity for the landfilling of inert waste is classified as a waste operation, requiring a permit under the Environmental Permitting Regulations (England and Wales) 2016.

3.1.2 A number of documents have been prepared to support the application and demonstrate that the environmental impact from the operations is minimised as far as possible. The permit application comprises:

- Application Forms:
    - Part A (About You);
    - Part B2 (General Bespoke Permit);
    - Part B4 (New Bespoke Waste Operation Permit);
    - Part F1 (Charges and Declarations);
- Non-Technical Summary;
- Operating Techniques;
- Amenity and Accident, and Habitats Risk Assessment;
- Environmental Setting and Site Design;
- Stability Risk Assessment;
- Hydrogeological Risk Assessment;
- Dust Management Plan;
- Site Drawings; and
- Financial Provision Spreadsheet.

3.1.3 The documents demonstrate that the site will be operated in accordance with the relevant legislation and Environment Agency guidance.

4 SITE OPERATIONS

4.1.1 Lightwater Quarries Ltd propose to accept clean inert wastes for disposal via landfill at Gebdykes Quarry. The waste will be placed in layers and compacted to fill the void that has been created through limestone extraction. This will form a stable landform in accordance with planning conditions requiring the restoration of the site.

4.1.2 Landfill operations will be undertaken in five distinct phases in the southern void of the quarry, while limestone extraction will continue within the north void. In the southern void, the total void is estimated to be approximately 1,800,000m^3. Approximately 3.6 million tonnes of inert waste will be imported for use in landfilling activities, with the site being backfilled at an approximate rate of 200,000 tonnes a year. The southern void forms the basis of this inert permit application, while the northern void will remain unfilled as part of the wider restoration.

4.1.3 In accordance with the Landfill Directive the site will be engineered to provide an engineered liner on basal and side slopes to act as a geological barrier. The liner is proposed to be constructed of crushed and screened dolomite fines (or other suitable imported material) of 650mm thickness, and will be constructed with a permeability of equal to or less than $6.5\text{x}10^{-8}$m/s (equivalent to a maximum of $1.0\text{x}10^{-7}$m/s for a 1m barrier).

4.1.4 Operations at the site will meet the requirements of the Environment Agency's guidance 'Landfill operators: environmental permits'.[1] An Operating Techniques document has been provided in support of this application detailing how the site will be managed.

4.1.5 All incoming inert materials will be subject to stringent pre-acceptance and acceptance checks. These checks are designed to ensure that only clean, permitted waste types are accepted for disposal, with any non-conforming materials diverted back to the site of origin or to a suitably permitted facility.

4.1.6 Site activities will be undertaken in accordance with an environmental management system developed to align with the Environment Agency's Guidance on Management Systems for permitted sites.

4.1.7 A Technically Competent Manager (TCM) with appropriate WAMITAB qualifications and experience will oversee the site operations.

[1] Landfill operators: environmental permits - Guidance - GOV.UK (www.gov.uk)

4.1.8 In addition to the landfilling activity, it is proposed to import soils and rubble/rock/brick/concrete onsite for screening and then export. These activities will be covered under a Standard Rules Permit (SR2010 No12) for the treatment of waste to produce soil, soil substitutes and aggregate. This activity will form a separate permit application.

5 ENVIRONMENTAL RISK AND MITIGATION

5.1.1 All risks associated with the landfilling activities will be managed through stringent site procedures. The proposed site operations have been subject to scrutiny to ensure that all risks from the activities have been identified.

5.1.2 Pro-active operational measures will be implemented to ensure that there is no pollution from fugitive emissions from site activities beyond the site boundary. Regular checks will be made around the site boundary and should fugitive emissions be detected the source will be identified and appropriate remedial action will be taken.

5.1.3 The site roads will be swept as necessary to prevent mud or debris being tracked out of the site.

5.1.4 The clean inert materials to be accepted at the site are not inherently odorous, and it is unlikely that any litter will be generated.

5.1.5 Operations will be restricted to daytime hours. All plant and equipment that is used onsite will be maintained in accordance with the manufacturer's recommendations to ensure that it operates correctly and without producing excessive noise.

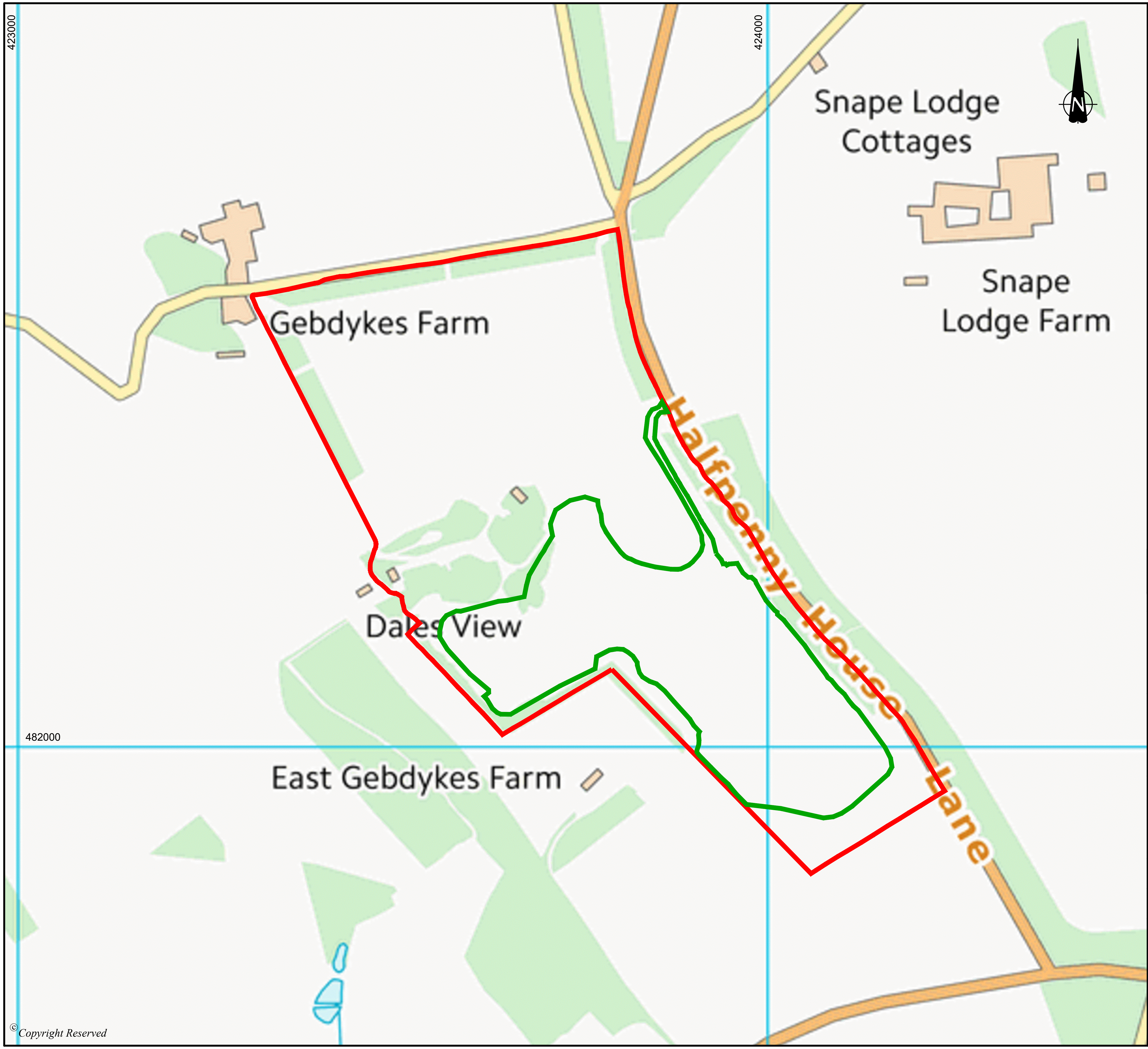
5.1.6 A Stability Risk Assessment supports the application, demonstrating that the proposed engineering of the void will be structurally and physically stable over the lifetime of the operation.

5.1.7 The application is also supported by a Hydrogeological Risk Assessment which details the groundwater monitoring to be implemented at the site. Regular environmental monitoring of groundwater will be undertaken to ensure that site operations are fully compliant with the conditions of the environmental permit. There are no proposed emissions to surface water. Surface water from the operational areas of the landfill is proposed to be captured in a lined lagoon and tested prior to discharge to groundwater.

5.1.8 Site staff will be suitably trained for their roles. Contractors working at the site will be inducted by a senior member of staff. Site plant will be operated by authorised staff only.

5.1.9 The site will be operated in accordance with an Environmental Management System, which ensures that all necessary procedures are in place to enable the continued identification, assessment and effective management of environmental impacts of the landfill.

DRAWINGS



DO NOT SCALE FROM THIS DRAWING

KEY

SITE BOUNDARY

PERMIT BOUNDARY

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D
A	FIRST ISSUE	09-02-23	DR	KH	AC

CLIENT

LIGHTWATER QUARRIES

PROJECT

GEBDYKES LANDFILL
PERMIT APPLICATION

DRAWING TITLE

PERMIT BOUNDARY PLAN

DRG No.	REV	SUIT. CODE
NT14621-003	A	

DRG SIZE	SCALE	DATE
A3	1:5000	10-10-22

DRAWN BY	CHECKED BY	APPROVED BY
DR	KH	AC

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LIGHTWATER QUARRIES LIMITED

GEBDYKES QUARRY LANDFILL ENVIRONMENTAL PERMIT APPLICATION

HYDROGEOLOGICAL RISK ASSESSMENT

APRIL 2023

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LIGHTWATER QUARRIES LIMITED

GEBDYKES QUARRY LANDFILL ENVIRONMENTAL PERMIT APPLICATION

HYDROGEOLOGICAL RISK ASSESSMENT

FEBRUARY 2023

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REVIEWED BY:

Anna Saich	Service Lead – Hydrogeology & Hydrology	Anna Saich

APPROVED BY:

Andrew Belton	Team Lead – Waste Resource Management	

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TABLES

APPENDICES

FIGURES

1 INTRODUCTION

1.1 Report Context

1.1.1 Wardell Armstrong (WA) has been commissioned by Lightwater Quarries Limited (the Client) to produce a Hydrogeological Risk Assessment (HRA) for the proposed landfill at Gebdykes Quarry (the Site). Gebdykes Quarry runs adjacent to the B6268 (Halfpenny House Lane), Masham, North Yorkshire at National Grid Reference (NGR) SE 23770 82304.

1.1.2 Gebdykes Quarry is a Magnesian Limestone quarry operated by Lightwater Quarries Limited. Permission for extraction at the Site was first granted in 1949 however the Site was worked prior to this date and now the existing quarry is nearing exhaustion of the currently permitted reserves. Current restoration proposals for the Site are for a low-level restoration scheme, which is now considered inappropriate for the Site's elevated location. There is now a preference to restore the existing void to original ground level. A new planning application is in progress to seek consent for landfilling the existing void with an estimated 3.6 million tonnes of inert waste. The Site will be filled at an approximate rate of 200,000 tonnes a year.

1.1.3 The HRA has been produced to support and Environmental Permit Application for the proposed inert landfill operations during restoration.

1.2 Purpose and Basis of Report

1.2.1 This HRA report has been prepared in support of the landfill permit application. The report is based on the following reports and documents relating to the Site:

- Factual Site Investigation and Monitoring Report by Wardell Armstrong, dated November 2020 (report reference NT14621/006);
- Technical Note: Pre-Application Technical Memo by Wardell Armstrong, dated May 2020 (report reference NT14621/001);
- Enhanced Pre-Application Advice Letter from the Environment Agency, dated June 2020;
- Groundwater Monitoring Reports by Wardell Armstrong (report references NT14621/007, NT14621/008, NT14621/009, NT14621/0010, NT14621/0011, NT14621/0012, NT14621/0013, NT14621/0014, NT14621/0015 and NT14621/0016);
- Enhanced Pre-Application Advice Letter from the Environment Agency, dated January 2021;

- Chapter 8 of the Environmental Statement by Wardell Armstrong including Appendix 8.2 Flood Risk Assessment, dated January 2022 (report reference NT14834/ES).

1.3 Environment Agency Engagement

1.3.1 Initial pre-application advice was provided by the Environment Agency in June 2020. A teleconference was held between WA and the Environment Agency on 23 June 2020 to discuss the proposed scheme, the hydrogeological site investigation undertaken at the Site, groundwater monitoring and the level of risk assessment for the HRA. The Pre-Application Technical Memo was provided following the teleconference (25 June 2020) and a response received from the Environment Agency on 29 June 2020 (Environment Agency reference EPR/JB3403TR/A001). Further pre-application advice was provided by the Environment Agency on 13 January 2021. As part of the further pre-application advice the Environment Agency confirmed that a Generic Quantitative Risk Assessment (GQRA) was appropriate for the Site.

1.4 Report Structure

1.4.1 The Site location and history, proposed installation, geology, hydrology and hydrogeology are summarised in Section 2. A Conceptual Hydrogeological Site Model (CHSM) is presented in Section 3. The CHSM forms the basis of the HRA which is presented in Section 4. Requisite surveillance is described in Section 5 and conclusions are presented in Section 6.

2 SITE CONDITIONS

2.1 Site Location and Description

2.1.1 The Site is located approximately 1.4km north-east of Masham. The Site location is shown in NT14621-HRA-001.

2.1.2 The Site occupies 33.7 hectares of land, with most of the Site as an open void. The depth of the void is currently 116m Above Ordnance Datum (AOD) in the south of the Site and the basal elevation of the landfill will be 116m AOD. The maximum surface elevation in the unworked areas to the north is 145m AOD.

2.2 Site History

2.2.1 Permission for extraction was granted in May 1949, however the Site was worked prior to this date. Planning permission was granted in November 2001 for a northern, eastern and southern extension to the quarry, forming the current quarry boundary. Mineral extraction is required to cease by September 2039. The quarry is now nearing exhaustion of the currently permitted reserves and it is proposed to restore the Site.

2.3 Proposed Installation

Installation Overview

2.3.1 Restoration of the Site will be achieved through infilling with clean inert materials and the Site will be classed as an inert landfill under the Landfill Directive.

Basal Lining System

2.3.2 The basal lining system will be constructed in accordance with the requirements of the Landfill Directive, which requires the liner to be equivalent to a 1m thick layer with a permeability equal to or less than $1.0x10^{-7}$m/s. The basal liner will be 0.65m in thickness and will consist of artificially established geological barrier with a permeability equal to or less than $6.5x10^{-8}$m/s. The artificially established geological barrier will typically comprise either crushed and screened dolomite fines or a clay rich material.

Side Sloping Lining System

2.3.3 The side slope lining system will be constructed in accordance with the requirements of the Landfill Directive, which requires the landfill sides to be equivalent to at least 1m thick with a permeability equal to or less than $1.0x10^{-7}$m/s. The initial side slope lining system will consist of a bund comprising either crushed and screened dolomite fines or a clay rich material, 2m in height and 3m in width, to connect to the existing side slope. The side slope lining system will be installed progressively with each waste lift. The artificially established geological barrier will have thickness of 0.65m and a permeability equal to or less than $6.5x10^{-8}$m/s.

Capping System

2.3.4 Due to the inert nature of the material, there is no requirement to prevent the formation of leachate. No formal capping is required and there is no requirement for any gas collection infrastructure.

2.4 Waste Stream

2.4.1 The proposed landfill will accept inert waste as presented in Table 1. The leaching limit values for acceptance of inert wastes are shown in Table 2.

Table 1: Proposed Waste Stream

01	WASTES RESULTING FROM EXPLORATION, MINING, QUARRYING AND PHYSICAL AND CHEMICAL TREATMENT OF MINERALS
01 01	Wastes from mineral excavation
01 01 02	Waste from mineral non-metalliferous excavation
01 04	Wastes from physical and chemical processing of non-metalliferous minerals
01 04 08	Gravel and crushed rocks other than those mentioned in 01 04 07
01 04 09	Waste sand and clays
02	WASTES FROM AGRICULTURE
02 04 01	Soil from cleaning and washing of beet
10	WASTES FROM THERMAL PROCESSES
10 12 08	Waste ceramics, bricks, tiles and construction products (after thermal processing)
10 13 14	Waste concrete
17	CONSTRUCTION AND DEMOLITION WASTES (INCLUDING EXCAVATED SOIL FROM CONTAMINATED SITES)
17 01	Concrete, bricks, tiles and ceramics
17 01 01	Concrete
17 01 02	Bricks
17 01 03	Tiles and ceramics
17 01 07	Mixtures of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06
17 03 02	Bituminous mixtures not containing dangerous substances (road planings only)
17 05	**Soil, stones and dredging spoil**
17 05 04	Soil and stones, including chalk, other than those mentioned in 17 05 03
19	WASTES FROM WASTE MANAGEMENT FACILITIES, OFF-SITE WASTE WATER TREATMENT PLANTS AND THE PREPARATION OF WATER INTENDED FOR HUMAN CONSUMPTION AND WATER FOR INDUSTRIAL USE
19 12	Wastes from the mechanical treatment of waste (e.g. sorting, crushing, compacting, pelletising) not otherwise specified
19 12 05	Glass (for fill purposes only, not for use in restoration top layer)
19 12 09	Minerals (for example sand and stones)
19 12 12	Other wastes (including mixtures of materials) from mechanical treatment of wastes other than those mentioned in 19 12 11 (Restricted to crushed bricks, tiles, concrete and ceramics only.)
20	MUNICIPAL WASTES (HOUSEHOLD WASTE AND SIMILAR COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL WASTES) INCLUDING SEPARATELY COLLECTED FRACTIONS
20 01	Separately collected fractions (except 15 01)
20 02	Garden and park wastes (including cemetery waste)
20 02 02	Soil and stones, only from gardens and parks.

Table 2: Leaching Limit Values for the Acceptance of Inert Wastes

Components	L/S = 10 l/kg mg/kg dry substance
Arsenic	0.5
Barium	20
Cadmium	0.04
Total chromium	0.5
Copper	2
Mercury	0.01
Molybdenum	0.5
Nickel	0.4
Lead	0.5
Antimony	0.06
Selenium	0.1
Zinc	4
Chloride	800
Fluoride	10
Sulphate[1]	1,000
Phenol index	1
Dissolved organic carbon[2]	500
Total dissolved solids[3]	4,000

Notes:

1 The limit value for sulphate may be increased to 6,000mg/kg, provided that the value of C_0 (the first eluate of a percolation test at L/S = 0.1 l/kg) does not exceed 1,500mg/l. It will be necessary to use a percolation test to determine the limit value at L/S = 0.1 l/kg under initial equilibrium conditions.

2 If the waste does not meet this value for dissolved organic carbon (DOC) at its own pH value, it may alternatively be tested at L/S = 10 l/kg and a pH of 7.5 – 8. The waste may be considered as complying with the acceptance criteria for DOC, if the result of this determination does not exceed 500mg/kg.

3 The value for total dissolved solids (TDS) can be used alternatively to the values for sulphate (SO4) and chloride. In the case of soils, a higher limit value may be permitted by the Environment Agency, provided a dissolved organic carbon value of 500mg/kg is achieved at L/S 10 l/kg at the pH of the soil or at the pH value of between 7.5 and 8.0.

2.5 Climate

2.5.1 Rainfall and Hydrogeological Effective Rainfall (HER) data from the Meteorological Office Rainfall and Evaporation Calculation System (MORECS Square 86) was obtained from the Meteorological Office (MET Office, 2021), and is presented in Table 3. Between 1971-2000 average rainfall was 713.2 mm/a.

Table 3: Average Rainfall and HER (mm) from 1971-2000, MORECS Square 86

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Annual**
Average rainfall (mm)	65.3	44.0	53.6	52.8	54.6	61.8	53.3	68.9	61.7	63.6	65.2	68.3	**713.2**
Average HER (mm)	46.2	26.4	23.9	17.6	6.2	4.0	0.2	2.9	3.3	10.0	17.9	35.3	**193.8**

2.6 Geology

Geological Overview

2.6.1 The geological setting of the Site and surrounding area is described below based on published British Geological Survey (BGS) 1:50,000 Scale mapping and information provided by the 2019 WA Investigation (SI), which involved the drilling and installation of four boreholes on Site. The superficial and bedrock successions are summarised within Table 4 and described in Sections 2.5.2 and 2.5.3, respectively. The borehole geology is described in Section 2.5.4.

<table>
<tr><th colspan="6">Table 4: Summary of Superficial and Bedrock Geology</th></tr>
<tr><th colspan="2">Geological Unit</th><th>Previous Naming</th><th colspan="2">Approximate Thickness (m)</th><th>Lithology</th></tr>
<tr><td colspan="2">Overburden (Topsoil)</td><td>-</td><td colspan="2">0.0- 1.1m[1]</td><td>Silty soils, clays, silts and made ground[1]</td></tr>
<tr><td colspan="2">Glacial Till (Diamicton)</td><td>-</td><td colspan="2">0.0-0.95m[1]</td><td>Brown/yellow sandy gravel[1]</td></tr>
<tr><td rowspan="2">Cadeby Formation – Dolostone</td><td>Sprotbrough Member (Upper Subdivision)[2]</td><td rowspan="2">Magnesian Limestone</td><td>15- 30m[2]</td><td rowspan="2">35.1- 52.6m[1] (full thickness not proven)</td><td rowspan="2">Dolomite and dolomitic limestone[2]. Commonly oolitc or granular, deposited in shallow carbonate seas[3].</td></tr>
<tr><td>Wetherby Member (Lower subdivision)[2]</td><td>14- 40m[2]</td></tr>
<tr><td rowspan="2">Rotliegend Group</td><td rowspan="2">Yellow Sands Formation</td><td>Permian Marl</td><td colspan="2" rowspan="2">0m (absent in Marsham area)[4]</td><td>Organic mudstone.</td></tr>
<tr><td>Basal Permian Sands</td><td>Discontinuous sequence of soft sandstone, breccia and conglomerate[2].</td></tr>
<tr><td colspan="2">Millstone Grit Group</td><td>-</td><td colspan="2">Greater than 200m[4]</td><td>Sandstones, interbedded with siltstones and mudstones</td></tr>
<tr><td colspan="6">Notes:
1. 2019 WA SI
2. The building Limestones of the Upper Permian, Cadeby Formation of Yorkshire (Lott and Copper, 2005)
3. British Geological Survey 1:50,000 Scale Mapping (British Geological Survey, 2020)
4. British Geological Survey 1:50,000 Series Maps England and Wales Sheet 51, Masham, Solid Edition</td></tr>
</table>

Superficial Geology

2.6.2 Published BGS 1:50,000 scale mapping indicates that superficial deposits in the form of Glacial Till (diamicton) are present in the south of the Site, although superficial deposits are absent from the majority of the Site. The 2019 WA SI recorded superficial deposits (described as brown/yellow sandy gravel) in borehole BHWA04 only located in the west of the Site (location shown in NT14621-HRA-001).

Bedrock Geology

2.6.3 Published BGS 1:50,000 scale mapping shows that at a regional scale, the bedrock geology is dominated by Dolostones of the Cadeby Formation, previously known as the Magnesian Limestone, part of the Zechstein group (British Geological Survey, 2020). The upper beds consist of cross-bedded oolitic limestones, whilst the lower beds comprise successions of domed stromatolites and dolomitized bryozoan-rich path reefs (Lott and Cooper, 2005). The bedrock was deposited in a shallow-marine environment along the western shoreline of the Zechstein sea, and dips regionally to the east/south-east.

2.6.4 The Cadeby Formation dips regionally toward the east/south-east. Stratigraphically, the Cadeby Formation is underlain by the Permian Marl of the Rotliegend Group. Where the Permian Marl is absent, the Cadeby Formation is directly underlain by the Basal Permian Sands Formation, part of the Rotliegend Group, which consists of sandstone, breccia and conglomerate (Lott and Cooper, 2005). In the Masham area the Cadeby Formation is unconformably underlain by the Millstone Grit Group, which consists of sandstones, siltstones and mudstones.

Borehole Geology

2.6.5 In November 2019 four boreholes were installed at the Site as part of the 2019 WA SI, by ID Drilling on behalf of Dunelm using Rotary Open Hole drilling techniques. The boreholes were installed with a 50mm internal diameter (ID) well pipe and raised well covers. The locations of the boreholes are shown in NT14621-HRA-001 and the ground conditions encountered are summarised in Table 5.

Table 5: Summary of Geology Encountered and Borehole Installation during the November 2019 SI

Borehole	Depth	Installation Details	Geology	Water Strike*
BHWA01	53m	0 - 34m Plain 34 - 40m Screened 40 - 53m Bentonite	0 - 0.4m Topsoil 0.4 - 53m Yellow Limestone	Dry
BHWA02	40m	0 - 34m Plain 34 - 40m Screened	0 - 0.45m Brown Topsoil 0.45 - 40m Yellow Limestone	Dry

Table 5: Summary of Geology Encountered and Borehole Installation during the November 2019 SI

Borehole	Depth	Installation Details	Geology	Water Strike*
BHWA03	40m	0 - 29m Plain 29 - 35m Screened 35 - 40m Bentonite	0 - 1.1m Brown Topsoil 1.1 - 3.2m Very Weathered Limestone 3.2 - 11.8m Weathered Limestone 11.8 - 27.1m Very Hard, Yellow Limestone 27.1 - 40m Weathered Limestone	Dry
BHWA04	40m	0 - 34m Plain 34 - 40m Screened	0 - 0.15m Brown Topsoil 0.15 - 1.1m Brown/Yellow Sandy Gravel 1.1 - 36.2m Yellow Limestone 36.2 - 40m Grey Mudstone	Dry

*Section 2.2.2 of the Factual Site Investigation and Monitoring Report noted that "Geological and hydrogeological information including geological boundaries and water strikes was recorded for all four boreholes". The reference to water strikes meant that if water strikes were encountered that these were recorded. No water strikes were recorded during drilling, all four boreholes were recorded to be dry as reported in Table 1 of the Factual Site Investigation and Monitoring Report.

2.6.6 Only borehole BHWA04 encountered superficial deposits, the superficial deposits consisted of brown/yellow sandy gravel. The lack of superficial deposits encountered in the other three boreholes across suggests that superficial deposits are sporadic and largely absent.

2.6.7 At a local scale, the 2019 WA SI confirmed the presence of the Cadeby Formation, which extends to a maximum recorded thickness of 53m bgl (below ground level) in borehole BHWA01, located south of the current quarry void. In general, the boreholes were not drilled to depths deep enough to quantify the interface between the Cadeby Formation and the underlying Millstone Grit Group, although borehole BHWA04 encountered grey mudstone at 36.2m bgl (102.5m AOD).

2.7 Hydrology

2.7.1 Ordnance Survey (OS) mapping shows that there are no surface water features within the Site boundary. There are two unnamed watercourses in the surrounding area, which are both classified as Ordinary Watercourses. The first is located at Snape Lodge Farm, approximately 500m to the east of the Site, which flows in a north-east direction away from Site. The second issues at Low Spring cottages, 900m to the west of the Site, and flows southwards away from the Site. There are also two unnamed ponds within the surrounding area, one located 0.4km east of the Site at Snape Lodge Farm and another located 0.37km south-west of the Site near Low Burton Wood (NT14621-HRA-001).

2.7.2 There are no rivers within the Site area, the closest is the River Ure, which is designated as a Main River by the Environment Agency. It is located approximately 815m west of the Site, and flows in a southerly direction. At its nearest point to the Site, the river elevation is approximately 80m AOD.

2.7.3 The Site is situated within two different surface waterbody catchments, the catchment divide follows the western edge of the Site and intersects the Site boundary at several points. The Site is primarily within the Ings Goit from Source to Burneston Beck Catchment (ID: GB104027068800) (Environment Agency, 2021a), but to the west the Site becomes a part of the Ure from Thornton Steward Beck to River Skell Catchment (ID: GB104027069461) (Environment Agency, 2021b). The 2019 Environment Agency classification of the Ings Goit from Source to Burneston Beck Catchment has a chemical status of Fail and an ecological status of Moderate. The Ure from Thornton Steward Beck to River Skell Catchment has a chemical status of Fail and an ecological status of Moderate. Both surface water body catchments have a chemical status of Fail due to the presence of polybrominated diphenyl ethers (PBDE).

2.7.4 Precipitation within the quarry area would be expected to either infiltrate at source, or naturally flow overland, subsequently accumulating in the quarry void and infiltrating the permeable bedrock. At a regional scale, aquifer recharge would be expected to occur in areas of topographic highs and where the cover of superficial deposits is sparse.

2.8 Hydrogeology

Hydrogeological System

2.8.1 The overlying superficial deposits (Glacial Till), where present, are classified as a Secondary Undifferentiated Aquifer by the Environment Agency. The Cadeby Formation (Magnesian Limestone) is classified as a Principal Aquifer by the Environment Agency (DEFRA, 2021), which is defined as "geology that exhibit high permeability and/or provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale". Groundwater flow and storage within the Principal Aquifer is associated with the secondary permeability of the formation, governed by fractures, fissures and joints.

2.8.2 Given the sparse cover of superficial deposits at the Site, the section of the aquifer within the Site can predominantly be considered as unconfined.

Hydraulic Properties

2.8.3 At a regional scale, the extent of fracturing is the biggest control on the aquifer properties of the Magnesian Limestone, and to a lesser extent the lithology and structure. The nature of fracturing is unpredictable, which can therefore lead to large variations in hydraulic conductivity and transmissivity (Allen *et al.*, 1997). The Cadeby Formation is part of the Lower Magnesian Limestone, with a given range of 1.9 x 10^{-6} m/d to 0.85 m/d, based on core data (Allen *et al*., 1997).

2.8.4 Hydraulic testing was undertaken during the 2019 WA SI, to obtain aquifer properties and improve the conceptual understanding of the Site. Falling Head Tests (FHT) were undertaken in all four boreholes during drilling Appendix A). The results are described in the Factual Site Investigation and Monitoring Report and a summary of the calculated indicative hydraulic conductivity values is summarised in Table 6.

Table 7: Summary of Falling Head Test Results

Borehole	Depth Tested (m bgl)	Geology Tested	Hydraulic Conductivity (m/d)
BHWA01	1.35 - 53	Limestone	0.0143
BHWA02	1.42 - 40	Limestone	4.48 x 10^{-4}
BHWA03	1.1 - 35.3	Limestone	5.37 x 10^{-4}
BHWA04	1.3 - 40	Limestone & Mudstone	1.55 x 10^{-3}

Notes
m bgl – metres below ground level

2.8.5 The FHTs were undertaken within the limestone within boreholes BHWA01, BHWA02 and BHWA03, and within the limestone and mudstone within borehole BHWA04. The calculated indicative values of hydraulic conductivity fall within the range of given values by Allen *et al.* (1997) and can be considered both reasonable and representative of the aquifer.

Groundwater Elevations

2.8.6 Groundwater elevation monitoring has been undertaken within the Cadeby Formation at four locations around the Site at boreholes BHWA01 to BHWA04 and at BH8 within the centre of the existing quarry void. The borehole locations are shown in NT14621-HRA-001. Groundwater level monitoring commenced in December 2019, initially using manual dips. Absolute water level elevations in m AOD were calculated by reducing water levels against surveyed datums. Subsequently, continuous data loggers were installed in July 2020, recording data hourly. Continuous groundwater elevation data was compensated using an on-site barometric logger.

2.8.7 Table 7 shows the manually recorded groundwater elevations from the boreholes around the Site.

Table 7: Manual Groundwater Elevation Measurements - The Site

Date	Measured By	Dip Level (m BTOC)					Groundwater Elevation (m AOD)				
		BH WA01[2]	BH WA02	BH WA03	BH WA04	BH8[1]	BH WA01	BH WA02	BH WA03	BH WA04	BH8[1]
Casing Elevation (m AOD)		*141.93*	*141.67*	*139.98*	*139.02*	118.67	*141.93*	*141.67*	*139.98*	*139.02*	118.67
23/12/2019	LQ	Dry	34.3	25.5	22.7	-	Dry	107.37	114.48	116.32	-
06/02/2020	LQ	Dry	34.6	24.5	22.0	-	Dry	107.07	115.48	117.02	-
07/04/2020	LQ	34.7	29.8	22.7	19.9	-	107.23	111.87	117.28	119.12	-
06/05/2020	LQ	34.5	32.7	22.7	20.3	-	107.43	108.97	117.28	118.72	-
03/06/2020	LQ	34.6	34.6	22.9	20.7	-	107.33	107.07	117.08	118.32	-
09/07/2020	WA	35.5	35.8	23.5	21.5	-	106.43	105.87	116.48	117.52	-
19/08/2020	WA	35.8	36.43	24.12	22.04	-	106.13	105.24	115.86	116.98	-
15/09/2020	WA	36.2	36.6	24.6	22.5	-	105.73	105.07	115.38	116.52	-
13/10/2020	WA	36.4	36.3	24.8	23.5	-	105.53	105.37	115.18	115.52	-
17/11/2020	WA	36.43	35.76	24.85	22.72	9.50	105.50	105.91	115.13	116.3	109.17
17/12/2020	WA	36.43	35.75	24.83	22.54	8.00	105.50	105.92	115.15	116.48	110.67
19/01/2021	WA	-	-	23.79	21.2	-	-	-	116.19	117.82	-
26/01/2021	WA	35.4	29.7	23.5	20.34	6.20	106.13	111.97	116.48	118.68	112.47
16/02/2021	WA	34.0	27.6	22.1	18.9	3.70	107.53	114.07	117.88	120.12	114.97
10/03/2021	WA	32.8	27.6	21.6	18.8	3.70	108.73	114.07	118.38	120.22	114.97
13/04/2021	WA	32.6	29.3	21.8	19.5	5.25	108.93	112.37	118.18	119.52	113.42
11/05/2021	WA	32.9	32.0	22.1	20.0	5.35	108.63	109.67	117.88	119.02	113.32
08/06/2021	WA	33.56	32.2	22.48	20.23	6.87	107.97	109.47	117.50	118.79	111.8
08/07/2021	WA	33.95	34.17	22.95	20.83	7.00	107.58	107.50	117.03	118.19	111.67
19/10/2021	WA	35.56	36.65	24.48	22.54	7.83	105.97	105.02	115.5	116.48	110.84
08/02/2022	WA	36.89	37.62	26.05	24.10	9.95	104.64	104.05	113.93	114.92	108.72
17/05/2022	WA	-	36.96	25.43	23.35	6.00	-	104.71	114.55	115.67	112.67
31/08/2022	WA	37.53	38.11	26.57	24.66	Dry	104	103.56	113.41	114.36	Dry
29/11/2022	WA	38.06	37.71	27.23	24.95	9.50	103.47	103.96	112.75	114.07	109.17

Notes
LQ - Lightwater Quarries (the Client) WA - Wardell Armstrong
m BTOC – Metres Below Top of Casing m AOD – Metres Above Ordnance Datum
- No measurement recorded
[1] Updated casing elevation following March 2021 topographic survey
[2] No top hat since December 2020, dip level from ground level (Elevation: 141.53m AOD)

2.8.8 Groundwater elevation data (December 2019 to November 2022) for the Site is presented in Appendix B. Rainfall data from Ripon (WeatherOnline, 2022) is displayed for context. Manual groundwater dip levels measured between December 2019 and April 2020 demonstrate that groundwater elevations rose, in response to winter rainfall recharge. Between April 2020 and October 2020, groundwater elevations have shown a general decline. Groundwater elevations rose from November 2020 with a rapid increase from December 2020 to the peak groundwater elevations in March 2021. Groundwater elevations would be expected to be at their highest in spring, in response to winter rainfall events. Between March 2021 and February 2022 groundwater elevations gradually declined, increasing slightly between February and April 2022 before continuing to decline to the latest data point in November 2022. Groundwater elevations in BH8 show more variability than other boreholes and appear to be trending upwards towards the end of the dataset in November 2022.

2.8.9 A more rapid increase in groundwater elevation is recorded in borehole BHWA02 in January 2021 compared to the other groundwater monitoring boreholes. To confirm the validity of the groundwater elevation data in this borehole the screened interval and depth to base data have been reviewed. Borehole BHWA02 is screened across a similar elevation to the other groundwater monitoring boreholes. The recorded depth to base for borehole BHWA02 is presented against the recorded groundwater elevation data in Appendix A. The depth to base data indicate that there may have been some silting of the borehole and the borehole was developed in January 2021. However, a sufficient water column was maintained in boreholes BHWA02 throughout the ongoing baseline groundwater monitoring, providing validity to the quality of groundwater sample obtained.

Groundwater Flow

2.8.10 The groundwater elevation data indicates that the hydraulic gradient generally follows a north-west to south-east orientation across the Site, coinciding with the dip of the limestone beds. The direction of groundwater flow fluctuates across the Site dependant on groundwater elevation; flow is orientated more easterly during the groundwater low in February 2022 (shown in NT14621-HRA-002), and more southernly during the groundwater high in March 2021 (NT14621-HRA-003).

2.8.11 The hydraulic gradient has remained relatively consistent throughout groundwater elevation monitoring. The hydraulic gradient was calculated as 0.017 in February 2022 during the groundwater low, and as 0.021 in March 2021 during the groundwater high.

2.8.12 Boreholes BHWA04 and BHWA03 are located hydraulically upgradient of the Site, whilst boreholes BHWA01 and BHWA02 are located downgradient of the Site.

Groundwater elevations tend to be lowest in borehole BHWA02, east of the Site, with the lowest recorded elevation of 104.05m AOD in February 2022.

2.8.13 Groundwater flow within the Cadeby Formation is dominated by secondary permeability, a combination of flow within fractures, fissures and joints. There is a minor component of intergranular storage, however this low due to the low intrinsic permeability of the Limestone.

Groundwater Quality

2.8.14 Groundwater underlying the Site resides entirely within the SUNO Magnesian Limestone groundwater body (ID: GB40401G701800) (Environment Agency, 2021c). In 2019, the groundwater body was classified as having a chemical status of 'Good' and a quantitative status of 'Good'.

2.8.15 Groundwater quality sampling has been carried out by WA between August 2020 to November 2022, consisting of a total of 13 monitoring rounds. Groundwater samples were obtained from four boreholes (BHWA01-BHWA04) and results are presented in Appendix C. Results have been compared against the UK Drinking Water Standards (UKDWS) and Environmental Quality Standards (EQS). Following completion of 13 monitoring rounds, the average has been calculated for determinands where the EQS value given is for the long term annual average.

2.8.16 The following determinands have been detected above the laboratory method detection limit (MDL) in at least one groundwater monitoring borehole between August 2020 and November 2022:

- Inorganics: ammoniacal nitrogen as N, chloride, nitrite, nitrate, total oxidised nitrogen and sulphate; and
- Metals: cadmium, calcium, copper, chromium, lead, manganese, magnesium, nickel, potassium, sodium and zinc.

2.8.17 The following determinands have been detected above the UK Drinking Water Standards (DWS) in at least one groundwater monitoring borehole:

- Inorganics: nitrite and nitrate; and
- Metals: manganese and magnesium.

2.8.18 No determinands have been detected over the Environmental Quality Standards (EQS) Short Term Maximum Allowable Concentration (MAC) between August 2020 and February 2022.

2.8.19 The following determinands have been detected above the EQS Long Term Annual Average (LTAA):

- Metals: cadmium, chromium, copper and zinc.

2.8.20 The average for copper in boreholes BHWA01, BHWA02 and BHWA03 exceeds the EQS LTAA.

2.8.21 Time series graphs for nitrite, nitrate, cadmium, chromium, copper, manganese, magnesium and zinc are presented in Appendix D. Appendix D also includes graphs of chloride, sulphate, lead and arsenic for which compliance limits are proposed (see Section 4.6). Determinands that exceed the UKDWS or where the average exceeds the EQS LTAA are discussed below.

2.8.22 Nitrite concentrations have exceeded the UKDWS on four occasions in BHWA04 with the highest concentration in September 2020. Nitrate has been identified to exceed the UKDWS on at least one occasion within every borehole. Nitrate concentrations have exceeded the UKDWS on eleven separate occasions within BHWA01, and nine in BHWA02, BHWA03 and BHWA04. The highest concentration in the November 2022 monitoring round was observed in BHWA01, in the south-west of the Site. Elevated nitrate concentrations are likely attributed to surrounding agricultural use.

2.8.23 Average copper concentrations were found to exceed the EQS LTAA in all boreholes, which may be attributed to the use of copper within some fungicides on surrounding agricultural land.

2.8.24 Manganese was identified to exceed the UKDWS in BHWA01, and magnesium was identified to exceed the UKDWS in BHWA01 and BHWA03, which is likely to be attributed to the use of fertilisers on surrounding agricultural land.

2.9 Licenced Abstractions

2.9.1 The Environment Agency have provided data on licenced abstractions within a 2km radius of the Site, which are outlined in Table 8. The locations of the abstractions are shown in NT14621-HRA-004.

Table 8: Licenced Abstractions Located within 2km of the Site

Licence Number	Name	Sector	Water Use	Abstracted Water Quantity		Source Type and Name	NGR	Distance From Site (km)
				Annual Max (m^3)	Daily Max (m^3)			
2/27/23/391	W H Greensit & Sons	Agriculture	Spray Irrigation - Direct	33,000	981.93	Groundwater: Borehole - Magnesian Limestone – Bedale	SE 24300 82800	0.52 east
2/27/22/010	Tarmac Aggregates LTD	Industrial, Commercial and Public Services	Dust suppression General Use Relating to Secondary Category (Medium Loss) Mineral Washing	983,810	4,015	Groundwater: Gravel Workings - Superficial Drift – Masham	SE 21687 82582	1.64 west
2/27/22/417	C H Greensit LTD	Agriculture	Spray Irrigation - Direct	8,220	513.7	Surface Water: River Ure, Masham	SE 23100 80670	1.48 south west
2/27/22/475	The Black Sheep Brewery PLC	Industrial, Commercial and Public Services	General Use Relating to Secondary Category (Medium Loss)	44,000	158	Groundwater: Borehole - Millstone Grit – Masham	SE 22380 81100	1.80 south west
						Groundwater: Borehole - Millstone Grit – Wellgarth	SE 22410 81120	1.83 south west
NE/027/0022/050	T & R Theakston LTD	Industrial, Commercial and Public Services	Process Water	27,000	134	Groundwater: Borehole - Millstone Grit – Masham	SE 22288 80778	1.86 south west
2/27/23/729/R01	Websters (Farmers) LTD	Agriculture	Spray Irrigation - Direct	34,000	925	Groundwater: Borehole - Magnesian Limestone – Bedale	SE 25993 81250	1.89 south east
2/27/22/051	T & R Theakston LTD	Industrial, Commercial and Public Services	General Use Relating to Secondary Category (Medium Loss)	4,660	68.19	Groundwater: Borehole - Millstone Grit - Ripon	SE 22300 81000	1.95 south west
2/27/22/017	T & R Theakston LTD	Industrial, Commercial and Public Services	General Cooling (Existing Licences Only) (Low Loss)	19,548	54.55	Groundwater: Well – Superficial Drift - Masham	SE 22200 80700	1.95 south west

2.9.2 Private Water Supplies

2.9.3 Private Water Supplies (PrWS) within a 2km radius of the Site have been identified from data provided by Harrogate Borough Council and Hambleton District Council. According to the public registers, two PrWS have been identified within a 2km radius of the Site. The first is licenced to Black Sheep Brewery (also licenced by the EA: 2/27/22/475) located in Crosshills, Masham, and is an abstraction of groundwater (unknown quantity) used for commercial processes. The second is an unnamed spring source abstraction of $1m^2$/d located in the vicinity of Mobray Hill Farm, approximately 1.95km south-east of the Site, and is used for domestic processes. The locations of the PrWS are shown in NT14621-HRA-004.

2.9.4 In May 2021 WA were advised by the Client of an unregistered PrWS at East Gebdykes Farm, located c.10m south-west of the Site. The landowner was contacted however was unable to provide a borehole log for the PrWS, or to confirm the geology that the PrWS abstracts water from. However, the landowner also reports that the borehole was targeted at the lower aquifer system (Millstone Grit) and is between 80 – 90m deep.

2.9.5 WA understands that whilst both properties at East Gebdykes Farm have access to mains water this is only used during periods when the pump within the PrWS is not operational i.e., during equipment failure. The PrWS is the preferred, primary source of water for the properties.

2.9.6 During the June 2021 water quality monitoring round WA obtained an additional sample from a tap on East Gebdykes Farm which is fed solely by the East Gebdykes Farm PrWS to enable chemical comparison between the water from the PrWS and the samples obtained at the Site. Although the physicochemical signature and redox conditions are similar in both the PrWS and the four onsite boreholes, the following key observations were made:

- calcium concentrations are 1.5 times higher in the PrWS than in the onsite boreholes;
- magnesium is present at half the concentration of the onsite boreholes. The onsite boreholes are installed within the Magnesian Limestone, which is a clear source of magnesium;

- copper and nickel are both detected an order of magnitude higher than the laboratory limit of detection within the PrWS, however were not recorded above the laboratory limit of detection within the onsite boreholes;
- sulphate was not detected above the laboratory limit of detection within the PrWS, and was recorded at concentrations between 30 – 45mg/l within the onsite boreholes; and
- zinc concentrations within the PrWS were three orders of magnitude higher than those recorded within the onsite boreholes.

2.9.7 As a result, it is likely that the PrWS is installed within a different geological formation to the onsite boreholes.

2.10 Discharges

2.10.1 There are 12 discharges within 2km of the Site, which are presented in Table 9. The majority of the discharges relate to private, or water company discharges to surface water. There is one discharge permit and three outlets for trade effluent Marfield Quarry and one discharge to land of treated domestic sewage at High Mains Cottage.

Table 9: Permitting Discharges within 2km of the Site

Permit Number	Site Name	Discharge Type	Receiving Waterbody	Outlet NGR	Distance From Site (km)
S/P/1540	6 Station Bungalow	WwTW (not water co) (not STP at a private premises)	River Ure	SE 23100 82100	0.40 south west
27/22/0107	Old Station Yard Holiday Park	Domestic Sewage	Unnamed Trib of the River Ure	SE 23060 81050	1.15 south west
27/22/0056	Shooting Holm SPS	Pumping Station on Sewerage Network (water company)	River Ure Via a Land Drain	SE 22640 81010	1.44 south west
27/22/0161	Leyburn Road CSO	Storm Tank/CSO on Sewerage Network (water company)	Tributary Of River Ure	SE 22580 81010	1.47 south west
27/22/0063	Masham Sewage Treatment Works	Sewage	River Ure	SE 23080 80630	1.51 south west
27/22/0162	Millgate Masham CSO	Storm Tank/CSO on Sewerage Network (water company)	Trib Of River Ure	SE 22714 80804	1.54 south west
QR.27/22/0030	Marfield Quarry (Masham)	Mineral/Gravel Extraction/Quarrying Trade Effluent	Lagoon At Marfield Pit	SE 21730 82530	1.60 west

Table 9: Permitting Discharges within 2km of the Site					
Permit Number	**Site Name**	**Discharge Type**	**Receiving Waterbody**	**Outlet NGR**	**Distance From Site (km)**
			Unnamed Trib of River Ure	SE 21730 82530	1.60 west
				SE 21590 82480	1.77 west
27/22/0132	Silver Street CSO	Storm Tank/CSO on Sewerage Network (water company)	Trib Of River Ure	SE 22538 80845	1.62 south west
C5482	High Mains Cottage	WwTW (not water co) (not STP at a private premises)	Discharge to Land	SE 21700 83300	1.76 north west
S/P/859	Marfield Pit	Domestic Sewage (multiple) (incl farm houses)	River Ure	SE 21500 82500	1.82 west

Note
SPS = Sewage Pumping Station
CSO = Combined Sewer Overflows
WwTW= Waste Water Treatment Works
STP = Sewage Treatment Plant
Trib = Tributary

3 CONCEPTUAL HYDROGEOLOGICAL SITE MODEL

3.1.1 A hydrogeological cross-section is included as NT14621-HRA-005 to show the main hydrogeological pathways at the Site. The Conceptual Hydrogeological Site Model (CHSM) is discussed in the form of “source, pathway and receptors” below.

3.2 Sources

3.2.1 The source will be the inert waste disposed during the restoration of the existing quarry void.

3.3 Pathways

3.3.1 Pathways for potential pollutant migration include any route from the inert waste (the Source) to the receptors.

3.3.2 There is a potential pathway for potential pollutants to migrate through the side wall liner into the Cadeby Formation (Principal Aquifer) or into the Glacial Till (Secondary Undifferentiated Aquifer) where present.

3.3.3 There is a potential pathway for the migration of potential pollutants via basal leakage to the underlying bedrock aquifer. Initially potential pollutants must migrate through the basal liner. As illustrated on NT14621-HRA-005 the base on the landfill is above the water table in the Cadeby Formation. The main pathway of downward migration will be through the unsaturated zone is via infiltration. Where the nature faulting, fissuring and jointing is extensive, another pathway may exist leading to the rapid migration of potential pollutants through the unsaturated zone.

3.3.4 Runoff from outside the operational areas of the Site will be allowed to infiltrate into the underlying bedrock with no discharge off Site. Surface water runoff from the operational areas of the Site will be prevented from infiltrating directly into the underlying bedrock and instead intercepted and diverted to a large lagoon to the north of the void area. The lagoon will be lined by a 1m thick layer of engineered clay, with no pathway for infiltration. Water within the lagoon will be tested for contamination. Any contaminated water will be isolated and mitigative measures to treat or remove the water will be undertaken. Uncontaminated water will be pumped as required to areas of quarry void outside of the development areas (within the wider quarry site) where it will infiltrate to ground.

3.4 Receptors

3.4.1 The potential groundwater receptors are groundwater in the Principal Aquifer (Cadeby Formation). Down-gradient groundwater abstractions from the Cadeby Formation also represent a secondary receptor, including the licenced abstraction 2/27/23/729/R01 and Mobray Hill Farm PrWS located 1.95km east of the Site.

3.4.2 The superficial deposits (Glacial Till) are a Secondary Undifferentiated Aquifer, however these deposits are absent from the majority of the Site. Thin superficial deposits (<1m thick) were recorded in borehole BHWA04 only and no water strikes were recorded in these deposits.

3.4.3 Potential surface water receptors include the two unnamed ponds at Snape Lodge Farm 0.4km to the east of the Site, and at Low Burton Wood, 0.37km to the south-west of the Site. The pond at Snape Lodge Farm is located down-hydraulic gradient of the Site, however the expected basal elevations of the pond are much higher than groundwater elevations at the Site, so it is unlikely that there is any interaction between groundwater and the pond. Additionally, there is no permanent drainage channel to the pond. Likewise, for the pond at Low Burton Wood there is also no permanent drainage channel and the pond is located up-hydraulic gradient of the Site, therefore interactions between groundwater and the pond are unlikely.

3.4.4 Other potential surface water receptors include the River Ure, located 0.9km to the west of the Site, which can be considered a sensitive receptor, as it is part of both a nitrate vulnerable water body and achieved a WFD Chemical Status of Fail in 2019 (Environment Agency, 2021b). However, the River Ure is located up-hydraulic gradient and there is no known permanent drainage channel from the Site to the river.

4 HYDROGEOLOGICAL RISK ASSESSMENT

4.1 Hydrogeological Risk Assessment Methodology

4.1.1 Given that the proposed landfill will accept only clean inert material, which by definition means that they will not undergo any significant physical, chemical or biological transformations and will not generate leachate, the material presents a low potential risk. A Generic Quantitative Risk Assessment (GQRA) is considered appropriate for an inert landfill on a Principal Aquifer based on Environment Agency guidance. The level of risk assessment was agreed with the Environment Agency as part of the pre-application process.

4.2 Priority Contaminants to be Modelled

4.2.1 Given the inert nature of the material and the strict pre-acceptance and acceptance procedures that will be in place for the Site it is unlikely that any leachate will contain any significant contamination.

4.2.2 It is considered that clean inert material could contain trace amounts of chloride, sulphate and lead and compliance limits have been proposed for these substances (Section 4.6). Chloride is a non-hazardous pollutant that is typically used as an indicator species to provide information regarding potential groundwater contamination from non-inert material as chloride can reach high concentrations in landfill leachate generated from degradable material from non-confirming wastes. Chloride is relatively persistent in the environment and is not easily retarded. Sulphate is representative of inorganic anions that may be present in any construction waste that contains concrete or small amounts of plasterboard or similar products. Fluoride (non-hazardous pollutant), and arsenic and lead (hazardous substances) may be present in paints/glazes used on ceramic products or tiles and arsenic and lead have been selected as an indicator of pollution from these types of materials.

4.2.3 The source term for the inert waste is based on proposed waste types and Waste Acceptance Criteria (WAC) values for inert waste (Appendix E). WAC data have been compared to the UKDWS and a “risk factor” has been calculated by dividing the WAC data by the UKDWS. Each determinand has been ranked based on the calculated risk factor. Lead and arsenic have the highest risk factor (both 5) which confirms that lead and arsenic are the key contaminants of concern and these contaminants have been modelled. Chloride has a risk factor of 0.32 (i.e. the WAC leachate concentration (80mg/l) is lower than the UKDWS (250mg/l)) and sulphate has a risk factor of 0.4 (i.e.

the WAC Leachate concentration (100mg/l) is lower than the UKDWS (250mg/l)). Chloride and sulphate have not been modelled as the risk factors are below one.

4.2.4 Interim compliance limits have been proposed for chloride, sulphate, lead and arsenic in Section 4.6. Monitoring of groundwater quality will include additional hazardous substances and non-hazardous pollutants, as detailed in Section 5.

4.3 LandSim Model

4.3.1 As discussed in Section 4.2 above, priority contaminants to be modelled are lead and arsenic. A simple LandSim model was developed for the Site to support the permit application. The model parameterisation based on site specific information (where available) and conservative assumptions is summarised in Table 10. The thickness of the unsaturated zone is set at zero for conservatism. The LandSim model inputs are included as Appendix F and the results are included as Appendix G. Electronic model files are included in Appendix H.

4.3.2 The model results are assessed against Environmental Assessment Limits (EALs). For hazardous substances, the EALs are typically based on the Minimum Reporting Values (MRV). If there is no published MRV, as is the case for lead and arsenic, the EAL is based on the laboratory method limit of detection (LOD).

4.3.3 Modelling results show maximum modelled 95th percentile concentrations at the base of the unsaturated zone are lower than the EAL for both lead and arsenic.

Table 10: Modelled Concentrations of Hazardous Substances at Base of the Unsaturated Zone

	95^{th} Percentile Concentration (mg/l)	Model Year of Occurrence of Peak Concentration	EAL (mg/l)
Lead	2.83E-14	13,458	0.01*
Arsenic	2.123E-3	1,681	0.01*

Notes
* Based on laboratory method LOD as no published MRV

4.4 Lifecycle Phases

4.4.1 Given the inert nature of the material, the absence of any biodegradable materials and the strict pre-acceptance and acceptance procedures that will be in place for the Site the physical characteristics of the deposited material are envisaged to remain constant. It is unlikely that there will be any significant change in quality of any leachate generated over the life of the Site.

4.4.2 The basal and side slope lining systems will be an artificially established geological barrier. Due to the inert nature of the waste it is not necessary to provide an artificial sealing layer above this mineral layer. In the absence of an artificial sealing layer the integrity of the containment system is unlikely to change with time.

4.4.3 The hydrogeological risk assessment presented is therefore considered appropriate for all stages of the landfill's lifecycle from operational to closure.

4.5 Accidents and Their Consequences

4.5.1 The possibility of rogue loads of non-inert material being deposited at the Site is considered in the selection of priority contaminants (Section 4.2). Non-inert material may lead to the generation of leachate containing potentially polluting substances. However, in the unlikely event of this occurring it is considered that the concentrations of pollutants within a leachate would be low due to the relatively low volume of any non-inert material within the landfill.

4.6 Review of Technical Precautions

4.6.1 The basal and sidewall lining system will be constructed in accordance with the requirements of the Landfill Directive. That is, there will be an artificially established geological barrier on the base 0.65m thick and greater than 0.65m thick on the side walls of the landfill. The layer will have a permeability equal to or less than $6.5x10^{-8}$m/s. The artificially established geological barrier will typically comprise either crushed and screened dolomite fines or a clay rich material.

4.6.2 Due to the inert nature of the material there is no requirement to prevent the formation of leachate. No formal capping is required, however the site will be restored with topsoil and returned to agricultural use.

4.6.3 The primary measure to prevent the deposition of rogue loads of non-inert material at the Site is the strict adherence to material acceptance criteria. The technical precautions are summarised in NT14621 - Operating Techniques.

4.6.4 The monitoring scheme is discussed in Section 5.

4.7 Emissions to Groundwater

Hazardous Substances

4.7.1 For hazardous substances, the compliance point would be the point at which the substance would enter groundwater below the Site.

Non-Hazardous Pollutants

4.7.2 For non-hazardous pollutants, the compliance point would be groundwater immediately downgradient of the Site boundary.

4.8 Surface Water Management

4.8.1 The Site is designed to allow surface water to either infiltrate at source into the highly permeable bedrock or flow overland into the quarry void, where it will then infiltrate into the bedrock. There is no surface water discharge from the Site. Details of the surface water management are included in the Operating Techniques report.

4.9 Hydrogeological Completion Criteria

Groundwater

4.9.1 Groundwater compliance limits have been proposed for chloride, sulphate, lead and arsenic (Table 11) for BHWA03 and BHWA04, based on the recorded concentrations during the baseline groundwater monitoring. Statistical analysis and graphical plots of chloride, sulphate, lead and arsenic are shown within Appendix I.

Table 11: Proposed Groundwater Compliance Limits (mg/l)

Substance	Hazardous Substance / Non-Hazardous Pollutant	UKDWS (mg/l)	MRV for Hazardous Substances	Proposed Compliance Limit BHWA03 (mg/l)	Proposed Compliance Limit BHWA04 (mg/l)	Basis
Chloride	Non-Hazardous Pollutant	250	N/A	37.1	47.9	Mean plus 3 standard deviations
Sulphate	Non-Hazardous Pollutant	250	N/A	46	54	Mean plus 3 standard deviations
Lead	Hazardous Substance	0.01	0.01*	0.002	0.001	Mean plus 3 standard deviations
Arsenic	Hazardous Substance	0.01	0.01*	0.001	0.001	Mean plus 3 standard deviations

Notes:
MRV = Minimum Reporting Value for hazardous substance. Where an MRV is not defined by the Environment Agency the laboratory method limit of detection has been used (indicated by *).

4.10 Surface Water

Surface water from the lagoon in the north of the void will be tested for contamination prior to being allowed to infiltrate to ground. As no surface water is currently present on Site, and therefore no monitoring data is available, preliminary compliance limits will be set in line with those for BHWA03.

5 REQUISITE SURVEILLANCE

5.1 The Risk Based Monitoring Scheme

5.1.1 A programme of groundwater and surface water monitoring has been implemented at the Site to provide baseline data on groundwater elevations and groundwater and surface water quality. It is proposed to maintain existing groundwater monitoring infrastructure to enable ongoing monitoring as described below.

5.2 Leachate Monitoring

5.2.1 Due to the low leaching potential of the clean inert material to be accepted no leachate collection infrastructure will be required and no leachate monitoring undertaken.

5.3 Groundwater Monitoring

5.3.1 Four boreholes have been installed at the Site to allow for background groundwater monitoring of the Cadeby Formation. Boreholes BHWA03 and BHWA04 are located west of the Site, and it is proposed to retain both boreholes as upgradient monitoring boreholes. Boreholes BHWA01 and BHWA02 are located east and south-east of the Site, and it is therefore proposed to retain both boreholes as downgradient monitoring boreholes. Due to the variation in groundwater flow directions (Section 2.7.4) it is proposed to install an additional downgradient monitoring borehole on the southern boundary of the Site to improve the monitoring network during the operational phase (see NT14621-HRA-006).

5.3.2 Following completion of the initial twelve months of groundwater monitoring to establish baseline conditions, both the frequency of monitoring and the sampling suite is proposed to be reduced in line with Environment Agency guidance on operational monitoring for inert landfills. It is proposed that these boreholes will be maintained and monitored every six months with groundwater levels recorded and groundwater samples taken for chemical analysis. In addition to the groundwater elevation it is proposed to also record the dip to base for each borehole to enable assessment of borehole condition as required. The proposed groundwater monitoring schedule is summarised in Table 12.

Table 12: Groundwater Monitoring Schedule		
Borehole	**Frequency**	**Determinand**
BHWA01, BHWA02, BHWA03, BHWA04	Every six months	Groundwater elevation. Dip to base. Chloride, Nitrite, Nitrate, Nitrogen, Sulphate, Cyanide, Lead, Arsenic, Cadmium, Calcium, Copper, Chromium, Manganese, Magnesium, Mercury*, Nickel, Potassium, Selenium, Sodium and Zinc.
Note: * The laboratory method LOD for the baseline monitoring is 0.1µg/l which is higher than the MRV for mercury (0.01µg/l), it is recommended that a LOD of 0.01µg/l be used.		

5.4 Surface Water Monitoring

5.4.1 Surface water from the lined detention basin is proposed to be monitored for the same suite outlined for groundwater monitoring above, prior to discharge to land.

6 CONCLUSIONS

6.1.1 A Conceptual Hydrogeological Site Model was developed in Section 3, following a review of the baseline conditions for the Site. Groundwater was identified as the key pathway for the potential migration of pollutants. The key pathways include: 1. The potential migration of pollutants through the sidewall liner into the superficial aquifer (where present) and bedrock aquifer, and 2. The potential migration of pollutants through basal leakage into the underlying bedrock aquifer.

6.1.2 A Generic Quantitative Risk Assessment was conducted to model priority contaminants for the proposed inert landfill. LandSim modelling results showed that maximum modelled 95th percentile concentrations at the base of the unsaturated zone are lower than the EAL for the priority contaminants, lead and arsenic.

6.1.3 Due to the variation in groundwater flow directions observed during the baseline monitoring it is proposed to install an additional downgradient monitoring borehole on the southern boundary of the Site to improve the monitoring network during the operational phase. During the operational phase, groundwater monitoring is proposed within all current groundwater monitoring boreholes, and the proposed additional downgradient borehole, on a six-month basis.

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APPENDICES

APPENDIX A

Falling Head Tests

Falling Head Permeability Test in a Borehole

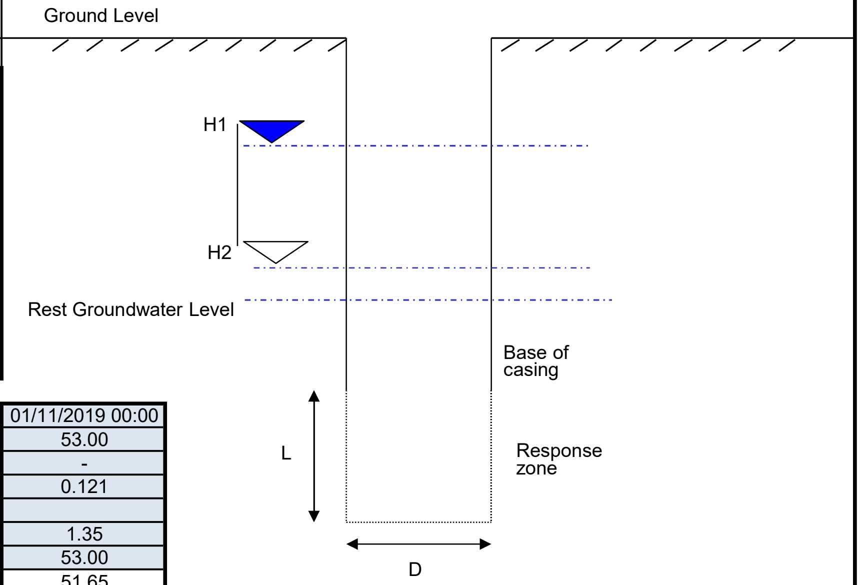
Project Name	Gebdykes Quarry Landfill Permit Application	Borehole ID	BHWA01
Project ID	NT14621	Operative	ID Drilling
Date of Test	01/11/2019	Checked	29/10/2020

Calculation of permeability (k) as per BS 5930, Section 25.4.6.1 (1999+A2:2010) - general approach

$$k = \frac{A \times \ln\left(H_1 / H_2\right)}{F \times (t_2 - t_1)} \qquad A = pi \times d^2/4$$

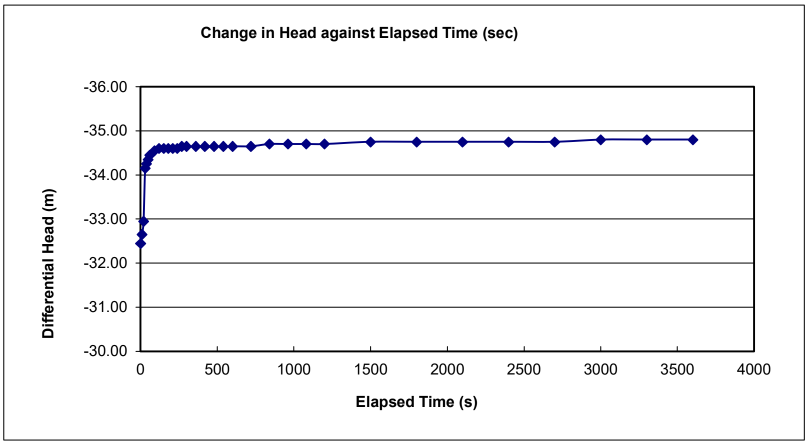
Where:
A = cross sectional area of borehole
H_1 = Head of water at time t_1
H_2 = Head of water at time t_2
F = Intake Factor

$$F = \frac{2\,pi \times L}{\ln\left(\left(L/D\right) + \left(1 + \left(L/D\right)^2\right)^{0.5}\right)}$$



Date of Test	01/11/2019 00:00
Depth of Borehole Below Ground Level (m)	53.00
Initial Groundwater Level (m BGL)	-
Diameter of borehole, D (m)	0.121
Top of response zone	1.35
Bottom of response zone	53.00
Length of response zone, L (m)	51.65
Intake Factor, F	48.07

Time (mins)	Elapsed Time (s)	Water depth (m BGL)	Differential Head, H (m)
	0	32.450	-32.45
	10	32.650	-32.65
	20	32.950	-32.95
	30	34.150	-34.15
	40	34.250	-34.25
	50	34.350	-34.35
	60	34.450	-34.45
	90	34.550	-34.55
	120	34.600	-34.60
	150	34.600	-34.60
	180	34.600	-34.60
	210	34.600	-34.60
	240	34.600	-34.60
	270	34.650	-34.65
	300	34.650	-34.65
	360	34.650	-34.65
	420	34.650	-34.65
	480	34.650	-34.65
	540	34.650	-34.65
	600	34.650	-34.65
	720	34.650	-34.65
	840	34.700	-34.70
	960	34.700	-34.70
	1080	34.700	-34.70
	1200	34.700	-34.70
	1500	34.750	-34.75
	1800	34.750	-34.75
	2100	34.750	-34.75
	2400	34.750	-34.75
	2700	34.750	-34.75
	3000	34.800	-34.80
	3300	34.800	-34.80
	3600	34.800	-34.80



Calculation of Permeability (k)

t_1 (s)	t_2 (s)	H_1 (m)	H_2 (m)	k (ms^{-1})
0	90	-32.45	-34.55	**-1.66E-07**

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CLIENT	Lightwater Quarries Ltd		
PROJECT	Gebdykes Quarry Landfill Permit Application		
FIGURE TITLE	FHT Analysis - BHWA01		
FIGURE NO.	DRAWN BY	APPROVED BY	DATE
FHT-01	BJ		29/10/2020

Falling Head Permeability Test in a Borehole

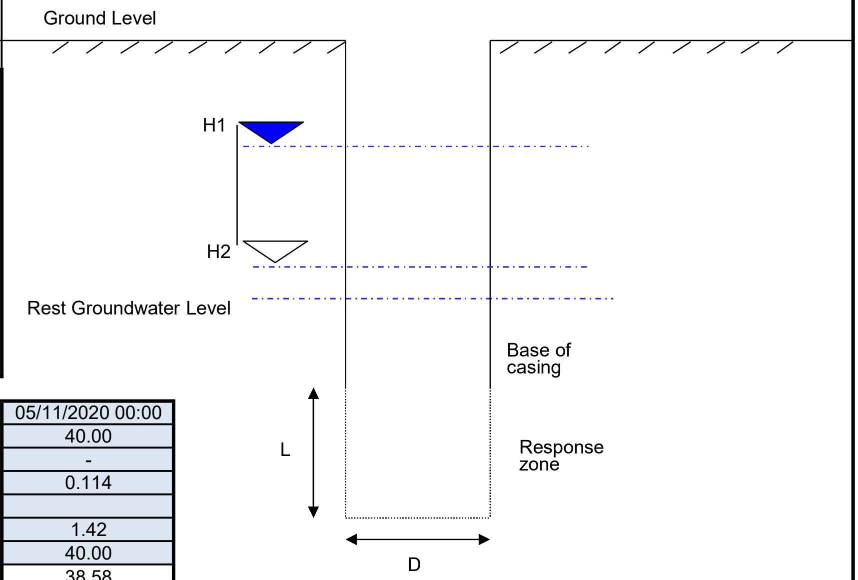
Project Name	Gebdykes Quarry Landfill Permit Application	Borehole ID	BHWA02
Project ID	NT14621	Operative	ID Drilling
Date of Test	05/11/2020	Checked	29/10/2020

Calculation of permeability (k) as per BS 5930, Section 25.4.6.1 (1999+A2:2010) - general approach

$$k = \frac{A \times \ln\left(\frac{H_1}{H_2}\right)}{F \times (t_2 - t_1)} \qquad A = pi \times d^2/4$$

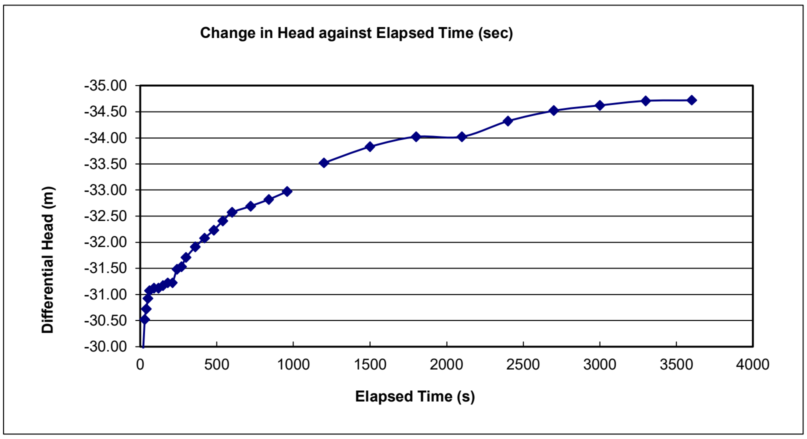
Where:
A = cross sectional area of borehole
H_1 = Head of water at time t_1
H_2 = Head of water at time t_2
F = Intake Factor

$$F = \frac{2\,pi \times L}{\ln\left(\left(\frac{L}{D}\right) + \left(1 + \left(\frac{L}{D}\right)^2\right)^{0.5}\right)}$$



Date of Test	05/11/2020 00:00
Depth of Borehole Below Ground Level (m)	40.00
Initial Groundwater Level (m BGL)	-
Diameter of borehole, D (m)	0.114
Top of response zone	1.42
Bottom of response zone	40.00
Length of response zone, L (m)	38.58
Intake Factor, F	37.21

Time (mins)	**Elapsed Time (s)**	**Water depth (m BGL)**	**Differential Head, H (m)**
	0	29.020	-29.02
	10	29.020	-29.02
	20	29.920	-29.92
	30	30.520	-30.52
	40	30.720	-30.72
	50	30.920	-30.92
	60	31.070	-31.07
	90	31.120	-31.12
	120	31.120	-31.12
	150	31.170	-31.17
	180	31.220	-31.22
	210	31.220	-31.22
	240	31.480	-31.48
	270	31.530	-31.53
	300	31.710	-31.71
	360	31.910	-31.91
	420	32.080	-32.08
	480	32.230	-32.23
	540	32.410	-32.41
	600	32.570	-32.57
	720	32.690	-32.69
	840	32.820	-32.82
	960	32.970	-32.97
	1080		
	1200	33.520	-33.52
	1500	33.830	-33.83
	1800	34.020	-34.02
	2100	34.020	-34.02
	2400	34.320	-34.32
	2700	34.520	-34.52
	3000	34.620	-34.62
	3300	34.710	-34.71
	3600	34.720	-34.72



Calculation of Permeability (k)

t_1 (s)	t_2 (s)	H_1 (m)	H_2 (m)	k (ms^{-1})
50	1800	-30.92	-29.92	**5.18E-09**

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CLIENT	Lightwater Quarries Ltd		
PROJECT	Gebdykes Quarry Landfill Permit Application		
FIGURE TITLE	FHT Analysis - BHWA02		
FIGURE NO.	DRAWN BY	APPROVED BY	DATE
FHT-02	BJ		29/10/2020

Falling Head Permeability Test in a Borehole

Project Name	Gebdykes Quarry Landfill Permit Application	Borehole ID	BHWA03
Project ID	NT14621	Operative	ID Drilling
Date of Test	08/11/2020	Checked	29/10/2020

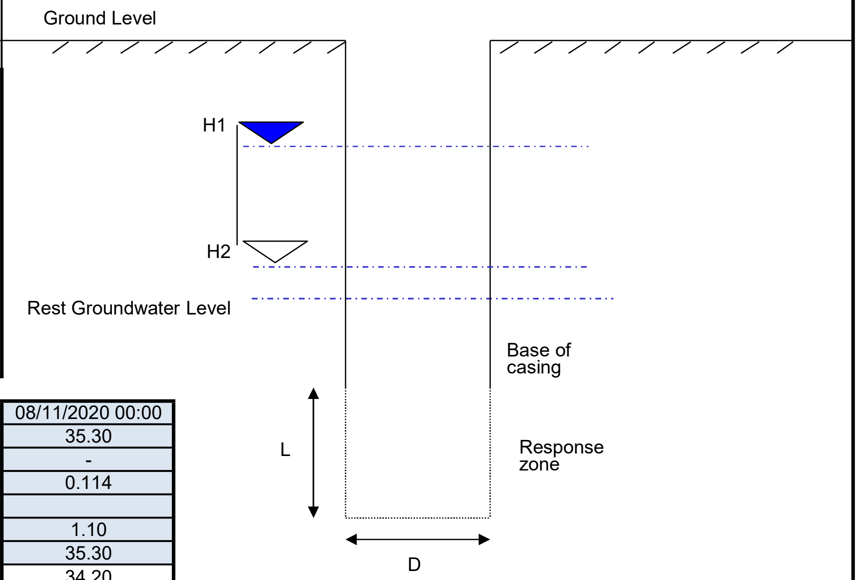
Calculation of permeability (k) as per BS 5930, Section 25.4.6.1 (1999+A2:2010) - general approach

$$k = \frac{A \times \ln\left(H_1 / H_2\right)}{F \times (t_2 - t_1)} \qquad A = pi \times d^2/4$$

Where:

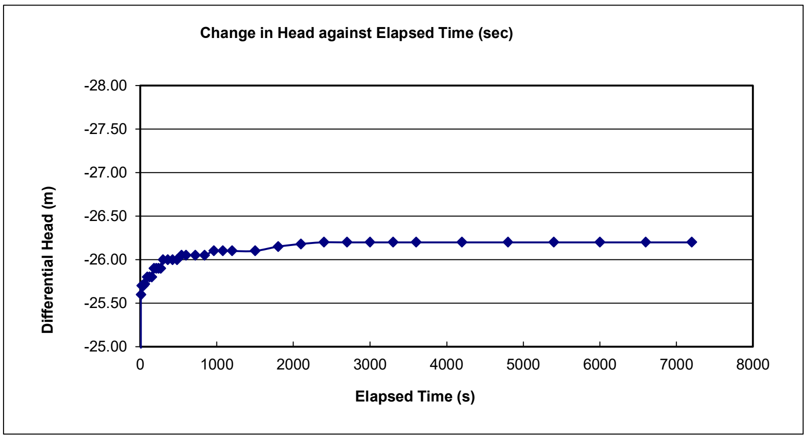
A = cross sectional area of borehole
H_1 = Head of water at time t_1
H_2 = Head of water at time t_2
F = Intake Factor

$$F = \frac{2\,pi \times L}{\ln\left(\left(L/D\right) + \left(1 + \left(L/D\right)^2\right)^{0.5}\right)}$$



Date of Test	08/11/2020 00:00
Depth of Borehole Below Ground Level (m)	35.30
Initial Groundwater Level (m BGL)	-
Diameter of borehole, D (m)	0.114
Top of response zone	1.10
Bottom of response zone	35.30
Length of response zone, L (m)	34.20
Intake Factor, F	33.61

Time (mins)	Elapsed Time (s)	Water depth (m BGL)	Differential Head, H (m)
	0		0.00
	10	25.600	-25.60
	20	25.700	-25.70
	30	25.700	-25.70
	40	25.700	-25.70
	50	25.720	-25.72
	60	25.720	-25.72
	90	25.800	-25.80
	120	25.800	-25.80
	150	25.800	-25.80
	180	25.900	-25.90
	210	25.900	-25.90
	240	25.900	-25.90
	270	25.900	-25.90
	300	26.000	-26.00
	360	26.000	-26.00
	420	26.000	-26.00
	480	26.000	-26.00
	540	26.050	-26.05
	600	26.050	-26.05
	720	26.050	-26.05
	840	26.050	-26.05
	960	26.100	-26.10
	1080	26.100	-26.10
	1200	26.100	-26.10
	1500	26.100	-26.10
	1800	26.150	-26.15
	2100	26.180	-26.18
	2400	26.200	-26.20
	2700	26.200	-26.20
	3000	26.200	-26.20
	3300	26.200	-26.20
	3600	26.200	-26.20
	4200	26.20	-26.20
	4800	26.2	-26.20
	5400	26.2	-26.20
	6000	26.2	-26.20
	6600	26.2	-26.20
	7200	26.2	-26.20



Calculation of Permeability (k)

t_1 (s)	t_2 (s)	H_1 (m)	H_2 (m)	k (ms^{-1})
10	960	-25.60	-26.10	**-6.22E-09**

CLIENT	Lightwater Quarries Ltd		
PROJECT	Gebdykes Quarry Landfill Permit Application		
FIGURE TITLE	FHT Analysis - BHWA03		
FIGURE NO.	DRAWN BY	APPROVED BY	DATE
FHT-03	BJ		29/10/2020

Falling Head Permeability Test in a Borehole

Project Name	Gebdykes Quarry Landfill Permit Application	Borehole ID	BHWA04
Project ID	NT14621	Operative	ID Drilling
Date of Test	15/11/2020	Checked	29/10/2020

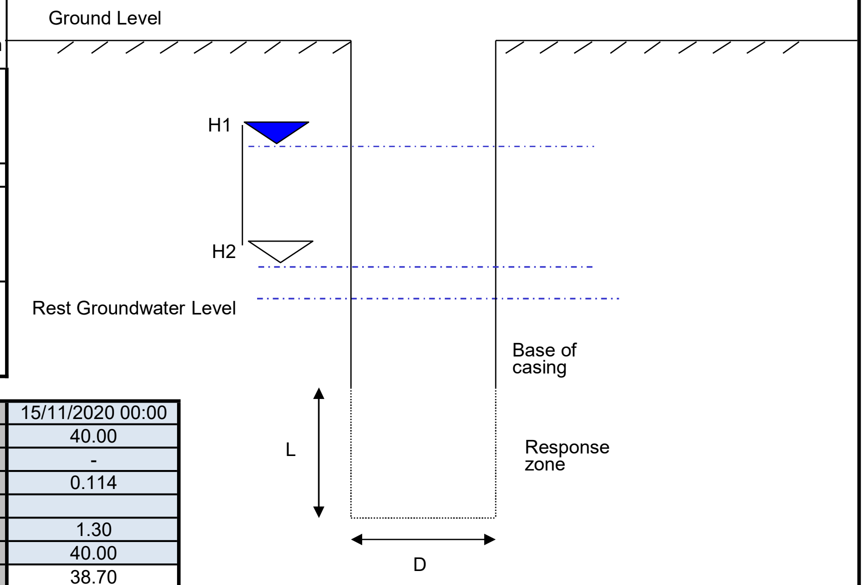
Calculation of permeability (k) as per BS 5930, Section 25.4.6.1 (1999+A2:2010) - general approach

$$k = \frac{A \times \ln\left(H_1 / H_2 \right)}{F \times (t_2 - t_1)} \qquad A = pi \times d^2/4$$

Where:

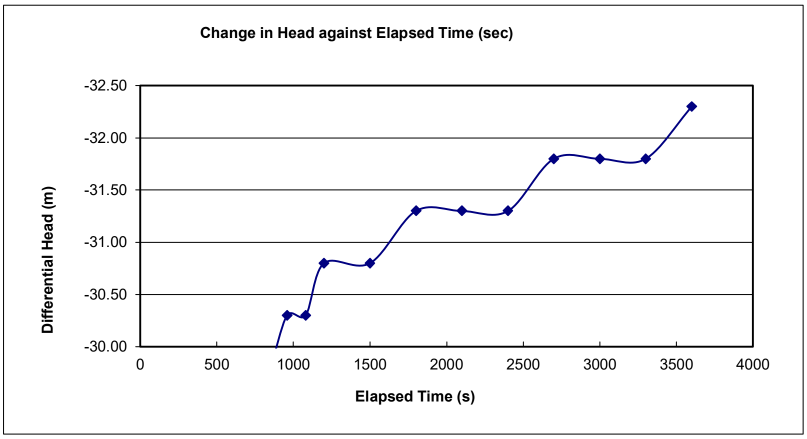
A = cross sectional area of borehole
H_1 = Head of water at time t_1
H_2 = Head of water at time t_2
F = Intake Factor

$$F = \frac{2\, pi \times L}{\ln\left(\left(L/D \right) + \left(1 + \left(L/D \right)^2 \right)^{0.5} \right)}$$



Date of Test	15/11/2020 00:00
Depth of Borehole Below Ground Level (m)	40.00
Initial Groundwater Level (m BGL)	-
Diameter of borehole, D (m)	0.114
Top of response zone	1.30
Bottom of response zone	40.00
Length of response zone, L (m)	38.70
Intake Factor, F	37.31

Time (mins)	**Elapsed Time (s)**	**Water depth (m BGL)**	**Differential Head, H (m)**
	0		0.00
	10	29.100	-29.10
	20	29.300	-29.30
	30	29.300	-29.30
	40	29.400	-29.40
	50	29.400	-29.40
	60	29.400	-29.40
	90	29.400	-29.40
	120	29.500	-29.50
	150	29.500	-29.50
	180	29.550	-29.55
	210	29.550	-29.55
	240	29.550	-29.55
	270	29.600	-29.60
	300	29.600	-29.60
	360	29.600	-29.60
	420	29.600	-29.60
	480	29.700	-29.70
	540	29.700	-29.70
	600	29.700	-29.70
	720	29.800	-29.80
	840	29.800	-29.80
	960	30.300	-30.30
	1080	30.300	-30.30
	1200	30.800	-30.80
	1500	30.800	-30.80
	1800	31.300	-31.30
	2100	31.300	-31.30
	2400	31.300	-31.30
	2700	31.800	-31.80
	3000	31.800	-31.80
	3300	31.800	-31.80
	3600	32.300	-32.30
	4200	32.30	-32.30
	4800	32.8	-32.80
	5400	32.8	-32.80
	6000	32.8	-32.80
	6600	33.3	-33.30
	7200	33.3	-33.30



Calculation of Permeability (k)

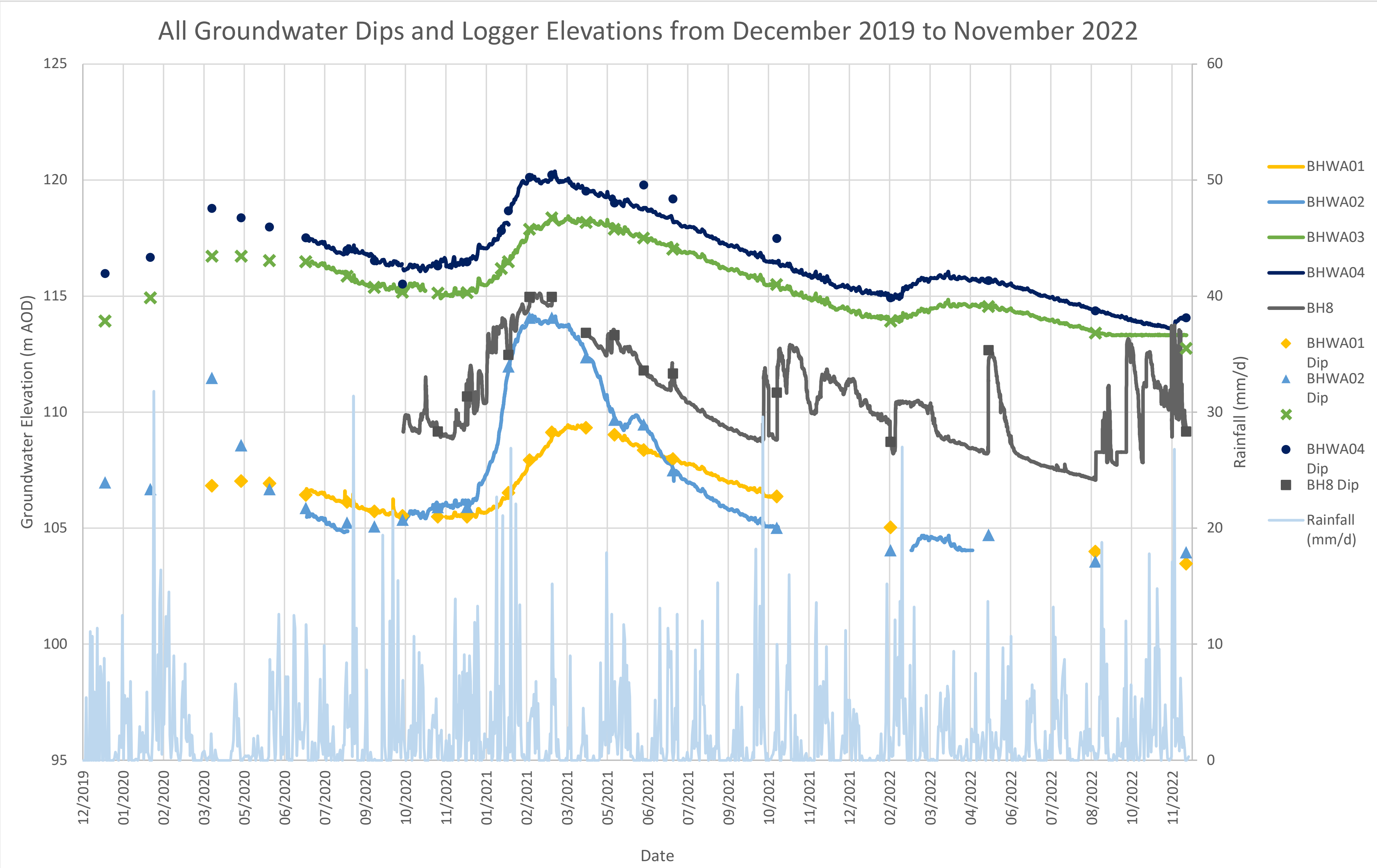
t_1 (s)	t_2 (s)	H_1 (m)	H_2 (m)	k (ms^{-1})
10	270	-29.10	-29.60	**-1.80E-08**

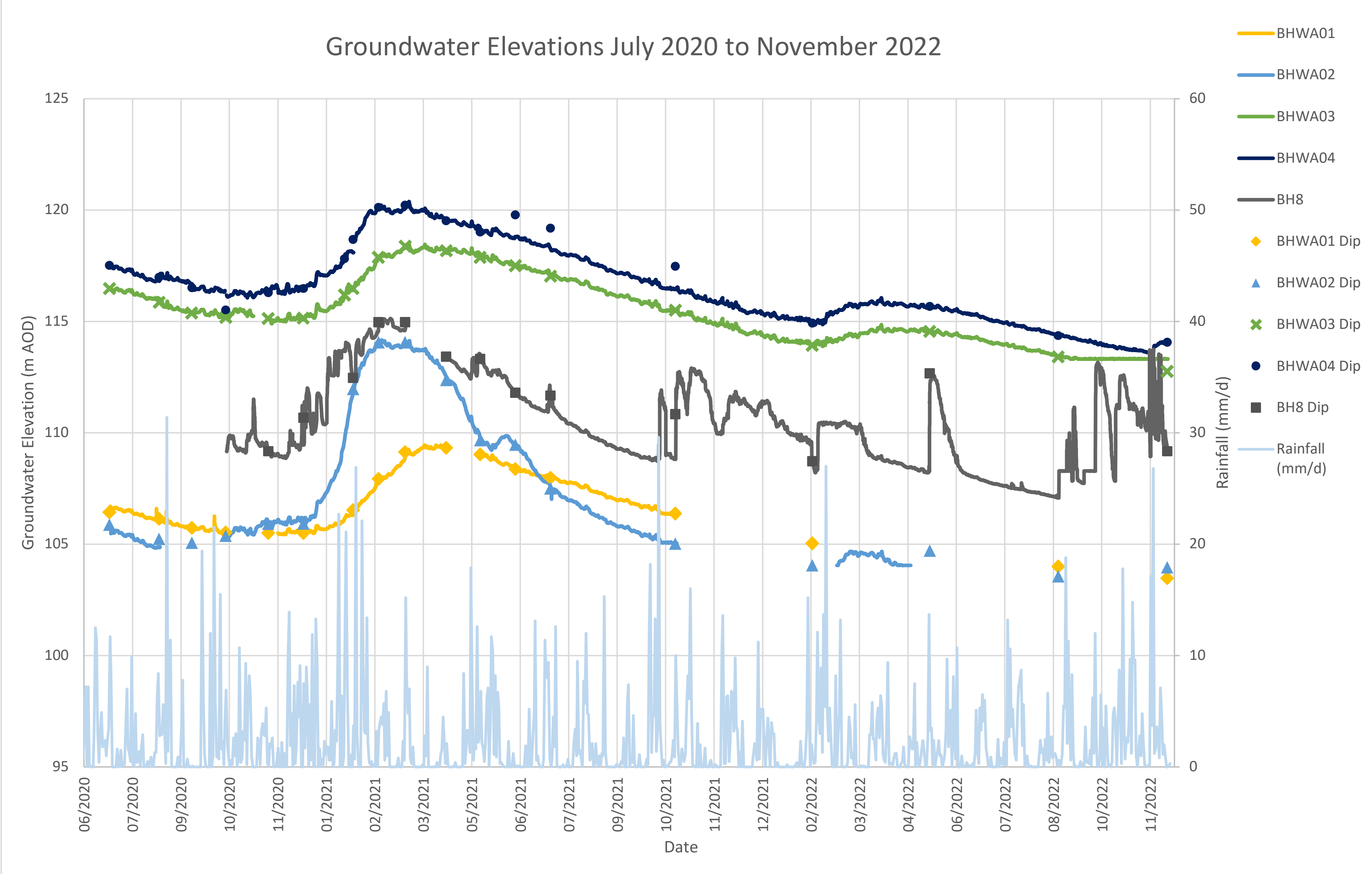
wardell armstrong

CLIENT	Lightwater Quarries		
PROJECT	Gebdykes Quarry Landfill Permit Application		
FIGURE TITLE	FHT Analysis - BHWA04		
FIGURE NO.	DRAWN BY	APPROVED BY	DATE
FHT-04	BJ		29/10/2020

APPENDIX B

Groundwater Elevation Graphs


All Groundwater Dips and Logger Elevations from December 2019 to November 2022
Groundwater Elevation (m AOD)
125
120
115
110
105
100
95
Rainfall (mm/d)
60
50
40
30
20
10
0
12/2019
01/2020
02/2020
03/2020
05/2020
06/2020
07/2020
09/2020
10/2020
11/2020
01/2021
02/2021
03/2021
05/2021
06/2021
07/2021
09/2021
10/2021
11/2021
12/2021
02/2022
03/2022
04/2022
06/2022
07/2022
08/2022
10/2022
11/2022
Date
BHWA01
BHWA02
BHWA03
BHWA04
BH8
BHWA01 Dip
BHWA02 Dip
BHWA04 Dip
BH8 Dip
Rainfall (mm/d)


Groundwater Elevations July 2020 to November 2022
Groundwater Elevation (m AOD)
Rainfall (mm/d)
Date
125
120
115
110
105
100
95
60
50
40
30
20
10
0
06/2020
07/2020
09/2020
10/2020
11/2020
01/2021
02/2021
03/2021
05/2021
06/2021
07/2021
09/2021
10/2021
11/2021
12/2021
02/2022
03/2022
04/2022
06/2022
07/2022
08/2022
10/2022
11/2022
BHWA01
BHWA02
BHWA03
BHWA04
BH8
BHWA01 Dip
BHWA02 Dip
BHWA03 Dip
BHWA04 Dip
BH8 Dip
Rainfall (mm/d)

APPENDIX C

Laboratory Analytical Results

Results	Units	UKDWS	EQS		BHWA01													
			Long Term (AA)	Short Term (MAC)	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Feb-22	Nov-22	Average
Inorganics																		
pH	pH	- -	- -	- -	7.65	8.04	-	8.03	8.04	7.92	7.7	7.68	7.96	7.66	7.73	7.67	7.4	7.83
Electrical Conductivity (20°C)	µg/l	- -	- -	- -	576	583	-	643	676	643	608	615	607	628	600	682	637	624
Alkalinity (Total) Colorimetry	mg/l Ca CO3	- -	- -	- -	231	241	-	205	215	210	190	175	200	185	225	265	300	213
Alkalinity by Titration (Bicarbonate)	mg/l Ca CO3	- -	- -	- -	165	215	-	205	215	210	190	175	200	185	225	265	300	205
Alkalinity by Titration (Carbonate)	mg/l Ca CO3	- -	- -	- -	<15	<15	-	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15
Total Dissolved Solids	mg/l	- -	- -	- -	913	476	-	234	475	869	396	372	320	439	102942	699	494	699
Total Suspended Solids	mg/l	- -	- -	- -	15305	3085	-	661	466	330	1083	466	1327	506	402	261	725	261
Ammoniacal Nitrogen as N	mg/l	- -	0.6	- -	<0.02	0.06	-	0.07	<0.02	<0.02	0.03	0.02	0.04	0.11	<0.02	0.06	0.13	0.06
Ammoniacal Nitrogen as NH4+	mg/l	0.5	- -	- -	-	0.077143	-	0.09	-	-	0.038571	0.0257143	0.0514286	0.14142857	-	-		0.0707
Chloride	mg/l	- -	- -	- -	17	17	-	21	22	22	22	22	20	22	21	20	22	21
Nitrite	mg/l	0.1	- -	- -	**0.1**	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.1**
Nitrate	mg/l	50	- -	- -	**70.4**	18.4	-	**103**	**72**	**67.4**	**61.5**	**70.2**	**55.4**	**63.5**	**57.2**	**66.8**	**53.2**	**64.2**
Nitrogen, Total Oxidised	mg/l	- -	- -	- -	15.9	4.2	-	23.2	16.2	15.2	13.9	15.9	12.5	14.3	12.9	15.1	12	14.5
Sulphate	mg/l	250	- -	- -	41	36	-	48	50	46	47	48	48	46	45	53	51	46
Cyanide (Total)**	mg/l	0.05	0.001	0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Dissolved Organic Carbon	mg/l	- -	- -	- -	2.1	2.8	-	-	-	-	-	-	-	-	-	-		2.5
Filtered (Dissolved) Metals																		
Arsenic (Dissolved)*	µg/l	10	50	- -	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cadmium (Dissolved)**	µg/l	5	0.25	1.5	<0.2	*0.5*	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.2
Calcium (Dissolved)	mg/l	250	- -	- -	56	149	-	-	75	78	78	71	73	193	80	82	80	94
Copper (Dissolved)	µg/l	2000	1	- -	*2*	*4*	-	*6*	<1	*2*	*2*	*3*	*3*	*4*	<1	*7*	<4	*3*
Chromium (Dissolved)*	µg/l	50	4.7	32	<1	<1	-	9	<1	<1	<1	<1	<1	2	<1	<1	<1	2
Chromium (Hexavalent)*	mg/l	- -	3.4	- -	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Lead (Dissolved)*	µg/l	10	1.2	14	<1	<1	-	<1	<1	<1	<1	<1	<1	4	<1	<1	<1	1
Manganese (Dissolved)	µg/l	50	123	- -	2	***401***	-	-	3	7	7	6	4	***293***	3	2	4	**73**
Magnesium (Dissolved)	mg/l	50	- -	- -	28	**70**	-	-	40	40	40	37	38	**98**	40	43	42	47
Mercury (Dissolved)	µg/l	1	- -	0.07	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mercury, Speciated*	µg/l	- -	- -	- -	<100	-	-	-	-	-	-	-	-	-	-	-		
Nickel (Dissolved)**	µg/l	20	4	34	<1	*4*	-	<1	<1	<1	<1	<1	<1	2	<1	<1	<2	1
Potassium (Dissolved)	mg/l	12	- -	- -	1	2	-	-	2	2	2	2	<1	<1	3	3	3	2
Selenium (Dissolved)**	µg/l	10	- -	- -	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sodium (Dissolved)	mg/l	- -	200	- -	10	33	-	-	8	9	8	8	8	8	8	9	9	11
Zinc (Dissolved)**	µg/l	- -	10.9	- -	1	8	-	3	3	2	3	3	2	*12*	7	9	5	5
BTEX																		
BTEX - Benzene*	µg/l	1	10	50	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
BTEX - Toluene*	µg/l	- -	74	380	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
BTEX - Ethyl Benzene*	µg/l	- -	20	200	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
BTEX - m & p Xylene	µg/l	30	- -	- -	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
BTEX - o Xylene	µg/l	30	- -	- -	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
PAH 16MS (w)																		
Acenaphthene*	µg/l	- -	- -	- -	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthylene	µg/l	- -	- -	- -	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Anthracene*	µg/l	- -	0.1	0.1	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)anthracene	µg/l	- -	- -	- -	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)pyrene*	µg/l	0.01	0.00017	0.27	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(b)fluoranthene*	µg/l	- -	- -	0.017	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(ghi)perylene	µg/l	- -	- -	0.0082	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(k)fluoranthene*	µg/l	- -	- -	0.017	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	µg/l	- -	- -	- -	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dibenzo(ah)anthracene	µg/l	- -	- -	- -	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene*	µg/l	- -	0.0063	0.120	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluorene	µg/l	- -	- -	- -	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Indeno(123-cd)pyrene	µg/l	- -	- -	- -	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Naphthalene**	µg/l	- -	2	130	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	µg/l	- -	- -	- -	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pyrene	µg/l	- -	- -	- -	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total PAH 16MS	µg/l	- -	- -	- -	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PAH-4 (Summed) Benzo(b)(ghi)(k) and Indeno	µg/l	0.1	- -	- -	<0.04	<0.04	-	-	-	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04			<0.04
Speciated PCB-WHO12																		
PCB BZ 81	µg/l	- -	- -	- -	<0.001	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 105	µg/l	- -	- -	- -	<0.001	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 114	µg/l	- -	- -	- -	<0.001	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 118	µg/l	- -	- -	- -	<0.002	-	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
PCB BZ 123	µg/l	- -	- -	- -	<0.001	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 126	µg/l	- -	- -	- -	<0.001	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 156	µg/l	- -	- -	- -	<0.001	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 157	µg/l	- -	- -	- -	<0.001	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 167	µg/l	- -	- -	- -	<0.001	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 169	µg/l	- -	- -	- -	<0.001	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 189	µg/l	- -	- -	- -	<0.001	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 77	µg/l	- -	- -	- -	<0.001	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Speciated PCB-WHO12*	µg/l	- -	- -	- -	<0.002	-	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

Notes
* Denotes Hazardous Substance
** Denotes Non-Hazardous Pollutant
- - Denotes No Screening Value
- Denotes Not Analysed
All Exceedances are shaded in Grey
Values in **Bold** exceed the UKDWS
Values in *Italics* exceed the EQS Long Term Annual Average
Values that are Underlined exceed the EQS Short Term Maximum Allowable Concentration

Results	Units	UKDWS	EQS		BHWA02													
			Long Term (AA)	Short Term (MAC)	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Feb-22	Nov-22	Average
Inorganics																		
pH	pH	- -	- -	- -	7.9	8.12	8.09	8.13	8.07	8.01	7.88	7.59	7.85	7.64	7.55	-	-	7.89
Electrical Conductivity (20°C)	µg/l	- -	- -	- -	524	502	496	481	474	494	541	569	584	591	644	-	-	536
Alkalinity (Total) Colorimetry	mg/l Ca CO3	- -	- -	- -	209	184	171	160	150	140	155	165	175	180	175	-	-	169
Alkalinity by Titration (Bicarbonate)	mg/l Ca CO3	- -	- -	- -	185	165	190	160	150	140	155	165	175	180	175	-	-	167
Alkalinity by Titration (Carbonate)	mg/l Ca CO3	- -	- -	- -	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	-	-	<15
Total Dissolved Solids	mg/l	- -	- -	- -	127	459	279	218	344	3625	135	528	221	424	131198	-	-	12505
Total Suspended Solids	mg/l	- -	- -	- -	1320	2342	563	1181	32	4025	4762	3194	5434	5207	2341	-	-	2764
Ammoniacal Nitrogen as N	mg/l	- -	0.6	- -	<0.02	0.06	0.38	0.07	0.09	0.02	0.11	0.07	0.04	0.25	0.07	-	-	0.11
Ammoniacal Nitrogen as NH4+	mg/l	0.5	- -	- -	-	0.077143	0.488571	0.09	0.115714	0.025714	0.141429	0.09	0.0514286	0.32142857	0.09	-	-	0.1491
Chloride	mg/l	- -	- -	- -	27	29	29	26	25	27	30	31	33	33	33	-	-	29
Nitrite	mg/l	0.1	- -	- -	**0.1**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	**0.1**
Nitrate	mg/l	50	- -	- -	**56.2**	11.7	**70.2**	**65.3**	43.9	**55.6**	**57.9**	**74.5**	**65.4**	**65.4**	**52.7**	-	-	**56.3**
Nitrogen, Total Oxidised	mg/l	- -	- -	- -	12.7	2.7	15.9	14.7	9.9	12.6	13.1	16.8	14.8	14.8	11.9	-	-	12.7
Sulphate	mg/l	250	- -	- -	27	27	30	24	24	24	27	29	29	31	30	-	-	27
Cyanide (Total)**	mg/l	0.05	0.001	0.005	<0.005	<0.005	<0.005	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	-	<0.005
Dissolved Organic Carbon	mg/l	- -	- -	- -	1.4	1.6	0.7	-	-	-	-	-	-	-	-	-	-	1.2
Filtered (Dissolved) Metals																		
Arsenic (Dissolved)*	µg/l	10	50	- -	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1
Cadmium (Dissolved)**	µg/l	5	0.25	1.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	-	<0.2
Calcium (Dissolved)	mg/l	250	- -	- -	59	58	63	-	51	51	59	63	64	63	73	-	-	60
Copper (Dissolved)	µg/l	2000	1	- -	1	2	4	3	<1	3	2	2	3	6	<1	-	-	3
Chromium (Dissolved)*	µg/l	50	4.7	32	<1	1	<1	*10*	*11*	<1	<1	<1	1	<1	<1	-	-	3
Chromium (Hexavalent)*	mg/l	- -	3.4	- -	<0.01	<0.01	<0.01	-		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01
Lead (Dissolved)*	µg/l	10	1.2	14	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1
Manganese (Dissolved)	µg/l	50	123	- -	2	4	4	-	<1	3	6	12	2	2	12	-	-	5
Magnesium (Dissolved)	mg/l	50	- -	- -	31	29	31	-	26	27	32	35	36	35	35	-	-	32
Mercury (Dissolved)	µg/l	1	- -	0.07	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	<0.1
Mercury, Speciated*	µg/l	- -	- -	- -	<100	-	-	-	-	-	-	-	-	-	-	-	-	<100
Nickel (Dissolved)**	µg/l	20	4	34	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1
Potassium (Dissolved)	mg/l	12	- -	- -	<1	1	9	-	<1	<1	2	1	<1	<1	3	-	-	2
Selenium (Dissolved)**	µg/l	10	- -	- -	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1
Sodium (Dissolved)	mg/l	- -	200	- -	12	12	13	-	11	12	12	12	13	12	12	-	-	12
Zinc (Dissolved)**	µg/l	- -	10.9	- -	1	4	*14*	2	1	2	2	3	2	3	6	-	-	4
BTEX																		
BTEX - Benzene*	µg/l	1	10	50	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	-	-	<1
BTEX - Toluene*	µg/l	- -	74	380	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	-	-	<1
BTEX - Ethyl Benzene*	µg/l	- -	20	200	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	-	-	<1
BTEX - m & p Xylene	µg/l	30	- -	- -	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	-	-	<1
BTEX - o Xylene	µg/l	30	- -	- -	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	-	-	<1
PAH 16MS (w)																		
Acenaphthene*	µg/l	- -	- -	- -	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01
Acenaphthylene	µg/l	- -	- -	- -	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01
Anthracene*	µg/l	- -	0.1	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01
Benzo(a)anthracene	µg/l	- -	- -	- -	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01
Benzo(a)pyrene*	µg/l	0.01	0.00017	0.27	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01
Benzo(b)fluoranthene*	µg/l	- -	- -	0.017	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01
Benzo(ghi)perylene	µg/l	- -	- -	0.0082	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01
Benzo(k)fluoranthene*	µg/l	- -	- -	0.017	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01
Chrysene	µg/l	- -	- -	- -	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01
Dibenzo(ah)anthracene	µg/l	- -	- -	- -	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01
Fluoranthene*	µg/l	- -	0.0063	0.120	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01
Fluorene	µg/l	- -	- -	- -	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01
Indeno(123-cd)pyrene	µg/l	- -	- -	- -	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01
Naphthalene**	µg/l	- -	2	130	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	-	-	0.01
Phenanthrene	µg/l	- -	- -	- -	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01
Pyrene	µg/l	- -	- -	- -	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01
Total PAH 16MS	µg/l	- -	- -	- -	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	-	-	0.01
PAH-4 (Summed) Benzo(b)(ghi)(k) and Indeno	µg/l	0.1	- -	- -	<0.04	<0.04	<0.04	<0.04	-	<0.04	0.01	<0.04	<0.04	<0.04	<0.04	-	-	<0.04
Speciated PCB-WHO12																-	-	
PCB BZ 81	µg/l	- -	- -	- -	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001
PCB BZ 105	µg/l	- -	- -	- -	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001
PCB BZ 114	µg/l	- -	- -	- -	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001
PCB BZ 118	µg/l	- -	- -	- -	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002
PCB BZ 123	µg/l	- -	- -	- -	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001
PCB BZ 126	µg/l	- -	- -	- -	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001
PCB BZ 156	µg/l	- -	- -	- -	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001
PCB BZ 157	µg/l	- -	- -	- -	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001
PCB BZ 167	µg/l	- -	- -	- -	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001
PCB BZ 169	µg/l	- -	- -	- -	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001
PCB BZ 189	µg/l	- -	- -	- -	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001
PCB BZ 77	µg/l	- -	- -	- -	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001
Total Speciated PCB-WHO12*	µg/l	- -	- -	- -	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002

Notes
* Denotes Hazardous Substance
** Denotes Non-Hazardous Pollutant
- - Denotes No Screening Value
- Denotes Not Analysed
All Exceedances are shaded in Grey
Values in **Bold** exceed the UKDWS
Values in *Italics* exceed the EQS Long Term Annual Average
Values that are Underlined exceed the EQS Short Term Maximum Allowable Concentration

Results	Units	UKDWS	EQS		BHWA03													
			Long Term (AA)	Short Term (MAC)	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Feb-22	Nov-22	Average
Inorganics																		
pH	pH	- -	- -	- -	7.73	8.04	8.23	7.82	7.78	8.82	7.77	7.36	7.88	7.57	7.5	7.6	7.55	7.8
Electrical Conductivity (20°C)	µg/l	- -	- -	- -	717	716	704	733	717	<10	713	720	711	741	709	757	716	662
Alkalinity (Total) Colorimetry	mg/l Ca CO3	- -	- -	- -	289	285	279	275	270	275	5705	300	265	275	305	350	360	739
Alkalinity by Titration (Bicarbonate)	mg/l Ca CO3	- -	- -	- -	325	285	65	275	270	275	5705	300	265	275	305	350	360	725
Alkalinity by Titration (Carbonate)	mg/l Ca CO3	- -	- -	- -	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15
Total Dissolved Solids	mg/l	- -	- -	- -	339	563	463	1702	483	679	466	485	287	510	103154	673	796	9150
Total Suspended Solids	mg/l	- -	- -	- -	944	191	441	11962	740	623	560	327	561	357	25	66	524	1400
Ammoniacal Nitrogen as N	mg/l	- -	0.6	- -	<0.02	0.04	<0.02	0.22	0.03	0.02	0.02	<0.02	0.02	0.21	0.03	<0.02	0.08	0.06
Ammoniacal Nitrogen as NH4+	mg/l	0.5	- -	- -	-	0.051429	-	0.282857	0.038571	0.025714	0.025714	-	0.0257143	0.27	0.0385714	-		0.0948
Chloride	mg/l	- -	- -	- -	31	33	33	34	32	33	33	31	31	36	30	30	31	32
Nitrite	mg/l	0.1	- -	- -	**0.1**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.1**
Nitrate	mg/l	50	- -	- -	**58.9**	15.9	29.3	**77.4**	**52.5**	**52.3**	48.3	**61.1**	49.4	**53.6**	**55.5**	**62.3**	**52.2**	**51.4**
Nitrogen, Total Oxidised	mg/l	- -	- -	- -	13.3	3.6	6.6	17.5	11.9	11.8	10.9	13.8	11.2	12.1	12.5	14.1	11.8	11.6
Sulphate	mg/l	250	- -	- -	31	32	34	35	31	30	30	30	17	31	37	35	37	31
Cyanide (Total)**	mg/l	0.05	0.001	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Dissolved Organic Carbon	mg/l	- -	- -	- -	1.6	1.4	1.6	-	-	-	-	-	-	-	-	-		1.5
Filtered (Dissolved) Metals																		
Arsenic (Dissolved)*	µg/l	10	50	- -	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cadmium (Dissolved)**	µg/l	5	0.25	1.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Calcium (Dissolved)	mg/l	250	- -	- -	82	82	94	-	82	80	81	78	82	79	86	93	86	84
Copper (Dissolved)	µg/l	2000	1	- -	2	2	12	7	<1	5	3	1	1	6	<1	13	<4	5
Chromium (Dissolved)*	µg/l	50	4.7	32	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1	1
Chromium (Hexavalent)*	mg/l	- -	3.4	- -	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Lead (Dissolved)*	µg/l	10	1.2	14	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2	<1	1
Manganese (Dissolved)	µg/l	50	123	- -	4	1	7	-	13	4	3	2	<1	<1	<1	<1	1	3
Magnesium (Dissolved)	mg/l	50	- -	- -	45	45	**52**	-	45	44	46	45	48	47	49	**51**	44	47
Mercury (Dissolved)	µg/l	1	- -	0.07	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mercury, Speciated*	µg/l	- -	- -	- -	<100	-	-	-	-	-	-	-	-	-	-	-		<100
Nickel (Dissolved)**	µg/l	20	4	34	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<2	<1
Potassium (Dissolved)	mg/l	12	- -	- -	6	4	5	-	5	6	5	5	4	<1	4	6	5	5
Selenium (Dissolved)**	µg/l	10	- -	- -	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sodium (Dissolved)	mg/l	- -	200	- -	17	13	14	-	13	14	12	12	12	12	13	13	12	13
Zinc (Dissolved)**	µg/l	- -	10.9	- -	3	3	*17*	2	6	*14*	4	2	2	4	3	3	3	5
BTEX																		
BTEX - Benzene*	µg/l	1	10	50	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
BTEX - Toluene*	µg/l	- -	74	380	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
BTEX - Ethyl Benzene*	µg/l	- -	20	200	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
BTEX - m & p Xylene	µg/l	30	- -	- -	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
BTEX - o Xylene	µg/l	30	- -	- -	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
PAH 16MS (w)																		
Acenaphthene*	µg/l	- -	- -	- -	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthylene	µg/l	- -	- -	- -	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Anthracene*	µg/l	- -	0.1	0.1	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)anthracene	µg/l	- -	- -	- -	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)pyrene*	µg/l	0.01	0.00017	0.27	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(b)fluoranthene*	µg/l	- -	- -	0.017	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(ghi)perylene	µg/l	- -	- -	0.0082	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(k)fluoranthene*	µg/l	- -	- -	0.017	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	µg/l	- -	- -	- -	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dibenzo(ah)anthracene	µg/l	- -	- -	- -	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene*	µg/l	- -	0.0063	0.120	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluorene	µg/l	- -	- -	- -	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Indeno(123-cd)pyrene	µg/l	- -	- -	- -	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Naphthalene**	µg/l	- -	2	130	<0.01	-	-	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	µg/l	- -	- -	- -	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pyrene	µg/l	- -	- -	- -	<0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total PAH 16MS	µg/l	- -	- -	- -	<0.01	-	-	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PAH-4 (Summed) Benzo(b)(ghi)(k) and Indeno	µg/l	0.1	- -	- -	<0.04	-	-	<0.04	-	<0.04	0.01	<0.04	<0.04	<0.04	<0.04	-		<0.04
Speciated PCB-WHO12																		
PCB BZ 81	µg/l	- -	- -	- -	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 105	µg/l	- -	- -	- -	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 114	µg/l	- -	- -	- -	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 118	µg/l	- -	- -	- -	<0.002	-	-	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
PCB BZ 123	µg/l	- -	- -	- -	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 126	µg/l	- -	- -	- -	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 156	µg/l	- -	- -	- -	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 157	µg/l	- -	- -	- -	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 167	µg/l	- -	- -	- -	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 169	µg/l	- -	- -	- -	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 189	µg/l	- -	- -	- -	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 77	µg/l	- -	- -	- -	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Speciated PCB-WHO12*	µg/l	- -	- -	- -	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

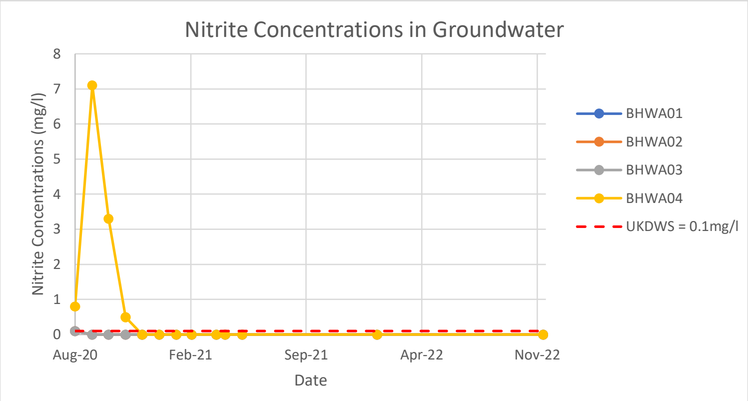
Notes
* Denotes Hazardous Substance
** Denotes Non-Hazardous Pollutant
\- - Denotes No Screening Value
\- Denotes Not Analysed
All Exceedances are shaded in Grey
Values in **Bold** exceed the UKDWS
Values in *Italics* exceed the EQS Long Term Annual Average
Values that are Underlined exceed the EQS Short Term Maximum Allowable Concentration

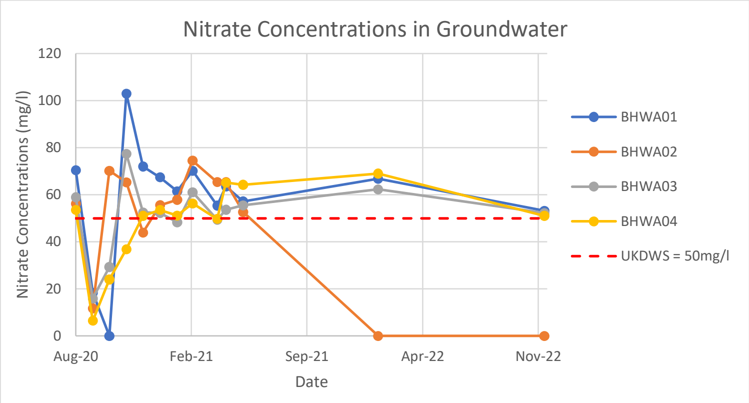
Results	Units	UKDWS	EQS		BHWA04													
			Long Term (AA)	Short Term (MAC)	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Feb-22	Nov-22	Average
Inorganics																		
pH	pH	- -	- -	- -	7.73	7.98	8.06	8.13	7.85	7.85	7.74	7.43	7.92	7.65	7.5	7.64	7.6	8
Electrical Conductivity (20°C)	µg/l	- -	- -	- -	650	451	563	528	660	<10	652	636	636	707	660	729	673	574
Alkalinity (Total) Colorimetry	mg/l Ca CO3	- -	- -	- -	264	231	248	210	240	230	225	250	255	175	210	310	330	237
Alkalinity by Titration (Bicarbonate)	mg/l Ca CO3	- -	- -	- -	230	195	275	210	240	230	225	250	255	175	210	310	330	234
Alkalinity by Titration (Carbonate)	mg/l Ca CO3	- -	- -	- -	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15
Total Dissolved Solids	mg/l	- -	- -	- -	69	348	332	1006	456	2270	1110	692	425	677	26	507	496	660
Total Suspended Solids	mg/l	- -	- -	- -	690	314	705	175	3131	4830	3748	7772	1549	7307	3508	21	404	2813
Ammoniacal Nitrogen as N	mg/l	- -	0.6	- -	<0.02	0.1	0.12	0.15	0.02	0.15	0.04	<0.02	0.03	0.21	0.06	0.04	<1.00	0.08
Ammoniacal Nitrogen as NH4+	mg/l	0.5	- -	- -	-	0.13	0.15	0.19	0.025714	0.192857	0.051429	-	0.0385714	0.27	0.0771429	-		0.1257
Chloride	mg/l	- -	- -	- -	32	15	22	19	28	27	27	28	24	34	44	29	27	27
Nitrite	mg/l	0.1	- -	- -	**0.8**	**7.1**	**3.3**	**0.5**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**1.0**
Nitrate	mg/l	50	- -	- -	**53.5**	6.5	24	36.8	**51.1**	**53.5**	**51.2**	**56.3**	49.7	**65.1**	**64.2**	**69**	**51.1**	48.4
Nitrogen, Total Oxidised	mg/l	- -	- -	- -	12.3	3.6	6.4	8.4	11.5	12.1	11.6	12.7	11.2	14.7	14.5	15.6	11.5	11.2
Sulphate	mg/l	250	- -	- -	38	22	36	26	44	32	35	33	18	39	34	39	34	33
Cyanide (Total)**	mg/l	0.05	0.001	0.005	<0.005	<0.005	<0.005	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Dissolved Organic Carbon	mg/l	- -	- -	- -	2.2	6.1	1.2	-	-	-	-	-	-	-	-	-		3.2
Filtered (Dissolved) Metals																		
Arsenic (Dissolved)*	µg/l	10	50	- -	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cadmium (Dissolved)**	µg/l	5	0.25	1.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Calcium (Dissolved)	mg/l	250	- -	- -	78	64	84	-	81	85	82	78	83	85	90	97	87	82
Copper (Dissolved)	µg/l	2000	1	- -	*1*	*3*	<1	*6*	<1	*13*	*1*	*2*	*2*	*4*	<1	*8*	<4	*4*
Chromium (Dissolved)*	µg/l	50	4.7	32	<1	1	2	<1	<1	<1	<1	<1	1	<1	1	<1	<1	1
Chromium (Hexavalent)*	mg/l	- -	3.4	- -	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.02	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02
Lead (Dissolved)*	µg/l	10	1.2	14	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Manganese (Dissolved)	µg/l	50	123	- -	4	72	17	-	5	2	2	1	1	<1	2	<1	1	10
Magnesium (Dissolved)	mg/l	50	- -	- -	38	25	39	-	38	39	37	36	39	40	40	44	38	38
Mercury (Dissolved)	µg/l	1	- -	0.07	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mercury, Speciated*	µg/l	- -	- -	- -	<100	-	-	-	-	-	-	-	-	-	-	-		<100
Nickel (Dissolved)**	µg/l	20	4	34	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<2	<1
Potassium (Dissolved)	mg/l	12	- -	- -	3	<1	2	-	3	3	3	2	<1	3	3	5	3	3
Selenium (Dissolved)**	µg/l	10	- -	- -	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sodium (Dissolved)	mg/l	- -	200	- -	10	11	11	-	10	11	9	9	10	11	10	12	10	10
Zinc (Dissolved)**	µg/l	- -	10.9	- -	5	*38*	4	*23*	3	1	2	2	3	2	3	6	7	8
BTEX																		
BTEX - Benzene*	µg/l	1	10	50	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1
BTEX - Toluene*	µg/l	- -	74	380	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1
BTEX - Ethyl Benzene*	µg/l	- -	20	200	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1
BTEX - m & p Xylene	µg/l	30	- -	- -	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1
BTEX - o Xylene	µg/l	30	- -	- -	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1
PAH 16MS (w)																		
Acenaphthene*	µg/l	- -	- -	- -	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthylene	µg/l	- -	- -	- -	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Anthracene*	µg/l	- -	0.1	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)anthracene	µg/l	- -	- -	- -	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)pyrene*	µg/l	0.01	0.00017	0.27	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(b)fluoranthene*	µg/l	- -	- -	0.017	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Benzo(ghi)perylene	µg/l	- -	- -	0.0082	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(k)fluoranthene*	µg/l	- -	- -	0.017	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	µg/l	- -	- -	- -	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dibenzo(ah)anthracene	µg/l	- -	- -	- -	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene*	µg/l	- -	0.0063	0.120	<0.01	*0.02*	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	*0.011*
Fluorene	µg/l	- -	- -	- -	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Indeno(123-cd)pyrene	µg/l	- -	- -	- -	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Naphthalene**	µg/l	- -	2	130	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	µg/l	- -	- -	- -	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pyrene	µg/l	- -	- -	- -	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Total PAH 16MS	µg/l	- -	- -	- -	<0.01	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
PAH-4 (Summed) Benzo(b)(ghi)(k) and Indeno	µg/l	0.1	- -	- -	<0.04	0.01	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	-		0.04
Speciated PCB-WHO12																		
PCB BZ 81	µg/l	- -	- -	- -	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 105	µg/l	- -	- -	- -	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 114	µg/l	- -	- -	- -	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 118	µg/l	- -	- -	- -	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
PCB BZ 123	µg/l	- -	- -	- -	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 126	µg/l	- -	- -	- -	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 156	µg/l	- -	- -	- -	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 157	µg/l	- -	- -	- -	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 167	µg/l	- -	- -	- -	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 169	µg/l	- -	- -	- -	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 189	µg/l	- -	- -	- -	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCB BZ 77	µg/l	- -	- -	- -	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Speciated PCB-WHO12*	µg/l	- -	- -	- -	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

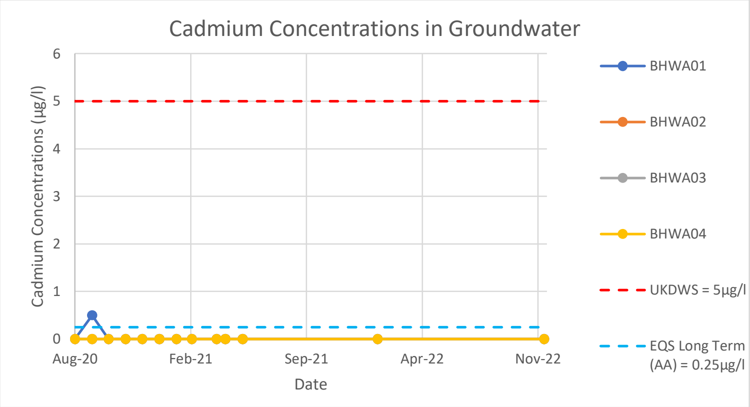
Notes
* Denotes Hazardous Substance
** Denotes Non-Hazardous Pollutant
\- - Denotes No Screening Value
\- Denotes Not Analysed
All Exceedances are shaded in Grey
Values in **Bold** exceed the UKDWS
Values in *Italics* exceed the EQS Long Term Annual Average
Values that are <u>Underlined</u> exceed the EQS Short Term Maximum Allowable Concentration

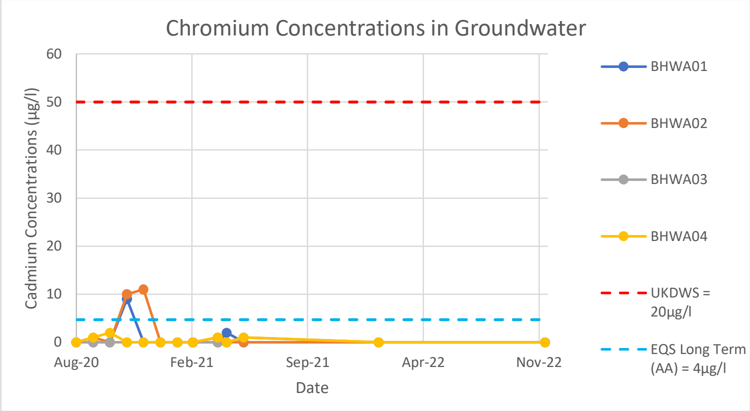
APPENDIX D

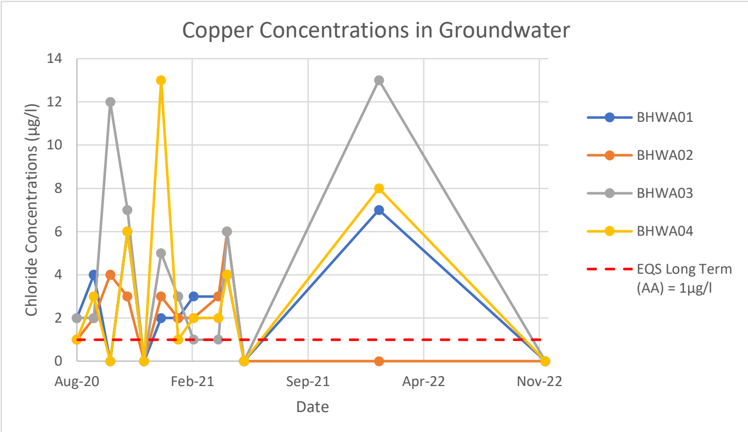
Groundwater Quality Graphs

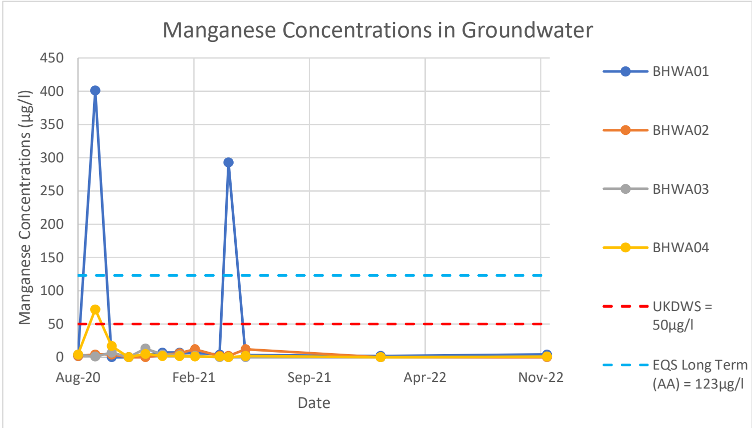

Nitrite Concentrations in Groundwater
Nitrite Concentrations (mg/l)
8
7
6
5
4
3
2
1
0
Aug-20
Feb-21
Sep-21
Apr-22
Nov-22
Date
BHWA01
BHWA02
BHWA03
BHWA04
UKDWS = 0.1mg/l

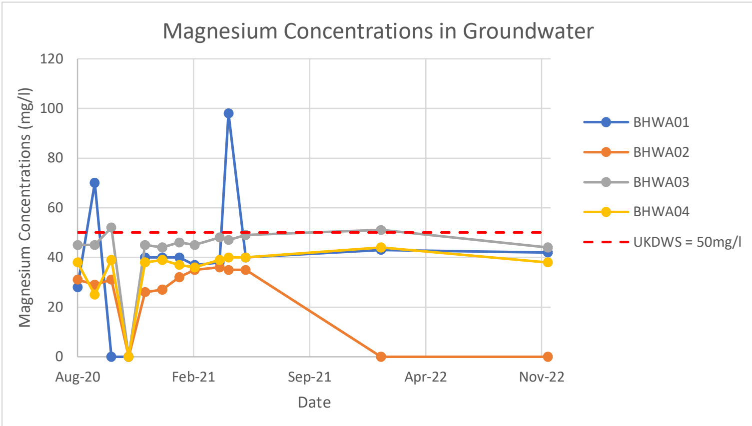

Nitrate Concentrations in Groundwater
Nitrate Concentrations (mg/l)
120
100
80
60
40
20
0
Aug-20
Feb-21
Sep-21
Apr-22
Nov-22
Date
BHWA01
BHWA02
BHWA03
BHWA04
UKDWS = 50mg/l

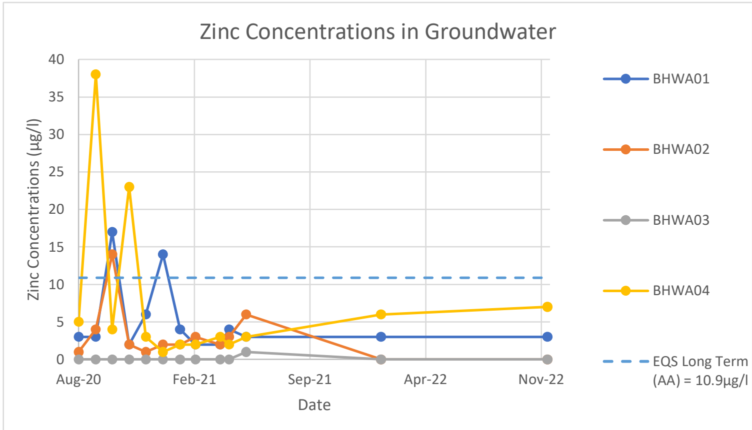

Cadmium Concentrations in Groundwater
Cadmium Concentrations (µg/l)
6
5
4
3
2
1
0
Aug-20
Feb-21
Sep-21
Apr-22
Nov-22
Date
BHWA01
BHWA02
BHWA03
BHWA04
UKDWS = 5µg/l
EQS Long Term (AA) = 0.25µg/l

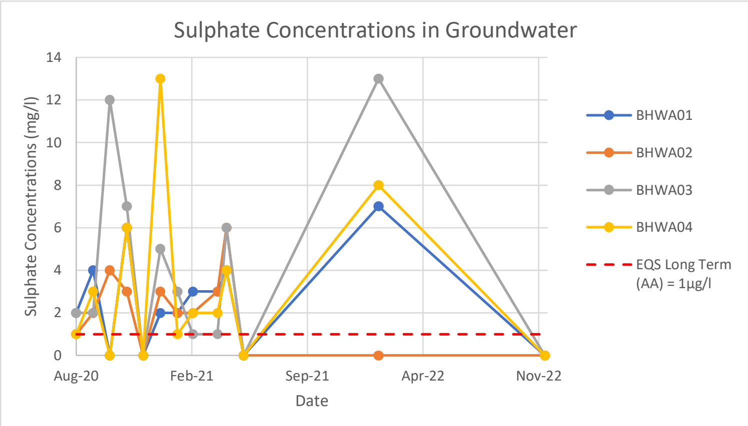

Chromium Concentrations in Groundwater
Cadmium Concentrations (µg/l)
60
50
40
30
20
10
0
Aug-20
Feb-21
Sep-21
Apr-22
Nov-22
Date
BHWA01
BHWA02
BHWA03
BHWA04
UKDWS = 20µg/l
EQS Long Term (AA) = 4µg/l

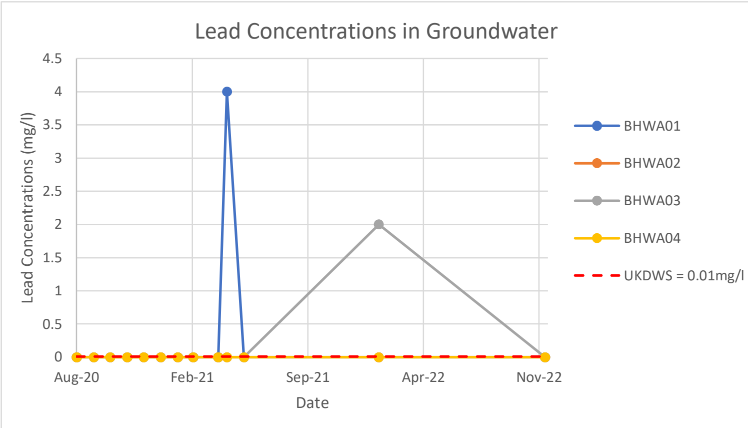

Copper Concentrations in Groundwater
Chloride Concentrations (µg/l)
14
12
10
8
6
4
2
0
Aug-20
Feb-21
Sep-21
Apr-22
Nov-22
Date
BHWA01
BHWA02
BHWA03
BHWA04
EQS Long Term (AA) = 1µg/l


Manganese Concentrations in Groundwater
Manganese Concentrations (µg/l)
450
400
350
300
250
200
150
100
50
0
Aug-20
Feb-21
Sep-21
Apr-22
Nov-22
Date
BHWA01
BHWA02
BHWA03
BHWA04
UKDWS = 50µg/l
EQS Long Term (AA) = 123µg/l


Magnesium Concentrations in Groundwater
Magnesium Concentrations (mg/l)
120
100
80
60
40
20
0
Aug-20
Feb-21
Sep-21
Apr-22
Nov-22
Date
BHWA01
BHWA02
BHWA03
BHWA04
UKDWS = 50mg/l


Zinc Concentrations in Groundwater
Zinc Concentrations (µg/l)
40
35
30
25
20
15
10
5
0
Aug-20
Feb-21
Sep-21
Apr-22
Nov-22
Date
BHWA01
BHWA02
BHWA03
BHWA04
EQS Long Term (AA) = 10.9µg/l


Sulphate Concentrations in Groundwater
Sulphate Concentrations (mg/l)
Date
0
2
4
6
8
10
12
14
Aug-20
Feb-21
Sep-21
Apr-22
Nov-22
BHWA01
BHWA02
BHWA03
BHWA04
EQS Long Term (AA) = 1µg/l


Lead Concentrations in Groundwater
Lead Concentrations (mg/l)
Date
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Aug-20
Feb-21
Sep-21
Apr-22
Nov-22
BHWA01
BHWA02
BHWA03
BHWA04
UKDWS = 0.01mg/l

APPENDIX E

Risk Factors

Limit values (mg/kg) for compliance leaching test using BS EN 12457 at L/S 10 l/kg

	mg/kg	mg/l*	Hazardous substance?	MRV for hazardous substances	UKDWS (mg/l)	Risk Factor***	Rank***
As (arsenic)	0.5	0.05	Yes	0.01**	0.01	5	1
Ba (barium)	20	2	No	-	1	2	3
Cd (cadmium)	0.04	0.004	No	-	0.005	0.8	9
Cr (chromium (total))	0.5	0.05	Yes	0.01**	0.05	1	6
Cu (copper)	2	0.2	No	-	2	0.1	13
Hg (mercury)	0.01	0.001	Yes	0.01	0.001	1	6
Mo (molybdenum)	0.5	0.05	No	-	-	-	-
Ni (nickel)	0.4	0.04	No	-	0.02	2	3
Pb (lead)	0.5	0.05	Yes	0.01**	0.01	5	1
Sb (antimony)	0.06	0.006	No	-	0.005	1.2	5
Se (selenium)	0.1	0.01	No	-	0.01	1	6
Zn (zinc)	4	0.4	No	-	5	0.08	14
Cl (chloride)	800	80	No	-	250	0.32	12
F (fluoride)	10	1	No	-	1.5	0.67	10
SO4 (sulphate)	1,000	100	No	-	250	0.4	11
Total dissolved solids (TDS)	4,000	400	No	-	-	-	-
Phenol index	1	0.1	No	-	-	-	-
Dissolved organic carbon	500	50	No	-	-	-	-

MRV = minimum reporting value from:
* WAC data (in mg/kg) converted to leachate concentrations (in mg/l) by a 10:1 conversion factor
** Laboratory method limit of detection as no published MRV
*** "Risk factor" is the inert waste WAC divided by the UKDWS. Rank based on calculated risk factor

APPENDIX F

Model Input Parameters

Input Parameters for LandSim Model				
Parameter		**Unit**	**Value**	**Derivation**
Location				
Location (x,y)		m	1000, 1000	Nominal location
Length and width (x,y)		m	700, 300	Length of proposed landfill parallel to groundwater flow direction and width perpendicular to groundwater flow direction
Monitoring Point (x,y)		m	1400, 1000	Nominal 50m down gradient
Source				
Management Control Duration		years	0	No leachate management
Infiltration to waste		mm/year	713.2	MORECS rainfall
Infiltration to grassland		mm/year	193.8	MORECS HER
End of Filling (from start of waste		Years	10	Assumed value
Cap Area		Ha	21	Based on landfill design
Basal Area		Ha	22	Based on landfill design
Final Waste Thickness		m	Single(22)	Based on landfill design
Waste Porosity		Fraction	Uniform(0.001,0.1)	Assumed value
Waste Density		kg/l	Uniform(0.8,1.5)	Assumed value
Waste Field Capacity		Fraction	Uniform(0.01,0.5)	Assumed value
Head of Leachate when Surface Water		m	Single(2)2	Based on landfill design
Values of m and c used to calculate the Kappa Value	Arsenic	kg/l	M = 0.0415	LandSim defaults
			C = -0.0862	
	Lead	kg/l	M = 0.0443	
			C = 0.0171	
Half Lives	Arsenic	years	Single(1E+9)	No degradation
	Lead	years	Single(1E+9)	
Leachate Quality Data	Arsenic	mg/l	Single(0.05)	Inert WAC
	Lead	mg/l	Single(0.05)	
Primary Drainage System				
Head on EBS		m	0.5	Nominal leachate head
Engineered Geological Barrier				
Barrier Type		-	Clay	Based on landfill design
Thickness		m	0.65	Assumed value
Density		kg/l	Single(1.8)	Assumed value
Moisture Content		Fraction	Single(0.15)	Assumed value
Longitudinal Dispersion		m	Single(0.065)	LandSim approach (10% of pathway length)
Hydraulic Conductivity		m/s	Single(0.000000065)	Based on landfill design
Biodegradation and Retardation Parameters within the Engineered Geological Barrier				
Partition Coefficient	Arsenic	l/kg	Single(250)	ConSim default for clay
	Lead	l/kg	Single(434.6)	
Aquifer pathway				
Pathway Length		m	Uniform(50,750)	Length of pathway parallel to groundwater flow direction. Groundwater flow direction on baseline groundwater montioring
Pathway Width		-	Single(300)	Width of pathway perpendicular to groundwater flow. Groundwater flow direction based on baseline groundwater montioring
Hydraulic Conductivity		m/s	Single(0.00000005)	Based on site specific testing.
Regional Gradient		-	Single(0.02)	Based on baseline groundwater monitoring
Mixing Zone Thickness		m	Single(10)	Based on geology and groundwater elevations
Pathway Porosity		Fraction	Single(0.25)	Assumed value
Longitudinal Dispersivity		m	Uniform(5,75)	LandSim approach (10% of pathway length)
Transverse Dispersivity		m	Single(90)	LandSim approach (3% of pathway length)

APPENDIX G

Landsim Model Results

Concentration of Arsenic in groundwater [mg/l]

At 30 years

01% of values less than 1.31571E-012
05% of values less than 1.33659E-012
10% of values less than 1.34507E-012
50% of values less than 1.38455E-012
90% of values less than 1.41132E-012
95% of values less than 1.41617E-012
99% of values less than 1.42623E-012

Minimum 1.26088E-012	Maximum 1.43686E-012	
Mean 1.37995E-012	Std. Dev. 2.63316E-014	Variance 6.93351E-028

At 100 years

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

At 300 years

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

At 1000 years

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0.0156146
90% of values less than 0.697264
95% of values less than 0.847106
99% of values less than 0.947573

Minimum 0	Maximum 0.993434	
Mean 0.205678	Std. Dev. 0.290107	Variance 0.084162

Concentration of Arsenic in groundwater [mg/l]

At infinity

01% of values less than 0

05% of values less than 4.95035E-015

10% of values less than 6.12341E-014

50% of values less than 5.25123E-013

90% of values less than 5.64126E-012

95% of values less than 1.0365E-011

99% of values less than 2.76084E-011

Minimum 0	Maximum 7.81409E-011	
Mean 2.17469E-012	Std. Dev. 5.44638E-012	Variance 2.96631E-023

Concentration of Lead in groundwater [mg/l]

At 30 years

01% of values less than 1.03429E-013
05% of values less than 1.04682E-013
10% of values less than 1.0597E-013
50% of values less than 1.12441E-013
90% of values less than 1.16082E-013
95% of values less than 1.16751E-013
99% of values less than 1.22401E-013

Minimum 1.01402E-013	Maximum 1.26603E-013	
Mean 1.11771E-013	Std. Dev. 4.06886E-015	Variance 1.65557E-029

At 100 years

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

At 300 years

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

At 1000 years

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

Concentration of Lead in groundwater [mg/l]

At infinity

01% of values less than 0

05% of values less than 8.31039E-016

10% of values less than 1.72332E-014

50% of values less than 1.35732E-012

90% of values less than 3.32718E-012

95% of values less than 4.1175E-012

99% of values less than 7.31903E-012

Minimum 0	Maximum 1.37878E-011	
Mean 1.61498E-012	Std. Dev. 1.5483E-012	Variance 2.39724E-024

Approx. time to Peak Conc. Arsenic at Offsite Compliance Point [years]

01% of values less than 1856
05% of values less than 1856
10% of values less than 1856
50% of values less than 1856
90% of values less than 2050
95% of values less than 2050
99% of values less than 2050

Minimum 1856	Maximum 2050	
Mean 1892.24	Std. Dev. 75.6515	Variance 5723.15

Approx. time to Peak Conc. Lead at Offsite Compliance Point [years]

01% of values less than 14859
05% of values less than 14859
10% of values less than 14859
50% of values less than 14859
90% of values less than 14859
95% of values less than 14859
99% of values less than 14859

Minimum 23	Maximum 20000	
Mean 14864.9	Std. Dev. 525.588	Variance 276242

Phase: Phase 1

Source Concentration of Arsenic [mg/l]

At 30 years

01% of values less than 0.0406982
05% of values less than 0.040901
10% of values less than 0.0413137
50% of values less than 0.0433214
90% of values less than 0.0444416
95% of values less than 0.0445971
99% of values less than 0.044697

Minimum 0.0405991	Maximum 0.0447354	
Mean 0.0430714	Std. Dev. 0.0011572	Variance 1.33912E-006

At 100 years

01% of values less than 0.0225002
05% of values less than 0.0229383
10% of values less than 0.0238492
50% of values less than 0.0286694
90% of values less than 0.0316541
95% of values less than 0.0320858
99% of values less than 0.0323657

Minimum 0.0222885	Maximum 0.0324737	
Mean 0.028145	Std. Dev. 0.00287459	Variance 8.2633E-006

At 300 years

01% of values less than 0.00413802
05% of values less than 0.00439463
10% of values less than 0.00496256
50% of values less than 0.00881418
90% of values less than 0.0120061
95% of values less than 0.0125245
99% of values less than 0.0128686

Minimum 0.00401774	Maximum 0.0130031	
Mean 0.0086037	Std. Dev. 0.00258056	Variance 6.65928E-006

At 1000 years

01% of values less than 1.10385E-005
05% of values less than 1.35266E-005
10% of values less than 2.03945E-005
50% of values less than 0.000142021
90% of values less than 0.000403466
95% of values less than 0.0004654
99% of values less than 0.000510023

Minimum 9.9915E-006	Maximum 0.000528261	
Mean 0.00017785	Std. Dev. 0.000146122	Variance 2.13517E-008

Phase: Phase 1

Source Concentration of Arsenic [mg/l]

At infinity

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

Phase: Phase 1

Source Concentration of Lead [mg/l]

At 30 years

01% of values less than 0.0298846
05% of values less than 0.0302583
10% of values less than 0.0310275
50% of values less than 0.0349362
90% of values less than 0.0372391
95% of values less than 0.0375656
99% of values less than 0.0377765

Minimum 0.0297031	Maximum 0.0378577	
Mean 0.0344808	Std. Dev. 0.00229227	Variance 5.25448E-006

At 100 years

01% of values less than 0.00679008
05% of values less than 0.00712544
10% of values less than 0.00785424
50% of values less than 0.0124451
90% of values less than 0.015942
95% of values less than 0.0164911
99% of values less than 0.0168532

Minimum 0.00663148	Maximum 0.0169942	
Mean 0.0121144	Std. Dev. 0.0029645	Variance 8.78827E-006

At 300 years

01% of values less than 9.8423E-005
05% of values less than 0.000114401
10% of values less than 0.000155028
50% of values less than 0.000651929
90% of values less than 0.00141191
95% of values less than 0.0015693
99% of values less than 0.00167933

Minimum 9.14248E-005	Maximum 0.00172357	
Mean 0.000716283	Std. Dev. 0.000468877	Variance 2.19846E-007

At 1000 years

01% of values less than 3.60888E-011
05% of values less than 5.99932E-011
10% of values less than 1.67487E-010
50% of values less than 2.14493E-008
90% of values less than 2.91898E-007
95% of values less than 4.17162E-007
99% of values less than 5.2448E-007

Minimum 2.81289E-011	Maximum 5.72641E-007	
Mean 8.85256E-008	Std. Dev. 1.3386E-007	Variance 1.79184E-014

Phase: Phase 1

Source Concentration of Lead [mg/l]

At infinity

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

Phase: Phase 1

Concentration of Arsenic at base of Clay Liner [mg/l]

At 30 years

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

At 100 years

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

At 300 years

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

At 1000 years

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0.000142591
90% of values less than 0.000728485
95% of values less than 0.000856617
99% of values less than 0.000948727

Minimum 0	Maximum 0.000981913	
Mean 0.000257959	Std. Dev. 0.000296044	Variance 8.76422E-008

Phase: Phase 1

Concentration of Arsenic at base of Clay Liner [mg/l]

At infinity

01% of values less than 0

05% of values less than 0

10% of values less than 0

50% of values less than 5.75074E-018

90% of values less than 1.9492E-017

95% of values less than 2.57207E-017

99% of values less than 4.32748E-017

Minimum 0	Maximum 1.49123E-016	
Mean 8.19306E-018	Std. Dev. 1.05046E-017	Variance 1.10347E-034

Phase: Phase 1

Concentration of Lead at base of Clay Liner [mg/l]

At 30 years
01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0
Minimum 0 Maximum 0
Mean 0 Std. Dev. 0 Variance 0

At 100 years
01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0
Minimum 0 Maximum 0
Mean 0 Std. Dev. 0 Variance 0

At 300 years
01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0
Minimum 0 Maximum 0
Mean 0 Std. Dev. 0 Variance 0

At 1000 years
01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0
Minimum 0 Maximum 0
Mean 0 Std. Dev. 0 Variance 0

Phase: Phase 1

Concentration of Lead at base of Clay Liner [mg/l]

At infinity

01% of values less than 0

05% of values less than 0

10% of values less than 0

50% of values less than 0

90% of values less than 1.14542E-017

95% of values less than 1.86798E-017

99% of values less than 4.9071E-017

Minimum 0	Maximum 3.94777E-016	
Mean 3.86767E-018	Std. Dev. 1.61115E-017	Variance 2.59581E-034

Phase: Phase 1

Concentration of Arsenic at base of Unsaturated Zone [mg/l]

At 30 years

01% of values less than 7.15535E-017
05% of values less than 9.11888E-017
10% of values less than 1.20885E-016
50% of values less than 1.82962E-016
90% of values less than 2.05403E-016
95% of values less than 2.16818E-016
99% of values less than 3.01572E-016

Minimum 5.22821E-017	Maximum 4.83819E-016	
Mean 1.70104E-016	Std. Dev. 4.25706E-017	Variance 1.81226E-033

At 100 years

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

At 300 years

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

At 1000 years

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 8.08747E-005
90% of values less than 0.0014073
95% of values less than 0.00168079
99% of values less than 0.00187301

Minimum 0	Maximum 0.00194478	
Mean 0.000443117	Std. Dev. 0.000581034	Variance 3.37601E-007

Phase: Phase 1

Concentration of Arsenic at base of Unsaturated Zone [mg/l]

At infinity

01% of values less than 0
05% of values less than 0
10% of values less than 3.72281E-018
50% of values less than 9.72442E-017
90% of values less than 8.11976E-016
95% of values less than 1.59045E-015
99% of values less than 2.95878E-015

Minimum 0	Maximum 8.20857E-015	
Mean 3.07686E-016	Std. Dev. 6.67549E-016	Variance 4.45622E-031

Phase: Phase 1

Concentration of Lead at base of Unsaturated Zone [mg/l]

At 30 years

01% of values less than 1.68908E-018
05% of values less than 1.70761E-018
10% of values less than 1.71717E-018
50% of values less than 1.75671E-018
90% of values less than 1.80065E-018
95% of values less than 1.82518E-018
99% of values less than 1.90682E-018

Minimum 1.64601E-018	Maximum 2.69872E-018	
Mean 1.76278E-018	Std. Dev. 6.20113E-020	Variance 3.8454E-039

At 100 years

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

At 300 years

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

At 1000 years

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

Phase: Phase 1

Concentration of Lead at base of Unsaturated Zone [mg/l]

At infinity

01% of values less than 1.69415E-019
05% of values less than 7.13466E-019
10% of values less than 2.10692E-018
50% of values less than 1.1086E-016
90% of values less than 2.57995E-016
95% of values less than 3.22282E-016
99% of values less than 6.21555E-016

Minimum 0	Maximum 2.37789E-015	
Mean 1.32249E-016	Std. Dev. 1.56143E-016	Variance 2.43806E-032

Phase: Phase 1

Approx. time to Peak Conc. Arsenic at Base of Unsaturated Zone [years]

01% of values less than 1681
05% of values less than 1681
10% of values less than 1681
50% of values less than 1681
90% of values less than 1681
95% of values less than 1681
99% of values less than 1681

Minimum 1681	Maximum 1681	
Mean 1681	Std. Dev. 0	Variance 0

Approx. time to Peak Conc. Lead at Base of Unsaturated Zone [years]

01% of values less than 13458
05% of values less than 13458
10% of values less than 13458
50% of values less than 13458
90% of values less than 13458
95% of values less than 13458
99% of values less than 13458

Minimum 17	Maximum 14859	
Mean 13400.7	Std. Dev. 955.903	Variance 913751

Phase: Phase 1

Concentration of Arsenic at Phase Monitor Well [mg/l]

At 30 years
01% of values less than 2.65842E-015
05% of values less than 2.72864E-015
10% of values less than 2.7598E-015
50% of values less than 2.85279E-015
90% of values less than 2.90494E-015
95% of values less than 2.91371E-015
99% of values less than 2.92993E-015

Minimum 2.52974E-015	Maximum 2.96242E-015	
Mean 2.83985E-015	Std. Dev. 5.99182E-017	Variance 3.59019E-033

At 100 years
01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

At 300 years
01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

At 1000 years
01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 3.45952E-005
90% of values less than 0.00154484
95% of values less than 0.00187682
99% of values less than 0.00209942

Minimum 0	Maximum 0.00220102	
Mean 0.000455694	Std. Dev. 0.000642752	Variance 4.1313E-007

Phase: Phase 1

Concentration of Arsenic at Phase Monitor Well [mg/l]

At infinity

01% of values less than 0

05% of values less than 0

10% of values less than 1.44769E-017

50% of values less than 1.11047E-016

90% of values less than 1.27296E-015

95% of values less than 2.22763E-015

99% of values less than 6.10808E-015

Minimum 0	Maximum 1.73455E-014	
Mean 4.83505E-016	Std. Dev. 1.2145E-015	Variance 1.475E-030

Phase: Phase 1

Concentration of Lead at Phase Monitor Well [mg/l]

At 30 years

01% of values less than 2.04319E-016
05% of values less than 2.06494E-016
10% of values less than 2.08829E-016
50% of values less than 2.19974E-016
90% of values less than 2.26639E-016
95% of values less than 2.28195E-016
99% of values less than 2.40144E-016

Minimum 2.01062E-016	Maximum 2.48457E-016	
Mean 2.19072E-016	Std. Dev. 7.301E-018	Variance 5.33046E-035

At 100 years

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

At 300 years

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

At 1000 years

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

Phase: Phase 1

Concentration of Lead at Phase Monitor Well [mg/l]

At infinity

01% of values less than 0

05% of values less than 2.06216E-019

10% of values less than 3.85058E-018

50% of values less than 3.01471E-016

90% of values less than 7.38638E-016

95% of values less than 9.14103E-016

99% of values less than 1.62484E-015

Minimum 0	Maximum 3.06088E-015	
Mean 3.58525E-016	Std. Dev. 3.43725E-016	Variance 1.18147E-031

Phase: Phase 1

Approx. time to Peak Conc. Arsenic at Phase Monitor Well [years]

01% of values less than 1856
05% of values less than 1856
10% of values less than 1856
50% of values less than 1856
90% of values less than 1856
95% of values less than 1856
99% of values less than 1856

Minimum 1856	Maximum 1856	
Mean 1856	Std. Dev. 0	Variance 0

Approx. time to Peak Conc. Lead at Phase Monitor Well [years]

01% of values less than 14859
05% of values less than 14859
10% of values less than 14859
50% of values less than 14859
90% of values less than 14859
95% of values less than 14859
99% of values less than 14859

Minimum 21	Maximum 16406	
Mean 14779.3	Std. Dev. 1152.77	Variance 1.32889E+006

Phase: Phase 1

Flow to Leachate Treatment Plant [l/day]

At 30 years

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

At 100 years

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

At 300 years

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

At 1000 years

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

Phase: Phase 1

Flow to Leachate Treatment Plant [l/day]

At infinity

01% of values less than 0

05% of values less than 0

10% of values less than 0

50% of values less than 0

90% of values less than 0

95% of values less than 0

99% of values less than 0

Minimum 0 Maximum 0

Mean 0 Std. Dev. 0 Variance 0

Phase: Phase 1

Head on EBS [m]

At 1000 years

01% of values less than 1.001E-010
05% of values less than 1.001E-010
10% of values less than 1.001E-010
50% of values less than 1.001E-010
90% of values less than 1.001E-010
95% of values less than 1.001E-010
99% of values less than 1.001E-010

Minimum 1.001E-010	Maximum 1.001E-010	
Mean 1.001E-010	Std. Dev. 1.15746E-017	Variance 1.33972E-034

At infinity

01% of values less than 1.001E-010
05% of values less than 1.001E-010
10% of values less than 1.001E-010
50% of values less than 1.001E-010
90% of values less than 1.001E-010
95% of values less than 1.001E-010
99% of values less than 1.001E-010

Minimum 1.001E-010	Maximum 1.001E-010	
Mean 1.001E-010	Std. Dev. 1.15746E-017	Variance 1.33972E-034

Phase: Phase 1

Surface Breakout [l/day]

At 300 years

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

At 1000 years

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

At infinity

01% of values less than 0
05% of values less than 0
10% of values less than 0
50% of values less than 0
90% of values less than 0
95% of values less than 0
99% of values less than 0

Minimum 0	Maximum 0	
Mean 0	Std. Dev. 0	Variance 0

Phase: Phase 1

Leakage through EBS [l/day]

At 100 years

01% of values less than 116731
05% of values less than 116731
10% of values less than 116731
50% of values less than 116731
90% of values less than 116731
95% of values less than 116731
99% of values less than 116731

Minimum 116731	Maximum 116731	
Mean 116731	Std. Dev. 0.0239463	Variance -0.000573427

At 300 years

01% of values less than 116731
05% of values less than 116731
10% of values less than 116731
50% of values less than 116731
90% of values less than 116731
95% of values less than 116731
99% of values less than 116731

Minimum 116731	Maximum 116731	
Mean 116731	Std. Dev. 0.0239463	Variance -0.000573427

At 1000 years

01% of values less than 116731
05% of values less than 116731
10% of values less than 116731
50% of values less than 116731
90% of values less than 116731
95% of values less than 116731
99% of values less than 116731

Minimum 116731	Maximum 116731	
Mean 116731	Std. Dev. 0.0239463	Variance -0.000573427

At infinity

01% of values less than 1.16731E+006
05% of values less than 1.16731E+006
10% of values less than 1.16731E+006
50% of values less than 1.16731E+006
90% of values less than 1.16731E+006
95% of values less than 1.16731E+006
99% of values less than 1.16731E+006

Minimum 1.16731E+006	Maximum 1.16731E+006	
Mean 1.16731E+006	Std. Dev. 0.0226161	Variance -0.000511489

Phase: Phase 1

Aquifer Flow [m³/year]

At 30 years

01% of values less than 42730.7
05% of values less than 42730.7
10% of values less than 42730.7
50% of values less than 42730.7
90% of values less than 42730.7
95% of values less than 42730.7
99% of values less than 42730.7

Minimum 0	Maximum 42730.7	
Mean 42688	Std. Dev. 1350.59	Variance 1.82409E+006

At 100 years

01% of values less than 42730.7
05% of values less than 42730.7
10% of values less than 42730.7
50% of values less than 42730.7
90% of values less than 42730.7
95% of values less than 42730.7
99% of values less than 42730.7

Minimum 0	Maximum 42730.7	
Mean 42688	Std. Dev. 1350.59	Variance 1.82409E+006

At 300 years

01% of values less than 42730.7
05% of values less than 42730.7
10% of values less than 42730.7
50% of values less than 42730.7
90% of values less than 42730.7
95% of values less than 42730.7
99% of values less than 42730.7

Minimum 0	Maximum 42730.7	
Mean 42688	Std. Dev. 1350.59	Variance 1.82409E+006

At 1000 years

01% of values less than 42730.7
05% of values less than 42730.7
10% of values less than 42730.7
50% of values less than 42730.7
90% of values less than 42730.7
95% of values less than 42730.7
99% of values less than 42730.7

Minimum 0	Maximum 42730.7	
Mean 42688	Std. Dev. 1350.59	Variance 1.82409E+006

Phase: Phase 1

Aquifer Flow [m³/year]

At infinity

01% of values less than 426455

05% of values less than 426455

10% of values less than 426455

50% of values less than 426455

90% of values less than 426455

95% of values less than 426455

99% of values less than 426455

Minimum 0 Maximum 426455

Mean 426029 Std. Dev. 13478.9 Variance 1.81682E+008

APPENDIX H

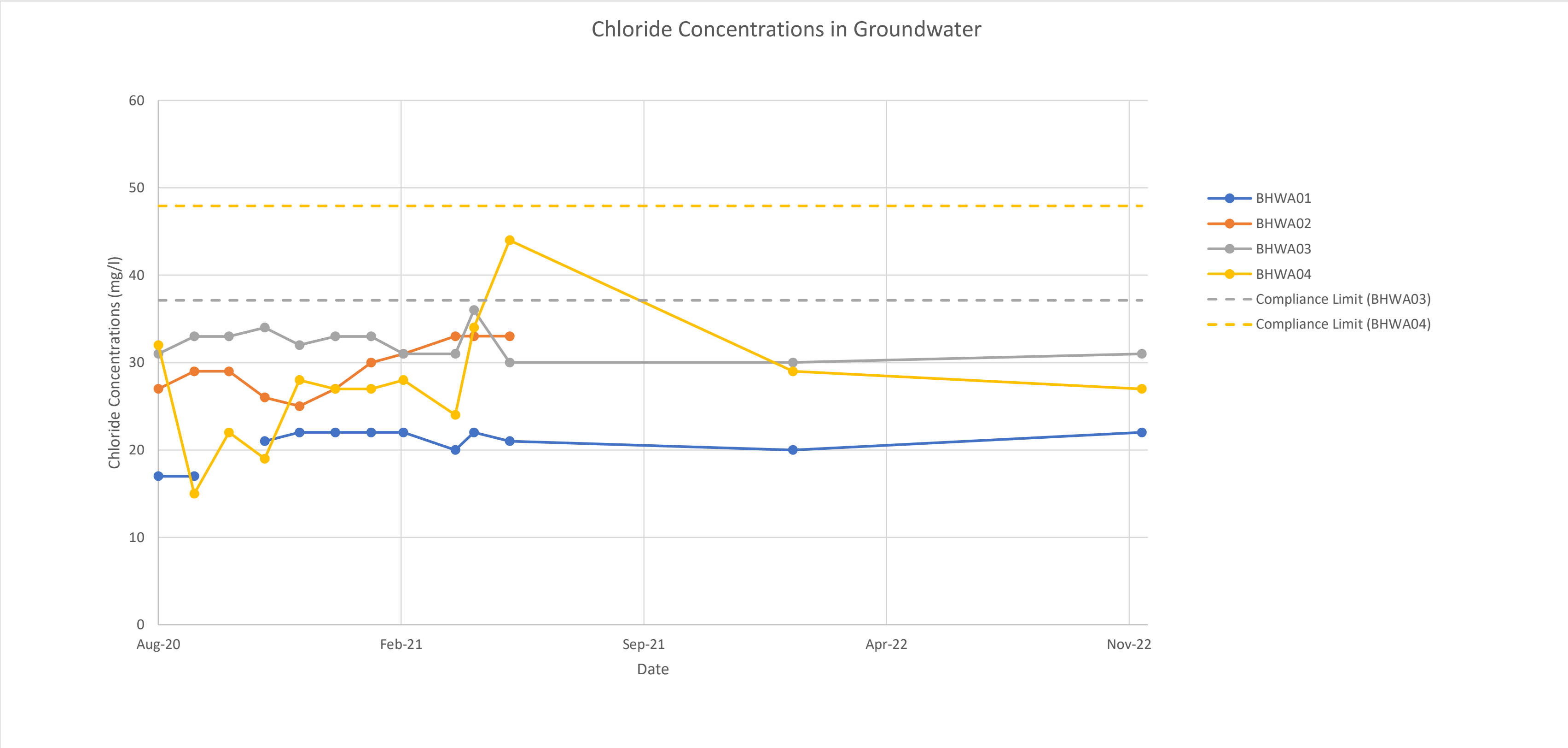
Gebdykes Landsim Model

APPENDIX I

Compliance Limits

Chloride (mg/l)

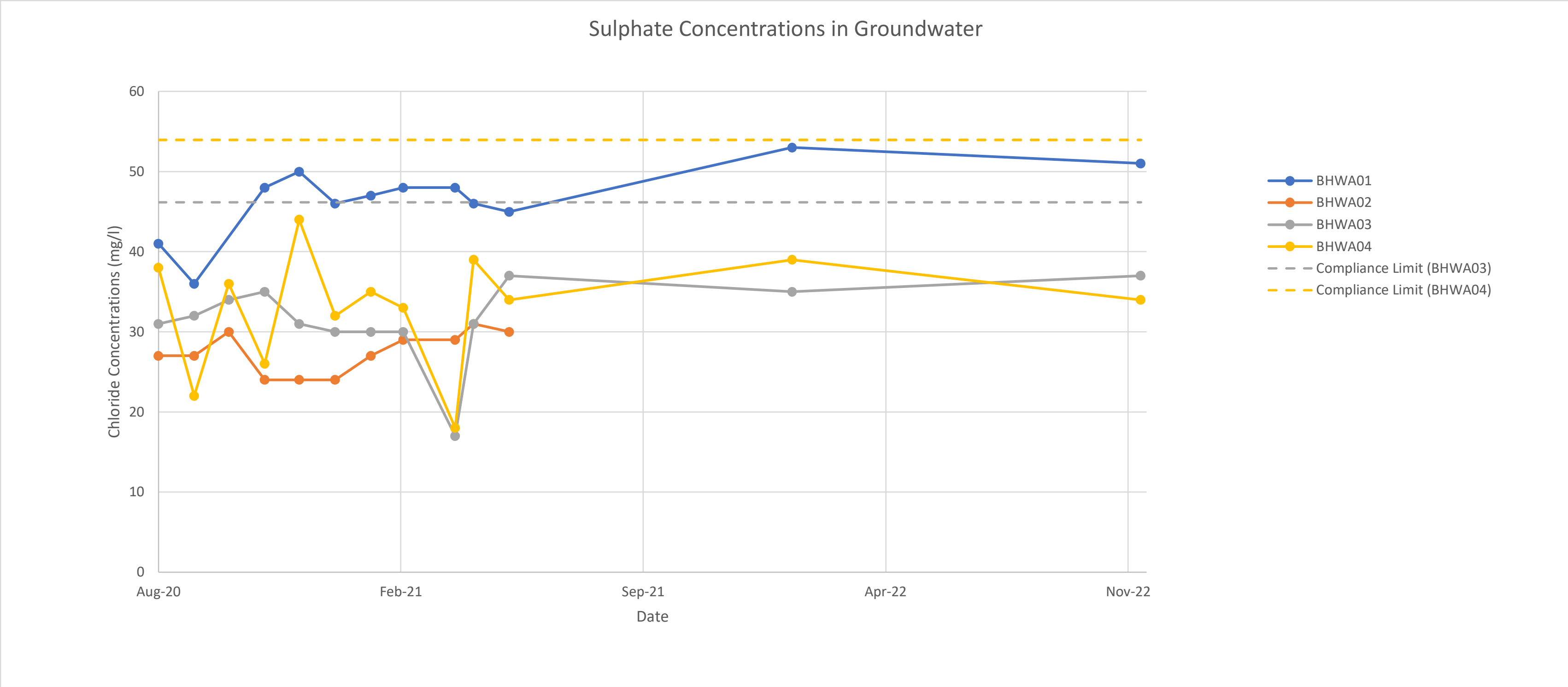
	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Feb-22	Nov-22	Mean	Standard Deviation	Compliance Limit*
BHWA01	17	17		21	22	22	22	22	20	22	21	20	22.0	20.7	1.8	-
BHWA02	27	29	29	26	25	27	30	31	33	33	33			29.4	2.8	-
BHWA03	31	33	33	34	32	33	33	31	31	36	30	30	31.0	32.2	1.7	37.1
BHWA04	32	15	22	19	28	27	27	28	24	34	44	29	27.0	27.4	6.8	47.9



Note:
* Compliance Limit based on mean + 3 standard deviations

Sulphate (mg/l)

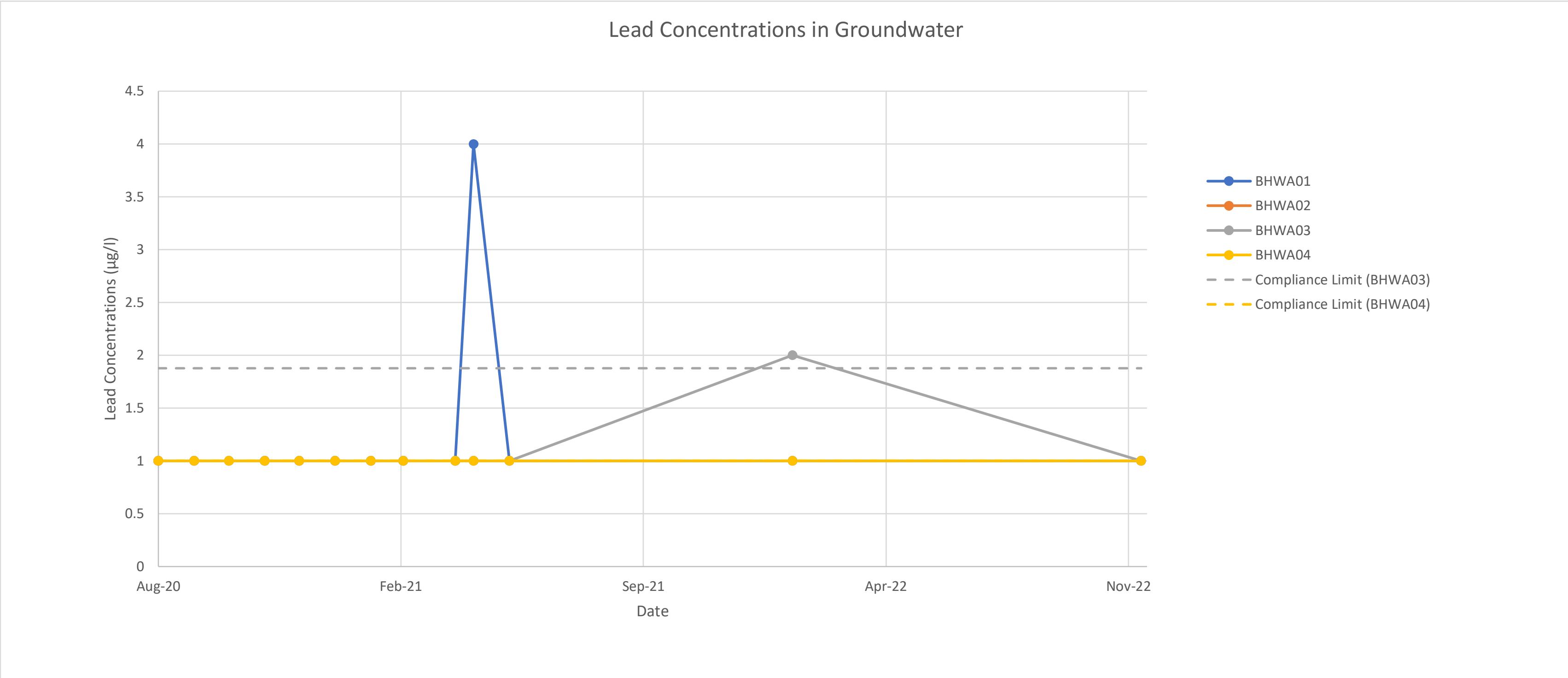
	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Feb-22	Nov-22	Mean	Standard Deviation	Compliance Limit*
BHWA01	41	36		48	50	46	47	48	48	46	45	53	51	46.6	4.3	-
BHWA02	27	27	30	24	24	24	27	29	29	31	30			27.5	2.5	-
BHWA03	31	32	34	35	31	30	30	30	17	31	37	35	37	31.5	4.9	46
BHWA04	38	22	36	26	44	32	35	33	18	39	34	39	34	33.1	7.0	54



Note:
* Compliance Limit based on mean + 3 standard deviations

Lead (µg/l)

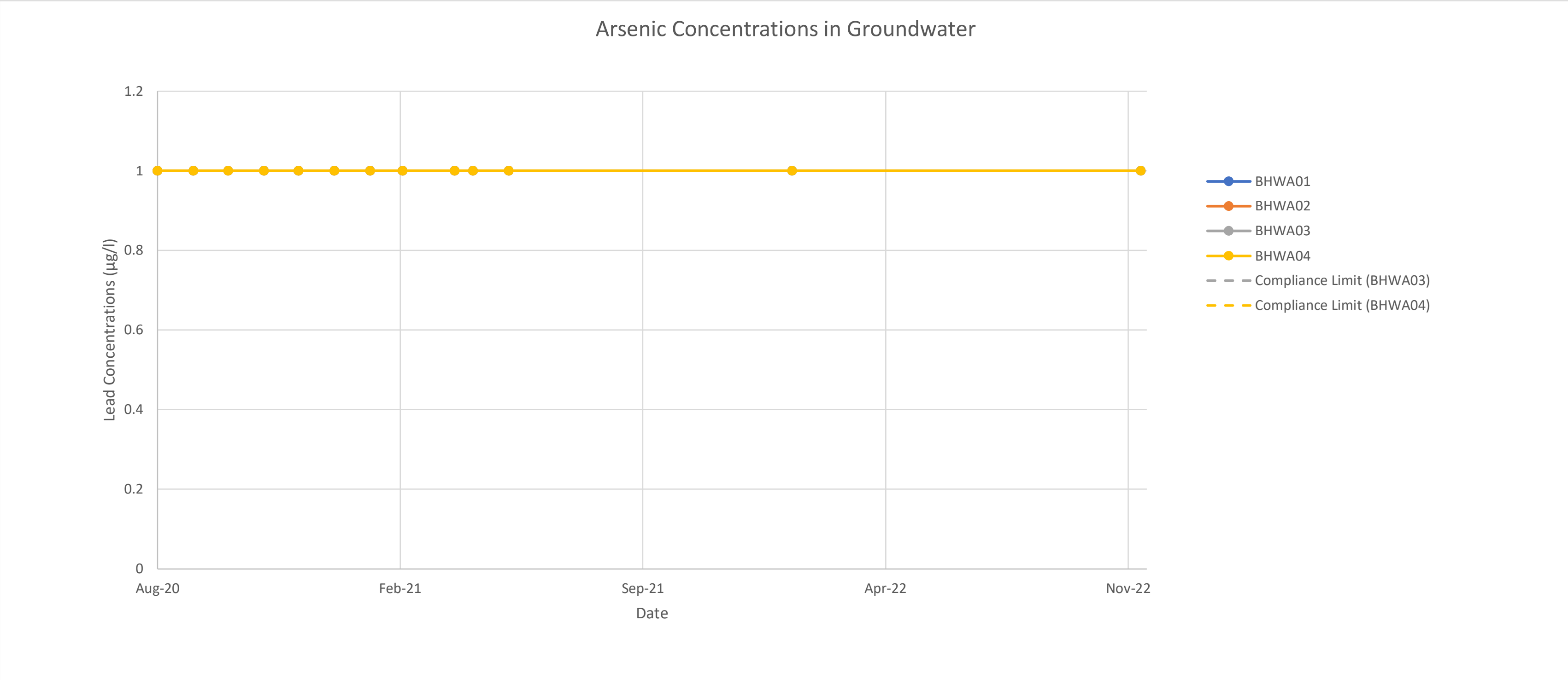
	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Feb-22	Nov-22	Mean	Standard Deviation	Compliance Limit*
BHWA01	1	1		1	1	1	1	1	1	4	1	1	1	1.3	0.8	-
BHWA02	1	1	1	1	1	1	1	1	1	1	1			1.0	0.0	-
BHWA03	1	1	1	1	1	1	1	1	1	1	1	2	1	1.1	0.3	2
BHWA04	1	1	1	1	1	1	1	1	1	1	1	1	1	1.0	0.0	1



Note:
* Compliance Limit based on mean + 3 standard deviations

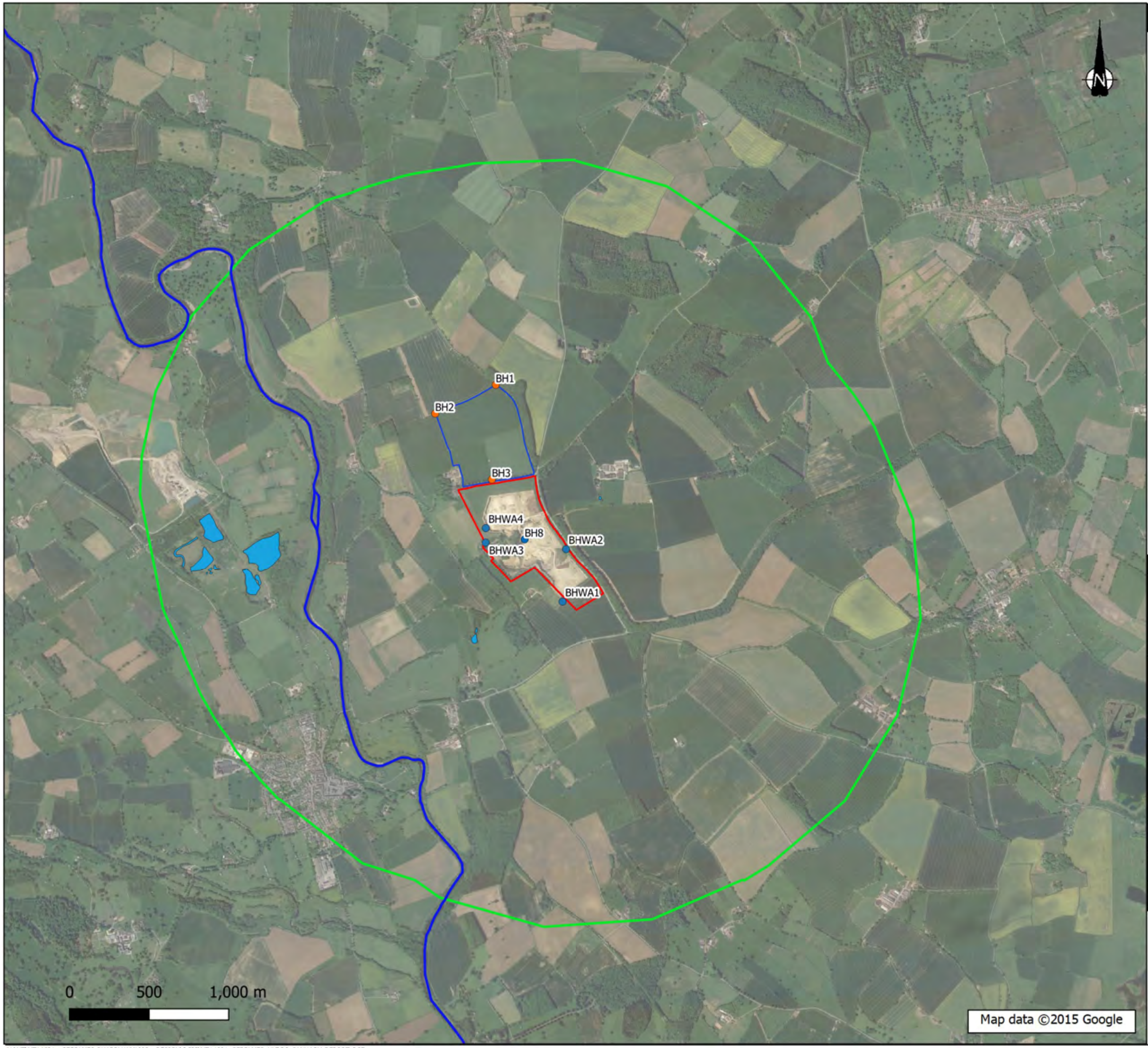
Arsenic (µg/l)

	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Feb-22	Nov-22	Mean	Standard Deviation	Compliance Limit*
BHWA01	1	1		1	1	1	1	1	1	1	1	1	1	1	0	-
BHWA02	1	1	1	1	1	1	1	1	1	1	1			1	0	-
BHWA03	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
BHWA04	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1



Note:
* Compliance Limit based on mean + 3 standard deviations

FIGURES



DO NOT SCALE FROM THIS DRAWING

Legend

- Site Boundary
- Other Land Under the Applicant's Control
- 2km Study Area
- Groundwater Monitoring Boreholes - Existing Quarry Area
- Groundwater Monitoring Boreholes - Northern Extension Area
- River Ure
- Ponds within Study Area

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D

CLIENT
Lightwater Quarries

PROJECT
Gebdykes Quarry Landfill Permit Applciation

DRAWING TITLE
Borehole Location Plan
NT14621-Figure 1

DRG No. NT14621-Figure 1		REV A
DRG SIZE A3	SCALE 1:23,524	DATE March 2021
DRAWN TR	CHECKED BY AS	APPROVED BY AS

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N:\NT\NT14621 - GEBDYKES QUARRY WML\03 - DESIGN\QGIS\NT14621_GEBDYKES_HYDRO_JANUARY_REPORT.QGZ

DO NOT SCALE FROM THIS DRAWING

Legend

- Site Boundary
- Other Land Under the Applicant's Control
- Groundwater Monitoring Boreholes, Groundwater Elevation (m AOD)
- Groundwater Contours August 2020 (m AOD)
- Groundwater Flow Direction

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D

CLIENT

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PROJECT

Gebdykes Quarry Landfill Permit Applciation

DRAWING TITLE

Groundwater Contour Plot August 2020

DRG No. NT14621-Figure 2		REV A
DRG SIZE A3	SCALE 1:3,500	DATE March 2021
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DO NOT SCALE FROM THIS DRAWING

Legend

- Site Boundary
- Other Land Under the Applicant's Control
- Groundwater Monitoring Boreholes,Groundwater Elevation (m AOD)
- Groundwater Contours January 2021 (m AOD)
- Groundwater Flow Direction

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D

CLIENT

Lightwater Quarries

PROJECT

Gebdykes Quarry Landfill Permit Applciation

DRAWING TITLE

Groundwater Contour Plot January 2021

DRG No. NT14621-Figure 3		REV A
DRG SIZE A3	SCALE 1:3,500	DATE March 2021
DRAWN TR	CHECKED BY AS	APPROVED BY AS

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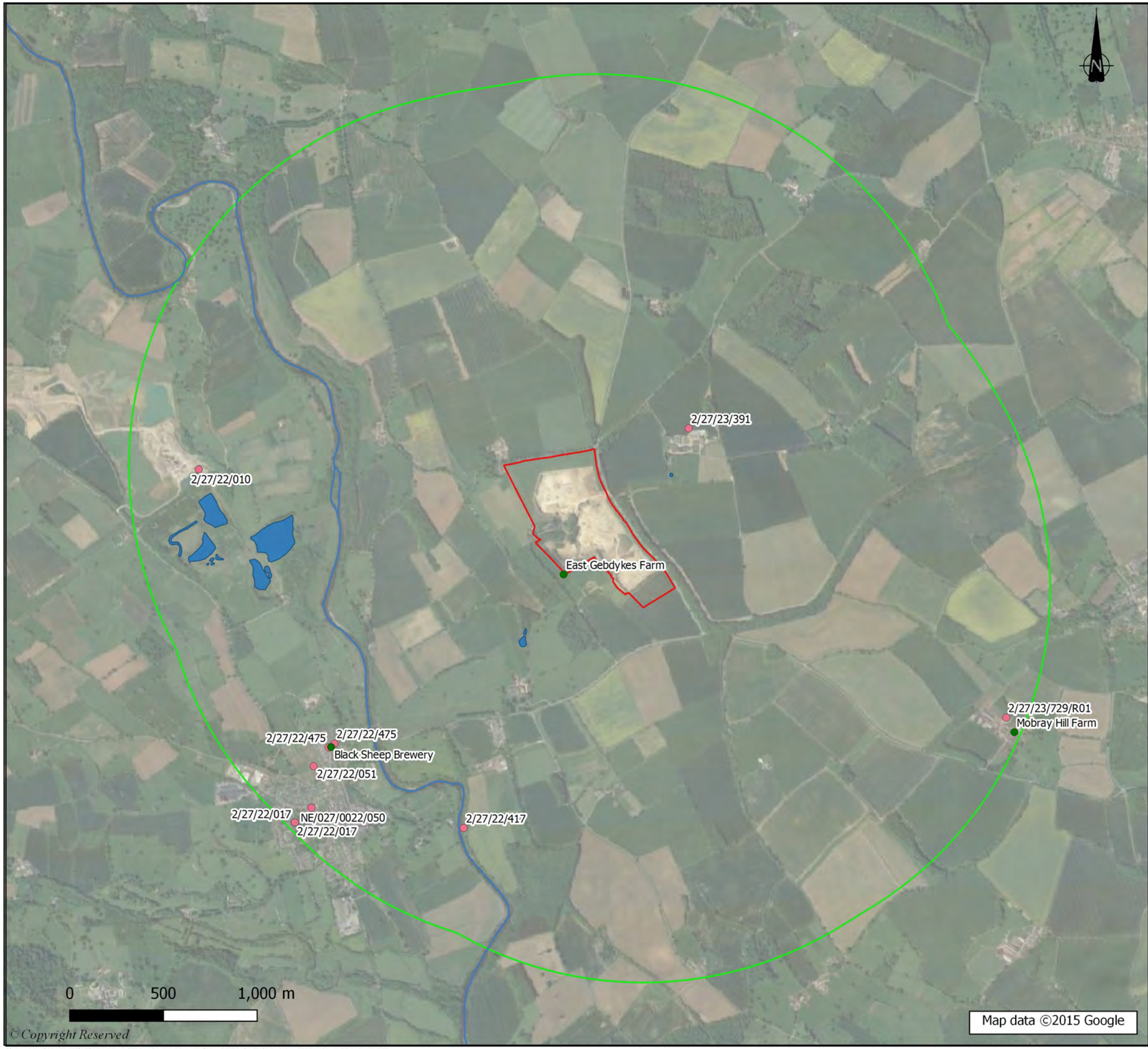

DO NOT SCALE FROM THIS DRAWING

Legend

- Site Boundary
- 2km Study Area
- River Ure
- Ponds within Study Area
- EA Licenced Abstractions
- PrWS Locations

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D
B	Additional PrWS included	09/21	BJ	RG	LB

CLIENT

Lightwater Quarries

PROJECT

Gebdykes Quarry Landfill Permit Applciation

DRAWING TITLE

Private Water Supplies and Licensed Abstractions
NT14621-Figure 4

DRG No. NT14621-Figure 4		REV A
DRG SIZE A3	SCALE 1:20,000	DATE September 2021
DRAWN TR	CHECKED BY LB	APPROVED BY LB

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MINERAL ESTATES
WASTE RESOURCE MANAGEMENT

LIGHTWATER QUARRIES LIMITED

APPLICATION FOR AN ENVIRONMENTAL PERMIT

GEBDYKES QUARRY LANDFILL

OPERATING TECHNIQUES

APRIL 2023

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DATE ISSUED:	**APRIL 2023**
JOB NUMBER:	**NT14621**
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VERSION:	**V2.0**
STATUS:	**FINAL**

LIGHTWATER QUARRIES LIMITED

APPLICATION FOR AN ENVIRONMENTAL PERMIT

GEBDYKES QUARRY LANDFILL

OPERATING TECHNIQUES

APRIL 2023

PREPARED BY:

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Alison Cook	Technical Director	

APPROVED BY:

Alison Cook	Technical Director	

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MINERAL ESTATES
WASTE RESOURCE MANAGEMENT

CONTENTS

APPENDICES

1 INTRODUCTION

1.1.1 Gebdykes Quarry is a limestone quarry located at Masham, North Yorkshire. Lightwater Quarries Limited are applying for an environmental permit to allow the landfilling of approximately 200,000 tonnes of clean inert materials per year to restore the site to original levels. In total 3,600,000 tonnes of clean inert materials will be deposited.

1.1.2 Landfill operations will be undertaken in five distinct phases in the southern void of the quarry, while limestone extraction will continue within the north void. An engineered artificially established (crushed and screened dolomite fines) geological barrier will be constructed to ensure compliance with the Landfill Directive. All clean inert materials to be landfilled at the site will meet the definition of inert in accordance with the Landfill Directive.

1.1.3 The site location and boundary of the permitted area are shown on drawing NT14621/003.

1.1.4 The site will be operated in accordance with Lightwater Quarries' environmental management system. All operations at Gebdykes Quarry will be managed by a Technically Competent Manager.

1.1.5 Operations at the site will meet the requirements of the Environment Agency's guidance "Landfill operators: environmental permits". This application fulfils requirements that are set out within the guidance. The following are included:

- a conceptual model of the site is provided within the Environmental Setting and Site Design (ESSD);
- details of the potential hazards and receptors at the site, and how risk will be mitigated are provided within the Accident and Amenity, and Habitats Risk Assessment;
- a description of the hydrogeological conditions of the site is provided within the Hydrogeological Risk Assessment (HRA);
- an initial desk study has been undertaken that identifies the conditions at the site and around the site. This is summarised in the ESSD;
- details of the site monitoring regime are provided within Section 8 and in the HRA;

- a list of permitted materials to be accepted at the site is provided as Appendix 1;
- details of material pre-acceptance and acceptance procedures, including compliance testing, are presented in Section 4;
- a Financial Provision spreadsheet is included in the application; and
- details of site closure are presented in Section 10.

1.1.6 Section 2 of this document details the permitted activities that are to be undertaken at the site.

1.1.7 The history of the site is detailed in Section 3.

1.1.8 The layout of the site is described in Section 4.

1.1.9 Details of pre-acceptance, acceptance and rejection criteria are described in Section 5.

1.1.10 A description of the operations that will be undertaken at the site is provided in Section 6.

1.1.11 Section 7 details how potential amenity issues (e.g. noise and dust) will be mitigated, and how records are kept.

1.1.12 The management of surface water is detailed in Section 8.

1.1.13 Section 9 provides details of the site monitoring regime.

1.1.14 Site management procedures are detailed in Section 10.

1.1.15 Section 11 covers procedures relating to the closure of the site and the aftercare period.

2 PERMITTED ACTIVITIES

2.1.1 The permitted activities will be limited to the landfilling of clean inert materials as set out in Table 1, below.

Table 2.1: Permitted Site Activities		
Activity	Schedule 1 Reference under EPR2016	Waste Framework Directive Classification
Inert landfill	Not listed	D1 deposit into or onto land, e.g. landfill

2.1.2 It is intended that the site will accept approximately 200,000 tonnes of clean inert materials per annum. The total amount of inert materials to be deposited at the site is 3,600,000 tonnes.

2.1.3 The site operations will be under the control of a Technically Competent Manager (TCM) who holds the appropriate WAMITAB certification. The TCM will attend site at a frequency in compliance with the Environment Agency's requirements for site attendance. In accordance with the guidance this is equivalent to 20% of operational hours during the first six months of site operations.

3 SITE HISTORY

3.1.1 Extraction of stone from land within the vicinity of the current Gebdykes Quarry dates back to at least the 1860s. The current Gebdykes Quarry and a quarry located adjacent to the site boundary to the northwest were known as "Gybdykes Quarry" at this time.

3.1.2 Gybdykes Quarry to the northwest of the current site has since been worked and restored into a small, wooded area.

3.1.3 The first permission for mineral extraction at the site was granted in 1949. The permission requires the following:

- All topsoil and overburden to be deposited in a level manner within the quarry workings, and the land to be returned to agriculture so far as practicable.

3.1.4 This planning permission was reviewed, resulting in a new permission (C2/97/135/0051C/MR) containing revised conditions being issued on 3rd February 1998.

3.1.5 Planning permission was granted on 5th November 2001 for a northern, eastern and southern extension to Gebdykes Quarry (C2/99/135/0051D). These permitted extensions form the scope of the existing quarry boundary. The permission required that:

- Following mineral extraction, overburden and other waste materials should be replaced to such levels so that, after the replacement of subsoil and topsoil the contours of the restored land shall conform with the restoration contours as indicated in the application details.

3.1.6 In accordance with the planning permission, the site is to be restored to original ground levels and for the purpose of agriculture. This is shown on drawing NT14834/Figure 3.6.

4 SITE LAYOUT

4.1.1 The quarry void is divided into a northern and southern void. Limestone extraction will continue within the north void area, while waste infilling commences within the southern excavation as per the subject of this permit application. It is proposed the northern void area will not be infilled, but will be restored at the quarry base level. Drawing NT14834/ 014 shows the proposed restoration level of the full extent of the inert landfill and the northern void area.

4.1.2 The landfill will completed in 5 phases, as shown in Drawings NT14834/Figure 3.1 – 3.5. The site will be subject to progressive restoration with each phase restored as it is completed.

4.1.3 Access to the site is gained from the site entrance at Halfpenny House Lane to the east, which is surfaced with concrete. Internal roads will be constructed from hardcore.

4.1.4 A weighbridge is located on site. This will be properly maintained and calibrated to allow accurate recording of materials entering and leaving the site.

5 MATERIAL ACCEPTANCE

5.1.1 A list of permitted inert materials to be accepted at the site is provided in Appendix 1. All materials accepted for landfilling will be inert and will either be accepted in accordance with the list of materials acceptable without testing or will be tested to demonstrate compliance with the inert material acceptance criteria in accordance with the Landfill Directive.

5.1.2 Pre-acceptance checks will be undertaken by the operator to confirm that the materials to be accepted are clean inert wastes are suitable for use prior to being accepted on to site.

5.1.3 Wastes listed under 2.1.1 of Annex 2003/33/EC [1]of the Landfill Directive may be accepted for disposal at the site without being subject to any additional testing provided:

- the waste is from a single stream and single source material. Different wastes contained within the list of wastes acceptable without testing may be accepted together, provided they are from the same source;
- the site of origin is not contaminated and the wastes do not contain other material or substances to an extent which increases the risk associated with the waste sufficiently to justify its disposal in another class of landfill.

5.1.4 Where inert materials are sourced from a brownfield site or there is any other reason to believe materials may not be fully inert or meet the above description, the materials producer will be required to provide representative analysis, showing that the material meets inert material acceptance criteria.

5.2 Pre-Acceptance

Initial Assessment

5.2.1 Pre-acceptance checks will be made to ensure that clean inert materials are compliant with the permit conditions. Inert materials will be subject to Level 1 Basic Characterisation, which will involve collecting details regarding the:

[1] 2003/33/EC: Council Decision of 19 December 2002 establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to Directive 1999/31/EC (legislation.gov.uk)

- Material producer;
- Process generating the inert materials;
- Quantity of clean inert materials;
- Material type;
- Material appearance (smell, colour and physical form);
- Classification under the list of waste regulations;
- Chemical analysis of the material, including leaching behaviour (unless on the list of materials acceptable without testing); and
- Six figure code according to the European Waste Catalogue.

5.2.2 This information will be assessed by a suitably competent person, to determine whether the clean inert materials are acceptable for deposit at the site. Where the results of Level 1 Basic Characterisation show that a material stream is not acceptable for deposit, the material will not be accepted at the site.

5.2.3 Where wastes are deemed to be acceptable the site weighbridge will be informed that the waste stream has been approved and the pre-acceptance data will be forwarded to the weighbridge, so that it is available to staff to make their acceptance checks when the waste arrives on site.

Compliance Testing

5.2.4 The operator will undertake Level 2 Compliance Testing at least once a year for each material stream subject to leaching tests by the producer. At least one sample will be taken for each relevant material stream. Level 2 Compliance Testing will demonstrate the integrity of Level 1 Basic Characterisation Testing and ensure compliance with the requirements of the Environmental Permit.

5.2.5 Level 2 compliance testing constitutes periodic testing which will be determined by the Site Manager based upon the type and tonnage of clean inert materials being accepted. It will be a simple standardised analysis to determine whether the inert material complies with the results of the basic characterisation and inert WAC.

5.2.6 All samples for Level 2 Compliance Testing will be stored in a closed container suitable for the material being contained (to be determined by a technically competent person). The containers will be clearly labelled and/or referenced sufficiently to identify sample source and date of delivery.

5.2.7 Samples will be submitted to an independent laboratory for analysis using MCERTs accredited techniques. The determinants for analysis will be selected on the basis of Level 1 basic characterisation. Copies of analytical results will be kept in a site log and made available to authorised officers of the Environment Agency.

5.2.8 Each load arriving at the site will be subject to Level 3 On-Site Verification. This comprises a check of the material transfer note or annual season ticket, and a visual inspection prior to and following deposit of clean inert materials at the site to ensure that the material appears compliant with the basic characterisation.

Acceptance

5.2.9 Clean inert materials will only be accepted when the site is adequately manned, allowing for acceptance checks and controlled deposit of the material.

5.2.10 On arrival at the site, clean inert materials will be weighed in at the weighbridge and transfer notes will be checked. If the driver does not have a Duty of Care Transfer Note or if the clean inert material is not in compliance with the permit conditions or the pre-acceptance information the Material Rejection Procedure will be followed.

5.2.11 The operator will inspect each load of clean inert material during unloading to ensure that it is acceptable and consistent with the pre-acceptance checks. Should non-conforming inert material be detected, this will wherever possible be reloaded onto the delivery vehicle and rejected from the site.

5.2.12 Records of all enquiries will be kept with pre-acceptance documentation (basic characterisation) in a log maintained in the site office. When a load of inert material is delivered to the site, this pre-acceptance documentation will be cross-referenced against the details given on the relevant material transfer notes/season tickets accompanying the inert material and the contents of the load.

5.2.13 The weight of each load will be recorded electronically, allowing the quantity of inert material that is deposited to be easily monitored.

5.2.14 Pre-acceptance and acceptance documentation will be made available for inspection by authorised officers of the Environment Agency on request.

Rejection

5.2.15 Any discrepancies found as a result of the checks detailed above will result in:

- referral to a suitable competent person;

- referral to the material producer or the material carrier's base, to confirm the nature of the inert material load;
- a written record being made in the site log to record the nature of the material and the actions that are taken; and
- where necessary, referral to the Environment Agency.

5.2.16 Where the investigation shows that waste is acceptable it will be directed to the tipping area. Otherwise, the waste will be rejected following the procedure below and a record will be made in the site log.

5.2.17 Where appropriate, material will either be returned to the producer/previous holder or re-directed to an appropriate authorised facility for disposal. Where it is not possible to directly reject the load, it will be removed to an on-site quarantine area for temporary storage prior to off-site removal to an authorised facility.

5.2.18 Should the non-compliance involve hazardous material or material that otherwise poses a heightened risk to the environment, the Environment Agency will be informed as soon as possible.

6 LANDFILLING

6.1 Site Activities

6.1.1 Landfill operations will be undertaken in five distinct phases in the southern void of the quarry as shown in Drawings NT14834/Figure 3.1 – 3.5. Limestone extraction will continue within the north void area contemporary to landfilling operations in the south. The infill works will comprise the placement of clean inert waste in layers of 2 – 3m, working up from the base of excavation to produce the agreed restoration profile.

6.1.2 The maximum depth of landfill will be 30m. A series of cross sections through the site, showing formation and levels are shown on Drawing NT14834/Figure 3.7. The sections show the existing profile of the quarry excavation, the site boundary and restoration profile. The Hydrogeological Cross Section (included in the Hydrogeological Risk Assessment) is provided as NT14621-Figure 5, showing the design of the design of the liner in context with the surrounding geology. The final restoration profile of the landfill area is that of a uniform surface, matching closely that of the original landform.

6.1.3 The basal and side slope lining systems will be constructed in accordance with the requirements of the Landfill Directive. The initial side slope lining system will comprise a bund constructed from crushed and screened dolomite fines, 2m in height and 3m in width, to connect to the existing side slope. The side slope lining system will be installed progressively with each waste lift. The basal liner will be 650mm in thickness. The artificially established geological barrier will comprise crushed and screened dolomite fines that will be compacted to provide a permeability equal to or less than 6.5×10^{-8}m/s, which is equivalent to a maximum of 1×10^{-7} m/s for a 1m thick barrier, as evidenced in the Materials Suitability Assessment in Appendix 2, submitted to the EA on 5th October 2022. If there is a shortfall of dolomite fines or the material becomes otherwise inconsistent, other suitable imported material will be used which is able to meet the required liner specification.

6.1.4 The north face of the landfill will be left as an open slope within the waste at a design profile of 1 in 3.

6.1.5 Inert materials will not degrade and can be properly compacted in layers to minimise settlement and achieve a stable landform.

6.2 Restoration

6.2.1 The site is to be restored to agricultural and nature conservation (calcareous grassland) uses. The final restoration profile is shown in drawing NT14834/Figure 3.6. In order to allow for the emplacement of final restoration materials, the last layer of inert material that is placed will placed to the necessary level below the adjoining undisturbed ground levels, to ensure the final restoration of the site will tie in to existing adjacent ground levels.

6.2.2 Following landfilling, overburden, subsoils and topsoil stripped from the site, along with any necessary imported subsoils will be placed over the clean inert material.

6.2.3 Phase 1 will be restored to Magnesian limestone grassland, while phases 2 – 5 will be restored to agricultural grassland.

6.2.4 To restore the site to magnesian limestone a soil profile will be created comprising 100mm of topsoil emplaced over limestone fines. For the agricultural grassland areas, the restoration soil profile will comprise approximately 300mm of topsoil (previously stripped from the site) over 600mm of subsoil (See Appendix 3 Landscape, Biodiversity and Restoration Management Plan).

6.2.5 No large pieces of inert material (over 150mm in size) will be included within the restoration layer.

6.2.6 Topsoil will form the final restoration contours and the site will be seeded to establish a healthy vegetation cover.

7 RECORD KEEPING AND CONTROL OF AMENITY ISSUES

7.1.1 The site will be inspected on a daily basis. Site staff will carry out a visual and olfactory assessment around the site boundary to check for emissions of litter, odour, noise, mud, or dust.

7.1.2 Should any issues be noted during the daily inspections these will be raised with site management and appropriate remedial action will be agreed. The remedial action agreed and the time that it was (or is to be) carried out will be noted in the site log.

7.1.3 All site infrastructure and site plant will be regularly inspected for leaks or damage. Inspections will be recorded within the site diary. Where leaks or damage are identified the equipment will be immediately repaired by suitably qualified staff or taken out of service. Any spills will be cleaned using a spill kit and recorded.

7.1.4 The site diary will be made available to warranted officers of the Environment Agency on request. Should any incident have the potential to cause significant emissions, the Environment Agency will be informed by telephone and remedial action will be agreed with the local environment officer.

7.1.5 Other records that are kept on site (either in electronic or hard copy format) include details of inert material enquiries and pre-acceptance information, copies of all material transfer notes for incoming and outgoing materials, details of any rejected loads, copies of the analysis of inert materials where required and results of any environmental monitoring.

7.2 Environmental Protection Measures

7.2.1 Measures will be employed throughout the operational life of the site to ensure that operations do not impact on the environment or amenity of the locality. Further details are provided in an Amenity and Accident Risk Assessment that is included with the permit application.

Mud

7.2.2 The site will be kept tidy with hardcore surfacing being provided for internal site roads to minimise the formation of mud. All site access roads will be maintained on a regular basis to minimise mud and dust arisings.

7.2.3 If appropriate the site entrance road will be swept at regular intervals to prevent any build-up of mud or debris.

7.2.4 Vehicles will be inspected before leaving the site and wheel cleaning facilities will be available to clean excessive mud from vehicles prior to exiting the site, as necessary. The 250m long entrance road onto Halfpenny Lane will be hard surfaced, further ensuring mud will not be tracked onto the highway.

7.2.5 Should any mud be tracked out of the site arrangements will be made to sweep the highway as soon as possible.

Dust

7.2.6 The production of dust will be minimised by ensuring that the site roads are properly maintained and where necessary cleaned. Clean inert materials processing will be located within the quarry so that the quarry walls provide screening and will also be located away from sensitive boundaries.

7.2.7 Clean inert materials placed in the landfill will be compacted before the end of the working day.

7.2.8 Vehicles entering and leaving the site that may contain dusty material will be covered or sheeted to contain dust.

7.2.9 A speed limit will be applied on site, helping to minimise the quantity of dust generated by moving vehicles.

7.2.10 To prevent the dispersal of dust that is created at the site, water from a bowser will be applied to the tipping face and site roads in dry weather or at other times when dust may be an issue.

Odour

7.2.11 The materials to be accepted at the site are inert and are not inherently odorous. Odorous materials will be rejected during waste acceptance check.

7.2.12 Regular checks for odour will be made around the site boundary. Should noticeable odour be detected, the source will be identified and appropriate remedial action will be taken.

7.2.13 Any non-conforming material that is causing a significant odour will be prioritised for removal off site and will be removed before the end of the working day where possible.

Noise

7.2.14 The site is situated within a rural setting with a number of farms nearby. The closest residential property is Gebdykes Farm, which is adjacent to the site boundary to the northwest. East Gebdykes Farm is located 150m to the southwest of the existing quarry.

7.2.15 Operations will be restricted to daytime hours (07:00 – 19:00 Monday to Friday and 07:00- 13:00 on Saturday) to minimise disturbance. Noise levels will be in compliance with the limits set in the planning permission for the site, as shown in Table 7.1, below

Table 7.1: Existing Noise Sensitive Receptor Locations

Receptor	Long Term Noise Limit $L_{Aeq\ 1\ hour}$ (dB)
ESR1 - Gebdykes Farm	52
ESR2 - High Burton Bungalow	42
ESR3 - Watlass Moor Cottages and Watlass Moor Farm	45
ESR4 - Snape Lodge Cottages and Snape Lodge Farm	46
ESR5 - Dales View	46
ESR6 - East Gebdykes Farm	44

7.2.16 All plant and equipment will be maintained in accordance with the manufacturer's recommendations to ensure that it functions correctly and without excessive noise.

7.2.17 Silencers shall be fitted, used, and maintained in accordance with manufacturers' instructions on all vehicles, plant and machinery used on the site. No machinery shall be operated with the covers open or removed.

7.2.18 Engines on delivery vehicles or mobile plant will be switched off where appropriate to prevent excessive idling.

7.2.19 Noise levels will be taken into consideration during the purchase of new equipment, with quieter models being utilised where this is practical and economically viable.

Vermin and Pests

7.2.20 Vermin and pests are not considered to be a significant risk as the site does not accept food wastes or other wastes likely to attract vermin. Inert materials will be compacted at the end of each working day to minimise areas on site where vermin may shelter.

7.2.21 An inspection of the site will be made on a daily basis and should there be any signs of a pest infestation a pest control contractor will be required to attend the site and eradicate the problem.

Litter

7.2.22 Due to the nature of the clean inert materials to be accepted on site, litter is not expected to be an issue.

7.2.23 Daily inspections of the site will be made, and any litter noted will be collected and placed in an appropriate receptible pending removal to an authorised site for disposal.

Storage of Potentially Polluting Substances

7.2.24 Fuel and other potentially harmful fluids for use in site plant will be stored in a tank or container with appropriate secondary containment. Any bunds will have a capacity of 110% of the largest tank.

7.2.25 Deliveries and refuelling will be supervised to ensure that any leakage or spillage is detected immediately and cleaned quickly. The level of liquid within the tanks will be checked before filling to avoid over filling.

7.3 Complaints

7.3.1 If any complaints are received about the landfilling operations, they will be recorded, investigated, and responded to without delay in accordance with the Lightwater Quarries' complaints handling procedures.

8 SURFACE WATER MANAGEMENT

8.1.1 There are no surface water courses within close proximity to the site. The closest is a pond located over 350m away to the southwest.

8.1.2 Runoff from outside the operational areas of the Site will be allowed to infiltrate directly into the underlying bedrock in line with the quarry's present surface water management arrangements. Surface water runoff from the operational areas of the Site, including that which has been in direct contact with waste, will be intercepted and diverted to a large lagoon to the north of the void area, and will be prevented from discharging directly to groundwater.

8.1.3 The lagoon will be lined by a 1m thick layer of engineered clay, with no pathway for infiltration. Water within the lagoon will be tested to ensure it meets the permitted water quality parameters before being pumped out to the wide quarry void where it will be allowed to infiltrate to ground. Preliminary compliance limits will be set in line with those for BHWA03, as supported by the Hydrogeological Risk Assessment provided with the permit application.

8.1.4 Any captured surface water which exceeds the permitted limits will be isolated and will not be allowed to discharge to groundwater. Mitigative measures to treat or remove the water to a permitted facility will be undertaken.

8.1.5 Appendix 4 provides the Flood Risk Assessment, which provides details of how surface water will be managed throughout each of the five landfill phases.

9 ENVIRONMENTAL MONITORING

9.1.1 Environmental monitoring will include the monitoring regime set out in Table 2 below.

Table 9.1: Environmental Monitoring Regime			
Parameter	**Monitoring Point**	**Determinands**	**Frequency**
Groundwater	BHWA01 BHWA02 BHWA03 BHWA04	Groundwater elevation. Dip to base. Chloride, Nitrite, Nitrate, Nitrogen, Sulphate, Cyanide, Lead, Arsenic, Cadmium, Calcium, Copper, Chromium, Manganese, Magnesium, Mercury, Nickel, Potassium, Selenium, Sodium and Zinc.	Every six months
Landfill Gas	From internal monitoring points	Methane, Carbon Dioxide, Oxygen , Atmospheric Pressure, Differential Pressure	Monthly following installation of boreholes.

9.1.2 There will be no discharges to surface water from the active landfill areas.

9.1.3 All monitoring that is undertaken will be recorded within the site diary and a copy of the results will be maintained in the site office.

9.1.4 Landfill gas monitoring boreholes will be installed as the landfill is completed. Two gas boreholes will be constructed per hectare. This is sufficient as part of the criteria to achieve surrender of the permit.

9.1.5 Due to the low risk of landfill gas generation there are no plans for peripheral monitoring boreholes around the site. In the unlikely event potential landfill gas is detected in an in-waste borehole during routine monitoring (i.e monitoring results detect methane >1% or carbon dioxide >5%), then monitoring will be increased to a weekly frequency. If the gas emissions continue to be detected, the operator will install peripheral monitoring boreholes to establish if the gas is migrating, with careful consideration to nearby sensitive receptors. The operator will contact the EA to report the findings and agree appropriate actions to protect the environment.

9.1.6 All monitoring boreholes will be installed in accordance with the methods and standards giving in the Environment Agency's "Landfill operators: environmental permits" guidance. The design of the boreholes will be agreed with the Environment Agency and construction of the boreholes will be undertaken in accordance with an agreed CQA Plan.

9.1.7 The landfill gas boreholes will be fitted with gas taps and provided with adequate protection to prevent any damage. The boreholes will be maintained and monitored during the post closure period. Given the inert nature of the material it is expected that gas monitoring will continue for 24 months following closure.

9.1.8 Further details regarding groundwater and surface water monitoring are provided in Section 5 of the Hydrogeological Risk Assessment.

9.1.9 An annual topographic survey will be carried out to monitor the landfill development and remaining void space.

10 MANAGEMENT

10.1 General

10.1.1 The site will be operated to ensure a high level of environmental protection. Potential causes of pollution will be managed in accordance with environmental management system which provides written procedures to be followed in carrying out the activities on site.

10.1.2 All site-based personnel will be aware of the potential causes of pollution at the site, and their roles in preventing pollution through good practice and following environmental legislation.

Site Management and Staffing

10.1.3 The site will be appropriately manned and supervised by competent and suitably trained personnel during operational periods.

10.1.4 The site will be under the direct control of a Technically Competent Manager (TCM). The TCM will ensure that the site is operated and maintained in accordance with the required standards.

10.1.5 All site-based personnel and contractors will be required to complete an induction before being allowed to start working on the site. The induction will include health and safety and environmental protection elements to ensure all those working on site are aware of the potential environmental issues and their role in managing the risks in accordance with the EMS.

10.1.6 Staff training will include the management of environmental risk in day to day operations, an awareness of all environmental consents and their conditions and the documented emergency procedures for dealing with incidents such as spills.

10.1.7 The qualifications, skills, and experience necessary for each role on site will be recorded. Training will be reviewed annually to identify where additional training or refresher training is required to keep these skills up to date.

10.1.8 Environmental considerations will apply to purchasing and process change to ensure that the site is operated with a high level of protection for the environment.

11 CLOSURE AND AFTERCARE

11.1.1 As detailed in Section 6, the site will be restored back to original ground level in the south, with the void remaining in the north. Following closure of the site the land will be returned to agricultural use.

11.1.2 The Landfill Directive only requires capping where there is a need to minimise leachate formation, i.e. at hazardous and non-hazardous landfills. As the site is only going to accept inert wastes no formal cap is required.

11.1.3 The restoration profile for the landfill has been designed to replicate the landform of the site before the quarry was developed, tying the landfill into the profile of the east, west and south and would be at 144m AOD at the highest point in the southern section of the landfill. The northern edge of the landfill would then slope down to the quarry floor to tie in with the existing access ramp. As shown in drawing NT14834/Figure 3.6, Phase 1 will be restored to Magnesian limestone grassland, and the remaining phases will be restored to agricultural grassland. Appendix 3 provides further details of the restoration design in the Landscape Biodiversity and Restoration Management Plan.

11.1.4 There will be minimal infrastructure to be maintained in the aftercare period, with the deposited inert material itself posing a low risk to the environment. Settlement will be minimal and the site is expected to be stable in the post closure period. This will be confirmed by an annual topographic survey.

11.1.5 It is very unlikely that there will be any damage to the engineered artificial geological barrier or other landfill infrastructure that might lead to pollution being caused. However, the restored surface and the monitoring boreholes will be inspected on a quarterly basis to ensure they remain fit for purpose and repairs will be made as necessary.

11.1.6 Monitoring of groundwater and landfill gas will continue during the post closure period in order to demonstrate that the site is chemically and physically stable and will not pose a risk to the environment.

11.1.7 Surrender of the permit will be largely based on records demonstrating good characterisation of the clean inert materials throughout the life of the site, proving that only inert materials have been deposited. This will be supplemented by the results of the environmental monitoring undertaken during the operational and post closure periods.

APPENDIX 1

List of Permitted Clean Inert Materials

Appendix 1 – Permitted Wastes

List of Inert Wastes	
01	**WASTES RESULTING FROM EXPLORATION, MINING, QUARRYING AND PHYSICAL AND CHEMICAL TREATMENT OF MINERALS**
01 01	**Wastes from mineral excavation**
01 01 02	Waste from mineral non-metalliferous excavation
01 04	**Wastes from physical and chemical processing of non-metalliferous minerals**
01 04 08	Gravel and crushed rocks other than those mentioned in 01 04 07
01 04 09	Waste sand and clays
02	**WASTES FROM AGRICULTURE**
02 04	**Wastes from Sugar Processing**
02 04 01	Soil from cleaning and washing of beet
10	**WASTES FROM THERMAL PROCESSES**
10 12	**Wastes from manufacture of ceramic goods, bricks, tiles and construction products**
10 12 08	Waste ceramics, bricks, tiles and construction products (after thermal processing)
10 13	**Wastes from manufacture of cement, lime and plaster and articles and products made from them**
10 13 14	Waste concrete
17	**CONSTRUCTION AND DEMOLITION WASTES (INCLUDING EXCAVATED SOIL FROM CONTAMINATED SITES)**
17 01	**Concrete, bricks, tiles and ceramics**
17 01 01	Concrete
17 01 02	Bricks
17 01 03	Tiles and ceramics
17 01 07	Mixtures of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06
17 03	**Bituminous mixtures, coal tar and tarred products**
17 03 02	Bituminous mixtures not containing dangerous substances (road planings only)
17 05	**Soil, stones and dredging spoil**
17 05 04	Soil and stones, including chalk, other than those mentioned in 17 05 03
19	**WASTES FROM WASTE MANAGEMENT FACILITIES, OFF-SITE WASTEWATER TREATMENT PLANTS AND THE PREPARATION OF WATER INTENDED FOR HUMAN CONSUMPTION AND WATER FOR INDUSTRIAL USE**
19 12	**Wastes from the mechanical treatment of waste (e.g. sorting, crushing, compacting, pelletising) not otherwise specified**
19 12 05	Glass (for fill purposes only, not for use in restoration top layer)
19 12 09	Minerals (for example sand and stones)
19 12 12	Other wastes (including mixtures of materials) from mechanical treatment of wastes other than those mentioned in 19 12 11 (Restricted to crushed bricks, tiles, concrete and ceramics only.)
20	**MUNICIPAL WASTES (HOUSEHOLD WASTE AND SIMILAR COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL WASTES) INCLUDING SEPARATELY COLLECTED FRACTIONS**
20 02	**Garden and park wastes (including cemetery waste)**
20 02 02	Soil and stones, only from gardens and parks.

APPENDIX 2

Materials Suitability Assessment

Wardell Armstrong
Sir Henry Doulton House, Forge Lane, Etruria, Stoke-on-Trent, ST1 5BD, United Kingdom
Telephone: +44 (0)1782 276 700 www.wardell-armstrong.com

Our ref: EW/GM/NT15899/RPT/001 *Date*: 05 October 2022
Your ref:

Mr Peter Marris
Environment Officer – Yorkshire Area Landfill
Environment Agency
First Floor, Foss House
Kings Pool
Peasholme Green
York, YO1 7PX

Dear Peter

Lightwater Quarries Limited - Gebdykes Quarry Landfill Site
Dolomite - Materials Suitability Trial Pad Protocol

Background

Gebdykes Quarry located in Masham North Yorkshire, is a Magnesian Limestone (Dolomite) Quarry operated by Lightwater Holdings Limited (the Client). Lightwater Holdings are proposing to fill the void created by the quarrying operations with inert waste. Lightwater Holdings are proposing to use the site won Dolomite in the construction of proposed mineral liner.

Material Suitability

It is proposed to use the site won Dolomite in the construction of the mineral liner. Two pre-placement samples of the Dolomite were tested in May 2022, the results of which are contained in Annex A. Samples were tested for Plasticity Index, Undrained Shear Strength and Permeability. The results of the Permeability Testing demonstrates that the material is capable of achieving the required permeability of $1.0x10^{-7}$m/s.

Proposed Site Investigations and Trial Pad Protocol

To confirm the suitability of the site-won Dolomite for use in the Engineered Mineral Liner we proposed to carry out a trial pad at the site using the proposed materials. A copy of the trial pad protocol is attached at Annex B. As part of the trial pad works a number of materials classification tests will be taken, the results of which will be used to further classify the material in line with LFE4.

We trust that our proposals are to your satisfaction, if you have any queries please do not hesitate to contact us.

Yours sincerely
for Wardell Armstrong LLP

EMMA WAINWRIGHT
Principal Engineering Geologist
ewainwright@wardell-armstrong.com

Enc

Annex A – Dolomite Testing Results
Annex B - Trial Pad Protocol Report

Annex A

Dolomite Testing Results

TEST REPORT

Lightwater Quarries Ltd
Potgate Quarry
North Stainley
Ripon
HG4 3JN

White Rose Laboratory Services Ltd
Lumley St • Castleford • WF10 5LB
01977 520625 • enquiries@whiteroselabs.co.uk

Report	WRL/22/0580perm
Issue date	25/05/22

Material	Old Stock Aggregate Lime		
Site	Gebdyke Quarry		
Specification	-	Sample Ref	S/22/0580
Source	Gebdyke Quarry	Sampled by	J Johnson
Supplier	Lightwater Quarries Ltd	Date sampled	04/05/22
Sample location	Stockpile	Date received	04/05/22
Sample type	Bulk	Date tested	24/05/22
Order number	-	Date reported	25/05/22

Subcontract Testing

Please find attached results of the following subcontracted testing

Permeability in a triaxial cell (PSL)

J Whelan
Laboratory Services Section Manager

LABORATORY REPORT

4043

Contract Number: PSL22/3343

Report Date:	24 May 2022
Client's Reference:	ORD/22/185
Client Name:	White Rose Laboratory Services Ltd Lumley Street Castleford West Yorkshire WF10 5LB

For the attention of: Joe Whelan

Contract Title:	Lightwater Quarries - Gebdyke
Date Received:	11/5/2022
Date Commenced:	11/5/2022
Date Completed:	24/5/2022

Notes: **Opinions and Interpretations are outside the UKAS Accreditation**

Checked and Approved Signatories:

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awatkins@prosoils.co.uk

PERMEABILITY IN A TRIAXIAL CELL

BS 1377 : Part 6 : 1990: Clause 6

Hole Number:	**Old Stockpile**	**Top Depth (m) :**	
Sample Number:	**S-22-0580**	**Base Depth (m) :**	
Sample Type:	**B**	**Lift Number:**	
Date	**04/05/22**	**Grid Reference:**	

Description of Specimen
Aggregate Lime
Remarks
Remoulded with 2.5Kg effort, natural moisture contact.

Initial Specimen Conditions		
Height	mm	101.15
Diameter	mm	101.51
Area	mm^2	8092.96
Volume	cm^3	818.60
Mass	g	1730
Dry Mass	g	1534
Bulk Density	Mg/m^3	2.11
Dry Density	Mg/m^3	1.87
Moisture Content	%	13
Voids Ratio	-	0.414
Specific Gravity	Mg/m^3	2.65
(assumed/measured)	-	assumed

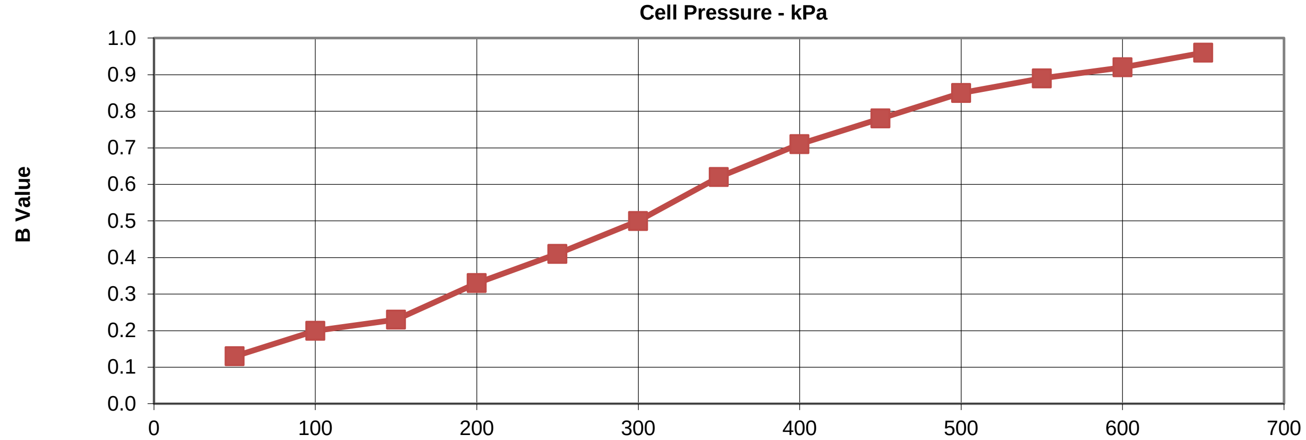
Final Specimen Conditions		
Moisture Content	%	17
Bulk Density	Mg/m^3	2.19
Dry Density	Mg/m^3	1.87

Test Setup		
Date Started		11/05/2022
Date Finished		13/05/2022
Top Drain Used		Y
Base Drain Used		Y
Method of Saturation		By back pressure
Direction Of Flow		Vertically Downwards
Saturation Time	Days	1
Consolidation Time	Days	1
Permeability Time	Days	1

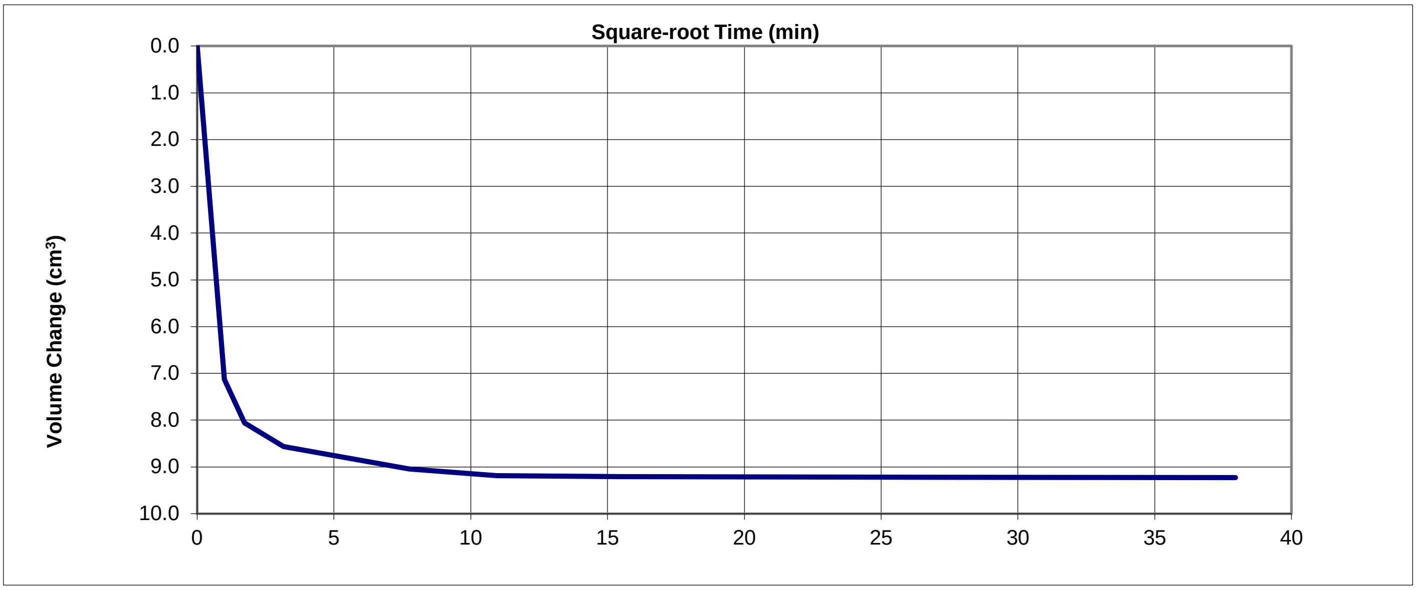
PERMEABILITY IN A TRIAXIAL CELL

BS 1377 : Part 6 : 1990 Clause 6

Specimen Details		
Hole Number		Old Stockpile
Sample Depth	m	
Sample No,		S-22-0580
Grid Reference		
Lift Number		
Saturation		
Cell Pressure Incr.	kPa	50
Back Pressure Incr.	kPa	50
Differential Pressure	kPa	10
Final Cell Pressure	kPa	650
Final B Value	-	0.96



Consolidation		
Effective Pressure	kPa	100
Cell Pressure	kPa	700
Back Pressure	kPa	600
Final PWP	kPa	600
PWP dissipation	%	100



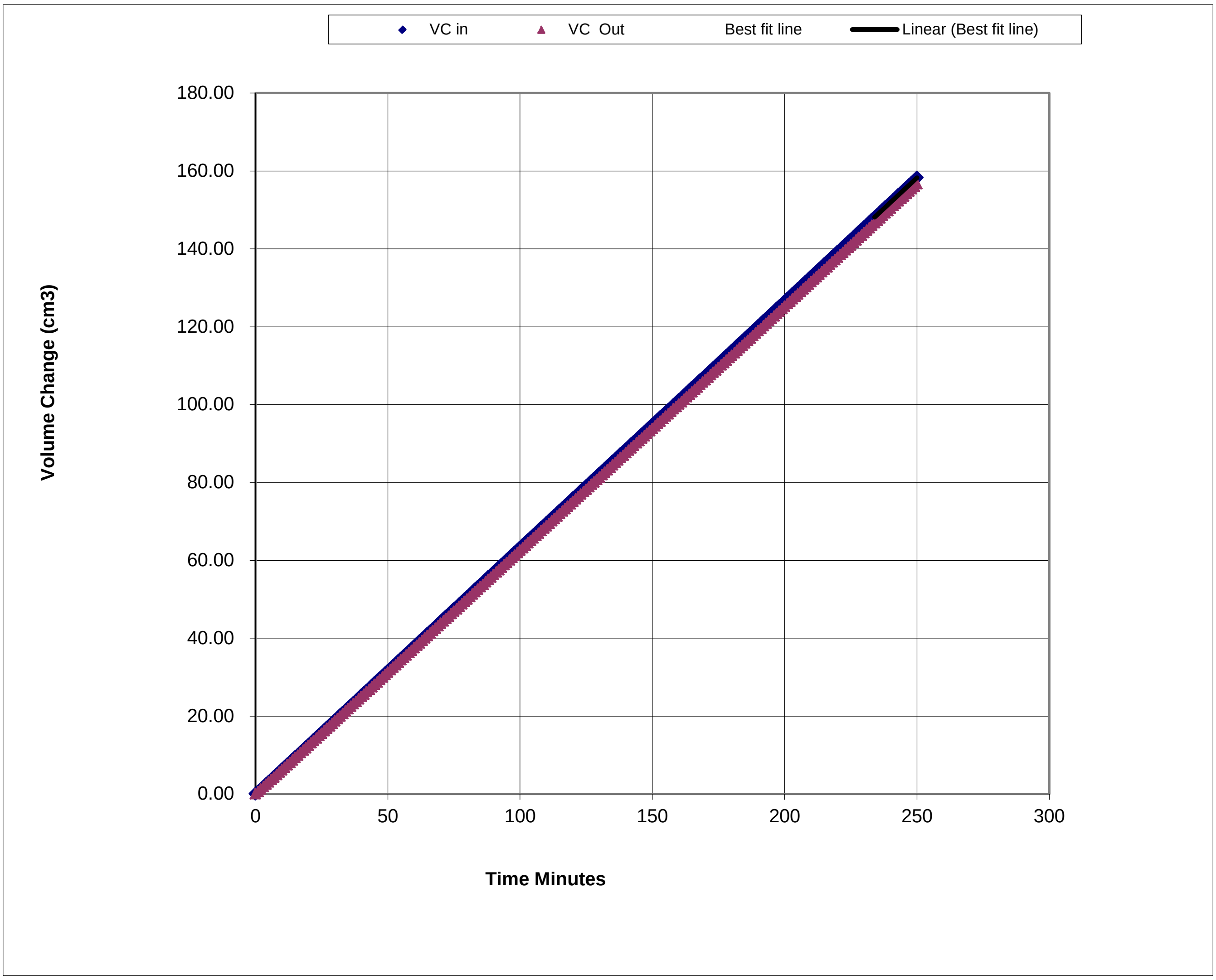
UKAS TESTING 4043	PSL Professional Soils Laboratory	Lightwater Quarries - Gebdyke	Contract No. PSL22/3343
			Client Ref ORD/22/185

PERMEABILITY IN A TRIAXIAL CELL

BS 1377 : Part 6 : 1990 Clause 6

Specimen Details		
Hole Number		Old Stockpile
Sample Depth	m	
Sample No.		S-22-0580
Grid Reference		
Lift Number		

Permeability Stage



Permeability Stage		
Cell Pressure	kPa	700
Mean Effective Stress	kPa	100
Back Pressure Diff.	kPa	20
Mean Rate of Flow	ml/min	0.6325
Average Temperature	'C	20
Vertical Permeability Kv	m/s	6.4E-08

UKAS TESTING 4043	PSL Professional Soils Laboratory	Lightwater Quarries - Gebdyke	Contract No. PSL22/3343 Client Ref ORD/22/185

TEST REPORT

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Report	WRL/22/0580pi
Issue date	25/05/22

Material	Aggregate Lime		
Site	Gebdyke Quarry		
Specification	-	Sample Nº	S/22/0580
Source	Gebdyke Quarry	Sampled by	J Johnson
Supplier	Lightwater Quarries Ltd	Date sampled	04/05/22
Sample location	Old stockpile	Date received	04/05/22
Sample type	Bulk	Date tested	12/05/22
Order number	-	Date reported	13/05/22

BS 1377-2 1990 Determination of liquid limit, cone penetrometer method

Liquid limit was determined by the one-point cone penetrometer method.
Test performed on wet-sieved material.

Liquid Limit	26	Pass 425µm	45 %

BS 1377-2 1990 Determination of plastic limit and plasticity index

Test performed on wet-sieved material.

Plastic Limit	Non Plastic	Pass 425µm	45 %
Plasticity index	Non Plastic		

All testing carried out at White Rose Laboratory Services Ltd, Lumley Street, Castleford
Test results relate only to items tested

J Whelan
Laboratory Services Section Manager

RT005/21/01

TEST REPORT

Lightwater Quarries Ltd
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Report	WRL/22/0580uss
Issue date	25/05/22

Material	Aggregate Lime		
Site	Gebdyke Quarry		
Specification	-	Sample Nº	S/22/0580
Source	Gebdyke Quarry	Sampled by	J Johnson
Supplier	Lightwater Quarries Ltd	Date sampled	04/05/22
Sample location	Old stockpile	Date received	04/05/22
Sample type	Bulk	Date tested	13/05/22
Order number	-	Date reported	13/05/22

BS 1377-7 1990 Cl 8 Determination of undrained shear strength in triaxial compression without measurement of pore pressure

Specimen parameters

The specimen was remoulded with a 2.5kg rammer.

Specimen height	200	mm	Specimen diameter	100	mm
Moisture content	12	%	Bulk Density	2.24	Mg/m³
			Dry density	2.00	Mg/m³

Test parameters

Rate of strain	0.625	%/min	Membrane type	laytex	
Cell pressure, σ_3	200	kPa	Membrane thickness	0.3	mm
			Membrane correction	0.39	kPa

Test results

Corrected maximum deviator stress at failure $(\sigma_1 - \sigma_3)_f$		852	kPa
Strain at failure		5	%
Mode of failure		Barrelling	
Shear strength	$c_u = ½(\sigma_1 - \sigma_3)_f$	426	kPa

All testing carried out at White Rose Laboratory Services Ltd, Lumley Street, Castleford
Test results relate only to items tested

J Whelan
Laboratory Services Section Manager

RT007/21/03

TEST REPORT

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Report WRL/22/0581perm
Issue date 25/05/22

Material	Aggregate Lime		
Site	Gebdyke Quarry		
Specification	-	Sample Ref	S/22/0581
Source	Gebdyke Quarry	Sampled by	J Johnson
Supplier	Lightwater Quarries Ltd	Date sampled	04/05/22
Sample location	New stockpile	Date received	04/05/22
Sample type	Bulk	Date tested	24/05/22
Order number	-	Date reported	25/05/22

Subcontract Testing

Please find attached results of the following subcontracted testing

Permeability in a triaxial cell (PSL)

J Whelan
Laboratory Services Section Manager

LABORATORY REPORT

PSL Professional Soils Laboratory

UKAS TESTING 4043

Contract Number: PSL22/3343

Report Date:	24 May 2022
Client's Reference:	ORD/22/185
Client Name:	White Rose Laboratory Services Ltd Lumley Street Castleford West Yorkshire WF10 5LB
For the attention of:	**Joe Whelan**
Contract Title:	Lightwater Quarries - Gebdyke
Date Received:	11/5/2022
Date Commenced:	11/5/2022
Date Completed:	24/5/2022
Notes:	**Opinions and Interpretations are outside the UKAS Accreditation**

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced other than in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

A Watkins (Director)	R Berriman (Quality Manager)	S Royle (Laboratory Manager)
L Knight (Assistant Laboratory Manager)	S Eyre (Senior Technician)	T Watkins (Senior Technician)

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PERMEABILITY IN A TRIAXIAL CELL

BS 1377 : Part 6 : 1990: Clause 6

Hole Number:	**New Stockpile**	**Top Depth (m) :**	
Sample Number:	**S-22-0581**	**Base Depth (m) :**	
Sample Type:	**B**	**Lift Number:**	
Date	**04/05/22**	**Grid Reference:**	

Description of Specimen
Aggregate Lime
Remarks
Remoulded with 2.5Kg effort, natural moisture contact.

Initial Specimen Conditions		
Height	mm	101.15
Diameter	mm	101.49
Area	mm^2	8089.77
Volume	cm^3	818.28
Mass	g	1703
Dry Mass	g	1525
Bulk Density	Mg/m^3	2.08
Dry Density	Mg/m^3	1.86
Moisture Content	%	12
Voids Ratio	-	0.422
Specific Gravity	Mg/m^3	2.65
(assumed/measured)	-	assumed

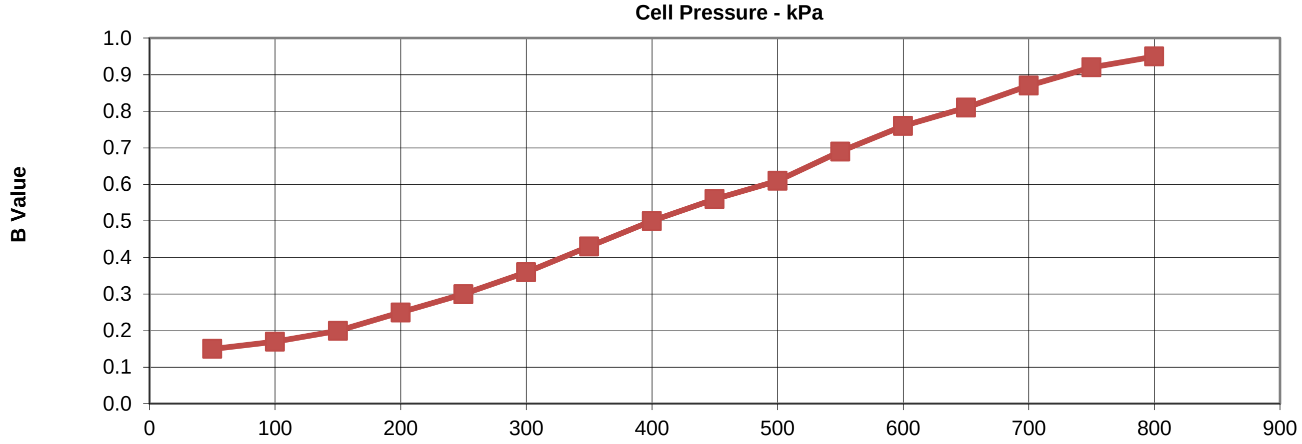
Final Specimen Conditions		
Moisture Content	%	15
Bulk Density	Mg/m^3	2.14
Dry Density	Mg/m^3	1.86

Test Setup		
Date Started		11/05/2022
Date Finished		13/05/2022
Top Drain Used		Y
Base Drain Used		Y
Method of Saturation		By back pressure
Direction Of Flow		Vertically Downwards
Saturation Time	Days	1
Consolidation Time	Days	1
Permeability Time	Days	1

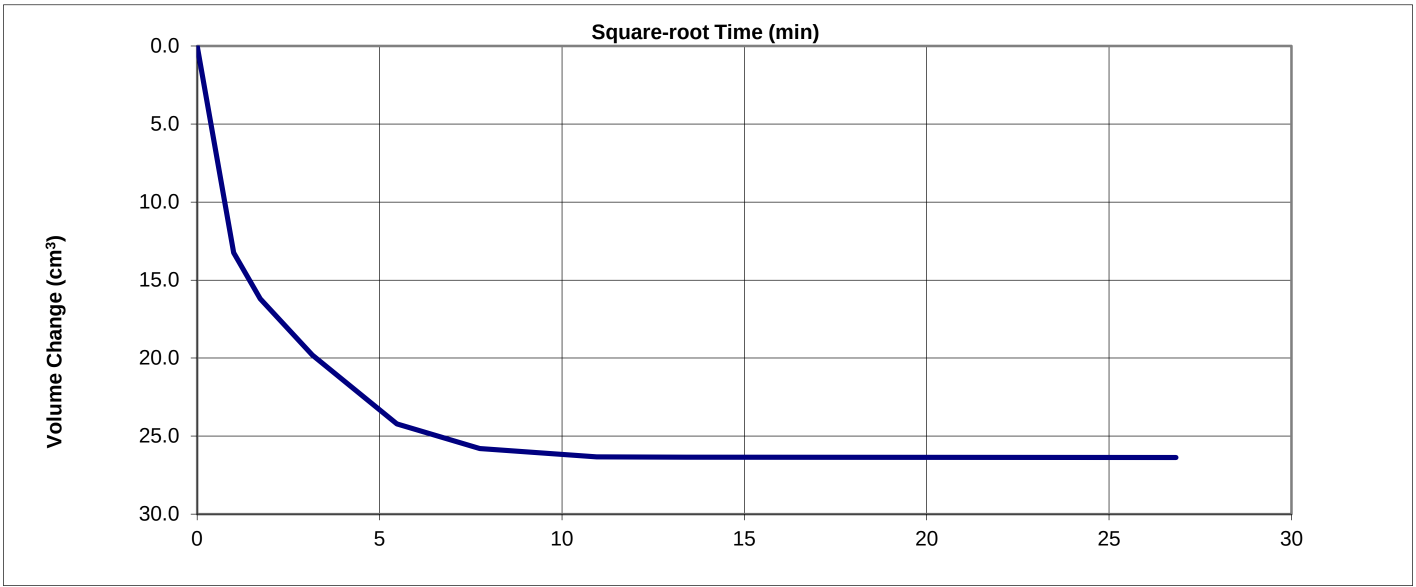
PERMEABILITY IN A TRIAXIAL CELL

BS 1377 : Part 6 : 1990 Clause 6

Specimen Details		
Hole Number		New Stockpile
Sample Depth	m	
Sample No,		S-22-0581
Grid Reference		
Lift Number		
Saturation		
Cell Pressure Incr.	kPa	50
Back Pressure Incr.	kPa	50
Differential Pressure	kPa	10
Final Cell Pressure	kPa	800
Final B Value	-	0.95



Consolidation		
Effective Pressure	kPa	100
Cell Pressure	kPa	850
Back Pressure	kPa	750
Final PWP	kPa	750
PWP dissipation	%	100



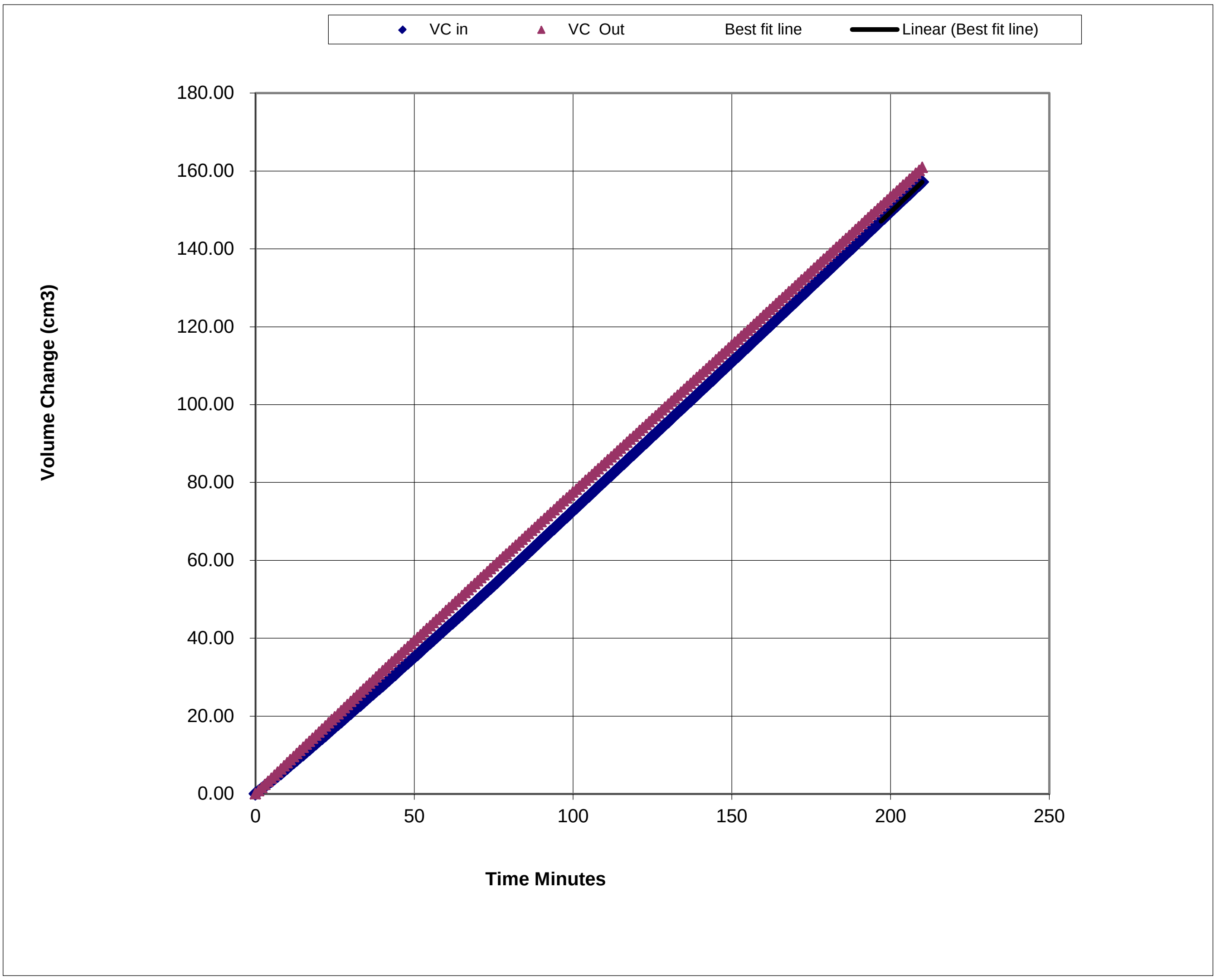
UKAS TESTING 4043	PSL Professional Soils Laboratory	Lightwater Quarries - Gebdyke	**Contract No.**
			PSL22/3343
			Client Ref
			ORD/22/185

PERMEABILITY IN A TRIAXIAL CELL

BS 1377 : Part 6 : 1990 Clause 6

Specimen Details		
Hole Number		New Stockpile
Sample Depth	m	
Sample No.		S-22-0581
Grid Reference		
Lift Number		

Permeability Stage



Permeability Stage		
Cell Pressure	kPa	850
Mean Effective Stress	kPa	100
Back Pressure Diff.	kPa	20
Mean Rate of Flow	ml/min	0.7708
Average Temperature	'C	20
Vertical Permeability Kv	m/s	7.9E-08

UKAS TESTING 4043	PSL Professional Soils Laboratory	**Lightwater Quarries - Gebdyke**	**Contract No.** **PSL22/3343** **Client Ref** **ORD/22/185**

TEST REPORT

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Report	WRL/22/0581pi
Issue date	25/05/22

Material	Aggregate Lime		
Site	Gebdyke Quarry		
Specification	-	Sample N°	S/22/0581
Source	Gebdyke Quarry	Sampled by	J Johnson
Supplier	Lightwater Quarries Ltd	Date sampled	04/05/22
Sample location	New stockpile	Date received	04/05/22
Sample type	Bulk	Date tested	09/05/22
Order number	-	Date reported	13/05/22

BS 1377-2 1990 Determination of liquid limit, cone penetrometer method

Liquid limit was determined by the one-point cone penetrometer method.
Test performed on wet-sieved material.

Liquid Limit	28	Pass 425µm	55 %

BS 1377-2 1990 Determination of plastic limit and plasticity index

Test performed on wet-sieved material.

Plastic Limit	Non Plastic	Pass 425µm	55 %
Plasticity index	Non Plastic		

All testing carried out at White Rose Laboratory Services Ltd, Lumley Street, Castleford
Test results relate only to items tested

J Whelan
Laboratory Services Section Manager

RT005/21/01

TEST REPORT

Lightwater Quarries Ltd
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Report	WRL/22/0581uss
Issue date	25/05/22

Material	Aggregate Lime		
Site	Gebdyke Quarry		
Specification	-	Sample Nº	S/22/0581
Source	Gebdyke Quarry	Sampled by	J Johnson
Supplier	Lightwater Quarries Ltd	Date sampled	04/05/22
Sample location	New stockpile	Date received	04/05/22
Sample type	Bulk	Date tested	09/05/22
Order number	-	Date reported	13/05/22

BS 1377-7 1990 Cl 8 Determination of undrained shear strength in triaxial compression without measurement of pore pressure

Specimen parameters

The specimen was remoulded with a 2.5kg rammer.

Specimen height	200	mm	Specimen diameter	100	mm
Moisture content	12	%	Bulk Density	2.13	Mg/m^3
			Dry density	1.90	Mg/m^3

Test parameters

Rate of strain	1	%/min	Membrane type	laytex	
Cell pressure, σ_3	200	kPa	Membrane thickness	0.3	mm
			Membrane correction	0.68	kPa

Test results

Corrected maximum deviator stress at failure $(\sigma_1 - \sigma_3)_f$		726	kPa
Strain at failure		10	%
Mode of failure		Barrelling	
Shear strength	$c_u = ½(\sigma_1 - \sigma_3)_f$	363	kPa

All testing carried out at White Rose Laboratory Services Ltd, Lumley Street, Castleford
Test results relate only to items tested

J Whelan
Laboratory Services Section Manager

RT007/21/03

Annex B

Trial Pad Protocol Report

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ENERGY AND CLIMATE CHANGE
ENVIRONMENT AND SUSTAINABILITY
INFRASTRUCTURE AND UTILITIES
LAND AND PROPERTY
MINING AND MINERAL PROCESSING
MINERAL ESTATES
WASTE RESOURCE MANAGEMENT

LIGHTWATER QUARRIES LIMITED

GEBDYKES QUARRY LANDFILL SITE

PROTOCOL FOR THE CONSTRUCTION OF EARTHWORKS TRIAL PAD

OCTOBER 2022

wardell armstrong

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DATE ISSUED:	**OCTOBER 2022**
JOB NUMBER:	**NT15899**
REPORT NUMBER:	**001**
VERSION:	**V1.0**
STATUS:	**FINAL**

LIGHTWATER QUARRIES LTD

GEBDYKES QUARRY LANDFILL SITE

PROTOCOL FOR THE CONSTRUCTION OF EARTHWORKS TRIAL PAD

OCTOBER 2022

PREPARED BY:

Emma Wainwright	Principal Engineering Geologist	

APPROVED BY:

Andy Belton	Technical Director	

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ENERGY AND CLIMATE CHANGE
ENVIRONMENT AND SUSTAINABILITY
INFRASTRUCTURE AND UTILITIES
LAND AND PROPERTY
MINING AND MINERAL PROCESSING
MINERAL ESTATES
WASTE RESOURCE MANAGEMENT

CONTENTS

1 OBJECTIVES

1.1.1 The aim of this field trial is to assess the suitability of the site won dolomite materials for use as a mineral liner during the construction of landfill cells at Gebdykes Quarry Landfill Site.

1.1.2 The field trial shall be supervised by a suitably qualified and experienced engineer.

2 MATERIAL TYPE

2.1.1 The Trial Pad will be constructed with the proposed material for the mineral liner.

2.1.2 Site-won dolomite has already been tested characterised as a suitable source material for the liner works as the proposed liner material, at time of writing. The engineering properties of the dolomite will be assessed following placement and compaction in the trial liner and compared to the results of laboratory testing undertaken for the classification of the material.

2.1.3 Any unsuitable materials will be removed during construction of the trial pad, unsuitable materials will include stones larger than 100mm.

3 TRIAL PAD DIMENSIONS

3.1.1 The area (excluding the perimeter zones) must be at least three machine widths wide (approximately 10m) by three-five machine lengths long (approximately 30m long, with 15m on the base and 15m on the batter) with additional zones for plant acceleration and deceleration.

3.1.2 The trial pad will be located either on prepared subgrade for the permanent liner or suitable subgrade which is representative of the conditions proposed for the permanent liner.

4 METHOD OF LAYER CONSTRUCTION

4.1.1 The trial pad will be constructed in accordance with Specification for Highway Works 2016 (SHW), tables 6/1 and 6/4 according to the following method:

4.1.2 250 mm thickness of dolomite (placed at 300mm);

4.1.3 So that the trial pad can be incorporated into the mineral liner, each lift will be compacted in accordance with the following number ofpasses from the roller:

Lift 1 6 passes

Lift 1 8 passes (2 additional passes on top of the 6 done previously)

Lift 2 4 passes

5 MATERIALS TESTING

5.1.1 Eight core (undisturbed) samples and 1 bulk (disturbed) will be taken from each 250mm layer on completion of each lift and subjected to the following tests and frequencies according to BS 1377: 1990:

Test	No. of Tests
Coefficient of Permeability - Triaxial Cell	2 per layer
Permeability Soakaway test	2 per layer
Hand Shear Vane	8 per layer
Particle Size Distribution (wet sieving)	1 per layer
Particle Size Distribution (sedimentation - pipette)	1 per layer
Index Properties (Atterberg limits, particle density)	1 per layer
Moisture Content (oven drying)	2 per layer

5.1.2 The shear strength of the dolostone will be recorded by hand shear vane at each test location to determine correlation between moisture content and shear strength for the placed material.

5.1.3 As part of the field trial the material will be reworked and wetted and dried to achieve a moisture content considered by the engineer to be suitable for compaction. Moisture content testing will be carried out as part of the testing suite above. The moisture content of the dolomite used in the field trial will be used to confirm the moisture content range required for the proposed works.

5.1.4 Upon completion of the trial pad, the adequacy of bonding between the individual layers will be investigated by careful stripping of the upper layer to verify that no definable interface is present between the layers.

6 PROGRAMME FOR THE WORKS

6.1.1 The commencement date for the trial pad construction is to be confirmed. The Environment Agency will be invited to observe the works with 48 hours' notice given.

6.1.2 As a minimum, the information to be recorded by the CQA Engineer will be:

6.1.3 Records of the type and condition of the material;

- Details of the method of excavation, transportation, treatment, conditioning, wetting and drying process and placement of the material;
- Details of the type, dimensions, weight and operating speed of compaction plant used along with all relevant specification sheets for the roller(s) used;
- The number of passes of the roller (or for each type of roller if more than oneis used);
- The method used for measuring moisture content and density of each sample point;
- Records of all field tests and samples, including failures with a diagramshowing sample positions;
- A photographic record of the trial must be maintained (especially for destructive testing; and
- Records of the survey and testing of the subgrade in accordance with the CQA Plan if the field trial liner is to be incorporated into the works.

7 REPORTING OF RESULTS

7.1 A discussion of the results and records of all field and laboratory testing will be submitted in a report to the Environment Agency.

7.2 Any required amendments to the proposed construction method statement following the trial or during subsequent construction shall be agreed with the CQA Engineer and approved by the Environment Agency.

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APPENDIX 3

Landscape Biodiversity and Restoration Management Plan v2

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ENERGY AND CLIMATE CHANGE
ENVIRONMENT AND SUSTAINABILITY
INFRASTRUCTURE AND UTILITIES
LAND AND PROPERTY
MINING AND MINERAL PROCESSING
MINERAL ESTATES
WASTE RESOURCE MANAGEMENT

LIGHTWATER QUARRIES LTD

Gebdykes Quarry Landfill

Landscape and Biodiversity Restoration and Management Plan

December 2022

Wardell Armstrong LLP
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DATE ISSUED:	December 2022
JOB NUMBER:	**NT14834**
REPORT NUMBER:	**Appendix 3.1**
VERSION:	**2**
STATUS:	**Final**

LIGHTWATER QUARRIES LTD

Gebdykes Quarry Landfill

Landscape And Biodiversity Restoration and Management Plan

December 2022

PREPARED BY:

Lucy Green	Associate Director (Landscape)	Lucy Green
Tim Palmer	Associate Director (Ecology)	pp. Lucy Green

REVIEWED AND APPROVED BY:

Nicholas Beale	Technical Director	N. Beale

CONTENTS

TABLES

1 INTRODUCTION

1.1.1 This Landscape and Biodiversity Restoration and Management Plan (LBRMP) has been prepared to support a planning application to North Yorkshire County Council seeking permission for an inert landfill into the southern half of Gebdykes quarry.

1.1.2 This LBRMP details the restoration proposals and short and long term management of existing adjacent habitats to be retained and protected during the development as well as proposed habitats to be created as part of the restoration scheme for the landfill. It also includes the northern half of the existing quarry, which would not be filled, the restoration and management operations for this area are the same as those proposed in the recent planning application for the northern extension to the quarry. This part of the quarry, either site of the access track to the northern extension, would be restored by 2026 as the initial phase of the extension is worked and ramps are created.

1.1.3 ES Figure 3.6 illustrates the restoration plan for the application area and ES Figures 3.1 to 3.5 illustrate the phasing of the landfill and progressive restoration.

2 BACKGROUND INFORMATION

2.1.1 Wardell Armstrong were commissioned by Lightwater Quarries to undertake a range of environmental surveys prior to submitting the both the planning applications for the landfill and the northern quarry extension. A Preliminary Ecological Appraisal (PEA) (WA, 2019, updated May 2020 and July 2021) was undertaken to map and characterise the habitats present on site and assess them for the suitability for use by protected or notable species. The results of the PEA did not identify the need for any additional Phase II ecology surveys other that those carried out for the northern quarry extension, which were undertaken throughout the 2020 survey season. The results of the surveys have been used to inform the Ecological Impact Assessment (EcIA) of the proposed development on the site. A range of mitigation and compensation measures (where necessary) have been provided to ensure that post restoration Gebdykes Quarry will provide a positive net biodiversity gain on site through retaining, enhancing and creating a diverse range of habitats and priority habitats for the area. The proposed restoration scheme has been designed through careful consideration of the natural landscape and local and national biodiversity targets. Consideration has been given to linking onsite habitats and those within the wider area to aid ecological connectivity.

2.1.2 The site was found to support limited range of habitats due to it being an operational quarry. The majority of peripheral habitats are to be retained.

2.1.3 Full reports for each species are provided as technical appendices to the ES Chapter, but in summary: no badger setts or signs of use were recorded within the application area. At least five species of bat were found to be foraging/commuting over the site, generally associated with hedgerows and woodland blocks located on the periphery of the site boundary and along Limekiln Lane which is line with mature trees on either side. GCN eDNA was recorded in one waterbody (WB2) located approximately 450m from the proposed northern quarry extension area. A total of 31 bird species were recorded within the site and the northern quarry extension area, of which 30 species were possibly, probably or confirmed breeding.

3 PROTECTION AND MANAGEMENT OF EXISTING HABITATS DURING OPERATION

3.1 Woodland, Trees and Hedgerows

3.1.1 All the existing trees, woodland and hedgerows surrounding the existing quarry void would be retained and protected during the landfill operations, they would be managed to ensure their screening potential and functionality as linking habitats is maximised.

3.1.2 For more details on the management of existing trees and woodland on site refer to section 5.7 below.

3.2 Fauna

3.2.1 A Construction Environmental Management Plan (CEMP) and site management plan will ensure impacts to fauna on site are minimised and the obligations pertaining to legally protected species are fully observed.

3.2.2 Management of retained peripheral hedgerows, trees and woodland will be carried out outside of the nesting bird season (taken to be March to August inclusive), which is the optimum time for undertaking such works.

3.3 Fencing

3.3.1 The boundary of the existing quarry is fenced in accordance with the Quarry Regulations, no further fencing is required during the operational phases.

3.3.2 All new woodland and hedgerow planting planted during restoration would be protected by stock-proof post and wire fencing or individual tree/shrub guards.

3.4 Soil handling

3.4.1 The Northern Quarry Extension ES Appendix 8.5 contains a Soil Management Plan (SMP) for both the existing quarry and the northern extension, which details soil handling, movements, storage and restoration. This would also apply to the inert landfill. No further soil stripping is required for the inert landfill. Soils stripped for the quarrying operations have been stored in bunds on the perimeters of the quarry, as shown on the topographic survey, ES Figure 2.8.

3.5 Invasive non-native species (INNS)

3.5.1 The site may be vulnerable to colonisation by some or all of the INNS listed below. In the event that INNS become established and deleteriously effect the target habitats, management will be undertaken, as required, using approved control methods.

- Japanese knotweed (*Reynoutria japonica*)
- Himalayan balsam (*Impatiens glandulifera*)
- Canadian goldenrod (*Solidago canadensis*)
- Monkeyflower (*Mimulus guttatus*)
- Australian swamp stonecrop (*Crassula helmsii*)
- Giant Hogweed (*Heracleum mantegazzianum*)
- Canadian Pondweed (*Elodea canadensis*)
- *Cotoneaster*

3.5.2 No invasive species have been recorded on site during Extended Phase I Habitat Surveys (WA, 2019/2020/2021). The arrival of invasive species (as listed above) on the site will be monitored throughout the extraction and restoration phases and the subsequent management phases, as detailed in Sections 4 and 5.

3.5.3 In the event that an invasive species is recorded on site or in adjacent land (within 50m) suitable control methods will be implemented as follows:

- The areas will be clearly marked out and areas that do not need to be disturbed will be fenced off.
- Areas that must be disturbed will be cleared of infested material as far as reasonably possible under supervision of an Ecologist. An assessment will be made as to whether it is better to retain the infested material on site for restoration within the infested area coupled with treatment or whether disposal offsite is more appropriate.
- Areas where infested materials have been identified will be cleared methodically with on-going assessment of the extent of infested ground. Only essential vehicles will be present in these areas.
- In areas of the site where invasive species have been identified, use of tracked machinery will be limited until infested areas have been cleared and/or identified and cordoned off.
- On leaving areas of the site known to contain infested material, any machinery or vehicles that have been used will be thoroughly cleaned (e.g. sterilised and cleaned) within a designated area. This area will be as close as possible to the infested area on which the machinery/vehicles have been working to avoid the spread of the species. Runoff will be contained to avoid spreading plant material.

This area will be monitored in the spring for any growth and a spraying programme/management will be implemented as necessary. Any machinery used in clearing infested areas will be similarly cleaned.

- Infested spoil will only be placed on top of a fabric/membrane in an approved, fenced area. Once the infested material is removed from these areas, they will be monitored for re-growth, particularly during the growing season and, if necessary, treated with an appropriate herbicide.
- No stockpiling of potentially infested material will take place within 10 m of a watercourse.
- All haulage lorries, dumpers, bags or skips carrying infested material will have the material covered during transit.
- Where infested material is to be removed from site this will have accompanying waste transfer documentation, for disposal in a licenced landfill site.
- Where application of herbicide is required as part the control this would only be undertaken by suitably qualified individuals (i.e. NPTC certified) and after obtaining all relevant permissions and consents from Environment Agency (for application near to water courses).
- Any areas of invasive species growth, treatment areas, bunds created for management of invasive species or buried invasive species will be demarcated on site constraint maps which will be provided to the Planning Authority.
- An invasive species management plan detailing all invasive species found within particular phased working areas and the intended treatment will be provided to the Planning Authority and approved before treatment begins.
- Any records of invasive species will be provided to the local Biodiversity Records Centre and the GB Non-Native Species Secretariat.

4 RESTORATION STRATEGY

4.1 Restoration aims and objectives

4.1.1 The key drivers behind the restoration of Gebdykes Quarry landfill are the delivery of tangible landscape and biodiversity benefits, together with the incremental realisation of appropriate nature conservation/biodiversity targets through the creation and subsequent management of interlinked terrestrial habitats.

4.1.2 The overall restoration scheme (refer to ES Figure 3.6) links together the habitat re-creation and to show continuity of conservation grasslands, hedgerows and woodland belts to provide a site that is ecologically connected both onsite and offsite linking with hedgerows and woodland compartments in the wider area.

Planning policy background

4.1.3 The Minerals and Waste Joint Plan, Publication Draft November 2016 Policy D10: Reclamation and after use provides the background to the overall aims and objectives for the restoration scheme, relevant sections of the policy are as follows:

"Part 1) Proposals which require restoration and afteruse elements will be permitted where it can be demonstrated that they would be carried out to a high standard and, where appropriate to the scale and location of the development, have demonstrably:

i) Been brought forward following discussion with local communities and other relevant stakeholders and, where practicable, the proposals reflect the outcome of those discussions;

ii) Taken into account the location and context of the site, including the implications of other significant permitted or proposed development in the area and the range of environmental and other assets and infrastructure that may be affected, including any important interactions between those assets and infrastructure;

iii) Reflected the potential for the proposed restoration and/or afteruse to give rise to positive and adverse impacts, including cumulative impacts, and have sought where practicable to maximise potential overall benefits and minimise overall adverse impacts;

iv) Taken into account potential impacts on and from climate change factors;

v) Made best use of onsite materials for reclamation purposes and only rely on imported waste where essential to deliver a high standard of reclamation;

vi) Provided for progressive, phased restoration where appropriate, providing for the restoration of the site at the earliest opportunity in accordance with an agreed timescale;

vii) Provided for the longer term implementation and management of the agreed form of restoration and afteruse (except in cases of agriculture or forestry afteruses where a statutory 5 year maximum aftercare period will apply).

Part 2) In addition to the criteria in Part 1) above, proposals will be permitted which deliver a more targeted approach to minerals site restoration and afteruse by contributing towards objectives, appropriate to the nature, scale and location of the site, including where relevant:

viii) Promoting the delivery of significant net gains for biodiversity and the establishment of a coherent and resilient ecological network, based on contributing, where practicable, towards established objectives including the creation of Biodiversity Action Plan habitats, and seeking to deliver benefits at a landscape scale."

Biodiversity aims

4.1.4 Lightwater Quarries Ltd. is committed to protecting and enhancing the value of its sites for wildlife, not only while they are active, but also during and post restoration.

4.1.5 Habitats & species occurring or with the potential to occur on site that are priority habitats & species ("Section 41 habitats & species" NERC Act 2006) or within the Harrogate and Hambleton Local Biodiversity Action Plans (LBAP) are listed in Table 1.

Table 1: Biodiversity priority habitats and species and aims for the restoration scheme

Priority habitat	Present on site	To be created	Restoration biodiversity aims
Arable field Margins	x	✓	Retain wide arable margins in re-instated farmland, to provide quality habitat for wildlife on site, increasing feeding opportunities for seed eating birds. Retain arable margins >4m wide.
Magnesian Grassland	x	✓	Magnesian grassland is to be created in the western field of the restored landfill and on steeper slopes around the periphery of the northern area of the quarry that would not be filled. The restoration scheme provides the opportunity to increase magnesian grassland in North Yorkshire and to encourage populations of associated priority species.

Table 1: Biodiversity priority habitats and species and aims for the restoration scheme			
Priority habitat	**Present on site**	**To be created**	**Restoration biodiversity aims**
Hedgerow	✓	✓	Re-instate hedgerows post- extraction and landfill. Hedgerows to be replanted using a diverse mix of species, to include elm (specifically for white letter hair streak, not recorded on site but known to be present locally). Saplings will be native species, ideally of local provenance. Manage hedgerows for the benefit of wildlife with appropriate management regime of laying/cutting.
Standing water/ wetland	x	✓	Drainage basins are required throughout the landfill process and 2 would be retained at restoration, these would be designed so as to retain some standing water and wetland areas in the base.
Priority species			**Restoration biodiversity aims**
Bats	✓	✓	Retain and protect mature trees around the periphery of the site, to provide roosting opportunities. Retain and enhance hedgerows and woodlands and a diverse range of flower rich grasslands to provide suitable sheltered foraging and commuting opportunities on site. Provide ecological connectivity through the site and to the wider area.
Great Crested Newt	x	✓	Provide suitable terrestrial and aquatic habitat (enhanced hedgerow network and standing water/ wetland) as part of the restoration scheme in the medium to long term.
Breeding birds – farmland bird assemblage Skylark, lapwing,	✓	✓	To retain existing populations and increase opportunities for breeding and foraging.
Brown Hare	✓	✓	Provide habitat (open fields) and connectivity to allow free movement of brown hares. Increase open field habitat to support populations.
Hedgehog	✓	✓	Increase habitat available by replanting hedgerows and woodland habitat. Provide cross site connectivity to enable safe passage.

Other aims

4.1.6 To restore and enhance the landscape and visual amenity value of the site.

Restoration objectives

4.1.7 In order to meet the above aims, the objectives of the restoration scheme are to create the areas/ lengths of the habitats and land uses in Table 2, as are illustrated on ES Figure 3.6. This will result in a diverse range of habitats and movement corridors for wildlife across the site.

Table 2: Proposed habitats and land uses within Restoration Scheme	
Land use	**Area/ length**
Existing woodland and scrub	7ha
Existing agricultural land	2ha
New woodland and scrub	1.8ha
Magnesian limestone grassland	6.6ha
Agricultural land	15.5
Hedgerows	822m
Drainage basins with water bodies and wetland	0.7ha

4.1.8 The aim of providing a range of habitats including priority habitats is to increase biodiversity on the site to benefit the species currently present and to enhance the area for associated priority target species, currently absent from site. Examples would be through provision of magnesian grassland and appropriate plant species the site could provide suitable habitat for butterflies such as dingy skipper *Erynnis tages* and brown argus *Aricia agestis*, and arable and pasture fields may support a range of farmland land birds to including skylark and lapwing.

4.1.9 Lightwater Quarries will ensure a suitable structure is in place to deliver the restoration and aftercare obligations. Lightwater Quarries will appoint an appropriate landscape contractor to manage the habitats in accordance with the Landscape and Biodiversity Management Plan and the CEMP. The roles and responsibilities will be set out within the sub-contractual agreement.

4.1.10 In addition, Lightwater quarries will ensure the scheme receives adequate financial funding and logistical management as well as expertise and advice on nature conservation, habitat creation, establishment, management and monitoring to ensure the restoration objectives are delivered to the highest standard. Prescriptions may be amended as a result of the monitoring observations to ensure that the medium and long terms aims of the scheme are realised.

4.2 The Restoration Scheme

Landform

4.2.1 The restored landform is shown on Figure 3.6 and cross sections through this are shown on Figure 3.7. The landform of the landfill has been designed to replicate the landform of the site before the quarry was developed, it therefore ties into the surrounding landform to the east, west and south and would be at 144m AOD at the highest point in the southern section of the landfill. The northern edge of the landfill would then slope down to the quarry floor to tie in with the existing access ramp.

4.2.2 The restored quarry edges of the northern area of the existing quarry would consist of a combination of slopes, both grass and scree, formed by pushing overburden and waste rock against the final worked face with varied gradients of 1:3 on average, or and combination of exposed faces no higher than 5m left as landscape features and slopes, to create a varied restoration profile. Restoration blasting would used as required to create the desired features. The aim of this restoration approach is to create a varied landform, to reduce the linear appearance of the final quarry void and to create a variety of habitats including magnesian limestone grassland, scree, and exposed faces, which are valuable for a range of specialist calcicole plant species and invertebrates. Woodland planting would also be used to soften the linear appearance. The quarry floor would be graded to gently sloping land suitable for agricultural use.

Soil Restoration

4.2.3 The restored soil profiles are listed in Table 3. Refer to the SMP in Appendix 8.5 of the Norther Quarry Extension ES for more details of the soil restoration.

Table 3: Restored soil profiles

Landcover	Topsoil depth (mm)	Subsoil depth (mm)
Agricultural land	300	600
Woodland/scrub	300	600
Magnesian limestone grassland	0	100 over limestone fines

Landcover and land use

4.2.4 The restored landfill and quarry would consist of a range of land uses from nature conservation to agriculture. A network of fields would be created divided by hedgerows with central fields returned to agricultural use and a magnesian limestone grassland field created in the west. Magnesian limestone grassland would also be created on the steeper slopes of the northern half of the existing quarry, along with scree and exposed rock faces as described above.

4.2.5 Pockets of additional woodland planting and scattered trees and scrub would be planted around the quarry perimeter at restoration. This, along with the management and thinning of the existing screening belts would aim to soften the appearance of the linear screening belts and add to landscape and habitat diversity of the restored site.

4.2.6 Drainage basins are required throughout the landfill process and 2 would be retained at restoration, these would be designed so as to retain some standing water and wetland areas in the base.

4.2.7 Estimated areas of different land uses that would be created within the restored quarry are presented in Table 2 above.

4.3 Methods of Habitat Creation and Planting Specifications

Woodland, scrub and Hedgerows

4.3.1 The woodland to be planted at restoration would consist of the species listed in Table 4 below. Scrub planting would consist of the species listed in Table 5 below.

4.3.2 Tree species to be planted in groups of 5-10 at an average 2.5m spacing (varying between 2m to 5m), within staggered wavy lines.

4.3.3 Pockets of additional woodland planting and scattered trees and scrub would be planted around the quarry perimeter at restoration. This, along with the management and thinning of the existing screening belts would aim to soften the appearance of the linear screening belts and add to landscape and habitat diversity of the restored site.

Table 4: Woodland planting mix

Common name	Species	%	Height (cm)	Specification
Canopy trees				
Field Maple Not within 3m of gas pipeline	*Acer campestre*	25	40-60	1+1 Transplant B
Oak Not within 6m of gas pipeline	*Quercus robur*	25	100-125	1+2 Transplant B
Rowan Not within 3m of gas pipeline	*Sorbus aucuparia*	20	40-60	1+1 Transplant B
Scots Pine Not within 6m of gas pipeline	*Pinus sylvestris*	10	40-60	Leader & laterals 2L C
Wych Elm/ English Elm/ Sapporo Autumn Gold Elm* Not within 6m of gas pipeline	*Ulmus glabra/ Ulmus procera/ Ulmus davidiana var. japonica × U. pumila*	20	40-60	1+1 Transplant B
Shrubs layer				
Blackthorn	*Prunus spinosa*	30	40-60	1+1 Transplant B
Dog Rose Not within 1.5m of gas pipeline	*Rosa canina*	10	40-60	1+1 Transplant B
Hawthorn	*Crataegus monogyna*	30	40-60	1+1 Transplant B
Hazel Not within 1.5m of gas pipeline	*Corylus avellana*	10	40-60	1+1 Transplant B

Table 4: Woodland planting mix				
Common name	**Species**	**%**	**Height (cm)**	**Specification**
Holly Not within 1.5m of gas pipeline	*Ilex aquifolium*	10	40-60	Leader & laterals 2L C
Wayfaring Tree Not within 1.5m of gas pipeline	*Viburnum lantana*	10	40-60	1+1 Transplant B
* Sapporo Autumn Gold Elm will only be used if disease resistant Wych Elm/ English Elm plants are not available, this would be agreed with the Planning Authority prior to planting				

Table 5: Scrub planting mix				
Blackthorn	*Prunus spinosa*	10	40-60	1+1 Transplant B
Dog Rose Not within 1.5m of gas pipeline	*Rosa canina*	10	40-60	1+1 Transplant B
Dogwood Not within 1.5m of gas pipeline	*Cornus sanguinea*	10	40-60	1+1 Transplant B
Hawthorn	*Crataegus monogyna*	20	40-60	1+1 Transplant B
Hazel Not within 1.5m of gas pipeline	*Corylus avellana*	30	40-60	1+1 Transplant B
Holly Not within 1.5m of gas pipeline	*Ilex aquifolium*	10	40-60	Leader & laterals 2L C
Wayfaring Tree Not within 1.5m of gas pipeline	*Viburnum lantana*	10	40-60	1+1 Transplant B

4.3.4 The trees and shrubs would be planted between November and March during their dormant period. Young plants would be protected from damage by browsing wild animals using suitable biodegradable tree guards. Species required to be supported by stakes would be checked annually to ensure no damage has occurred.

4.3.5 The hedgerow planting would consist of the species listed in Table 6.

Table 6: Hedgerow species				
Common Name	**Species**	**Height (cm)**	**Specification**	**%**
Hawthorn	*Crataegus monogyna*	40-60	1+1 Transplant B	40
Hazel Not within 1.5m of gas pipeline	*Corylus avellana*	40-60	1+1 Transplant B	20
Blackthorn	*Prunus spinosa*	40-60	1+1 Transplant B	10
Field maple Not within 3m of gas pipeline	*Acer campestre*	40-60	1+1 Transplant B	10
Wych Elm/ English Elm/ Sapporo Autumn Gold Elm* Not within 6m of gas pipeline	*Ulmus glabra/ Ulmus procera/ Ulmus davidiana var. japonica × U. pumila*	40-60	1+1 Transplant B	10

Table 6: Hedgerow species				
Common Name	**Species**	**Height (cm)**	**Specification**	**%**
Holly Not within 1.5m of gas pipeline	*Ilex aquifolium*	40-60	Leader & laterals 2L C	5
Dog Rose Not within 1.5m of gas pipeline	*Rosa canina*	40-60	1+1 Transplant B	5
* Sapporo Autumn Gold Elm will only be used if disease resistant Wych Elm/ English Elm plants are not available, this would be agreed with the Planning Authority prior to planting				

4.3.6 Native species hedgerow trees (including oak, field maple, rowan, wild cherry, Elm) would also be introduced at random spacings at the rate of 4 trees/200m, except for within the vicinity of the gas pipeline. These trees would be individually marked with coloured tags and would not subsequently be trimmed as part of any early hedgerow management operations. The hedgerow trees would be planted as Standard trees (250 - 300cm high) pit planted and protected using individual tree shelters.

4.3.7 Pre-planting, the areas would be rotovated and a bark mulch applied to reduce the growth of competitive weeds at least 3 weeks prior to planting.

4.3.8 In order to ensure that healthy, vigorous growth is achieved in newly planted trees and shrubs, the following specification would be applied:

- all planting stock supplied would be in accordance with BS3936 and would be the best quality of their respective kind;
- all plant stock would be supplied from a reputable nursery which can supply species of local provenance where possible;
- all plant material would be healthy, vigorous and sound transplanted nursery stock with well-formed fibrous root systems and well-formed heads; and
- plant material to be free from pest and diseases, undamaged and any containers free from weeds, prior to planting.

4.3.9 The trees and shrubs would be notch planted, with the exception of the holly and pine which would be pit planted, and protected using 1.2m high tree tubes or guards constructed of a biodegradable material and/or post and wire fencing. The hedgerow trees and shrubs would be planted in double staggered rows, at 30cm spacings.

4.3.10 Ground flora will be allowed to develop naturally.

Agricultural land

4.3.11 Land intended for an agricultural after use would either be seeded with an agricultural grassland mix (medium to long-term grass-ley mixture with clover) or entered into arable cropping (wheat – barley rotation). Seeding would be carried out in March to May or September to October, when climatic conditions are suitable for establishment. The restoration of land to agricultural land will aim to achieve ALC grades 3a and 3b.

Arable margins

4.3.12 The aim is to retain arable margins ranging from >4m in width, in areas of arable agricultural restoration. The margins will be allowed to naturally regenerate from the natural seed bank to encourage wildlife on arable farmlands and reduce fertiliser and pesticide drift (if used) on conservation grasslands. For more floristically diverse swards within the arable margins a commercial seed[1] can be used (such as cornfield Annuals) and sown as detailed within paragraph 4.3.19.

Magnesian limestone grassland

4.3.13 The aim is for the creation and management of the calcareous grassland is to work towards achieving a floristically diverse, identifiable magnesian limestone grassland community, which would ultimately have affinities with NVC community CG3 - *Bromopsis erecta* grassland. Much of the below, follows prescriptions outlined within Ashwood (2014), and the CIEEM webinar Habitat Creation: Creating and Restoring Grasslands (2019), presented by Penny Simpson.

Seeding from Green Hay

4.3.14 This is the preferred method of habitat creation and would involve consultation with the LPA and liaison with site managers of local sites to discuss obtaining an appropriate source or if magnesian limestone grassland already created on site or at Potgate Quarry is establishing successfully this would be used as a green hay source. Seeding from green hay requires taking a hay cut at the appropriate time of year and spreading it over the freshly prepared ground. However, it must be noted that magnesian limestone grassland is traditionally managed through grazing, so this might not be a feasible option.

[1] John Chambers Wildflower Seed - https://www.johnchamberswildflowers.co.uk/wildflower-seeds-mixes/100-wildflower-mixes/john-chambers-pro-cornfield-annuals-100-wildflower-seed-mix

4.3.15 Should a suitable donor site be available, the hay crop would be taken after flowering, but prior to seeds being dropped. Given that a key target species in this instance would be upright brome, which flowers from late May, a hay cut will be taken in late June or mid-July (subject to the donor sites management plan/HLS scheme). The cut hay would be spread on the prepared ground within 24 hours. Hay from the donor site can be spread at a ratio of 1:3, where hay from 1ha of cut grassland can be used as a source for 2-3ha of newly created grassland.

4.3.16 Biosecurity measures would be undertaken to stop the spread of undesirable species between the donor and receptor sites, in this instance the spread of invasive species such as Himalayan balsam and butterfly bush. This could involve the cleaning of equipment between sites.

4.3.17 The phased restoration might allow green hay to be utilised across a number of different phases of the scheme. Once established within the site, the restored areas of magnesian limestone grassland, could be used as donor sites.

4.3.18 Seed from target species could be hand collected from the donor site to be spread on the receptor site, particularly upright brome, which is not widely available within commercial seed mixes and is a key component of magnesian limestone grassland communities.

Seeding from commercial Seed

4.3.19 If a green hay source cannot be found, or the quantity of available hay is not sufficient for the amount of habitat to be created, a suitable commercial[2] calcareous seed mix would be used. The seed mix would be of local provenance, where available. A mix of both grasses and wildflowers would be used and as a minimum the species listed in Table 7 would be included within the mix (subject to agreement with local nature conservation organisations):

Table 7: Calcareous grassland seed mix

Common name	Species	Common name	Species
Upright brome*	*Bromopsis erecta*	Common knapweed	*Centaurea nigra*
Salad burnet	*Poterium sanguisorba*	Hoary Plantain	*Plantago media*
Glaucous sedge	*Carex flacca*	Lady's Bedstraw	*Galium verum*
Ribwort plantain	*Plantago lanceolata*	Crested hair-grass	*Koeleria macrantha*
Common bird's-foot-trefoil	*Lotus corniculatus*	Field scabious	*Knautia arvensis*

[2] John Chambers Wildflower Seed or similar

Table 7: Calcareous grassland seed mix			
Common name	**Species**	**Common name**	**Species**
Sheep's-fescue	*Festuca ovina*	Selfheal	*Prunella vulgaris*
Rough hawkbit	*Leontodon hispidus*	Quaking-grass	*Briza media*
Fairy flax	*Linum catharticum*	Common rockrose	*Helianthemum nummularium*
*If available			

4.3.20 The results of the soil analysis would dictate the desired sowing rate. Seed distributors often recommend a sowing rate as high as 40kg/ha, and it is considered that nutrient rich soils might require this sowing rate. For nutrient poor substrates 10-15kg/ha is a suitable sowing rate as grass and undesirable species growth is not expected to be as vigorous. Seeds would be sown in September/October and due to the size of the habitats created the seed would be sown using a tractor mounted seed drill. Immediately following sowing the seedbed would be rolled using a flat roller.

4.3.21 Newly sown areas would be protected from trampling by people and grazers (including rabbits where possible). Bird scarers would be used after seeding to discouraging seed eating birds.

4.3.22 It is important to note that it can take up to five years to establish a stable grassland community, with early establishment being patchy and 'weedy' in appearance.

4.3.23 The condition of the grassland would be reviewed within 6 months of seeding and any areas which have failed to establish would be re-seeded. To control any flush of annual weeds, within the first year the grassland may require up to four cuts, however, Ashwood (2014) notes that:

"Typically, first-year cutting regimes will not be necessary for grassland established on bare mineral substrate…"

4.3.24 As such, the created grassland would be monitored within the first year and if grass growth is considered to be vigorous a cut would be taken. The sward length would ideally be kept at 100mm or below.

Waterbodies and wetlands

4.3.25 The drainage basins will be profiled with irregular shorelines with gradient variations from 1:3 to 1:10 to maximise the variety of aquatic and marginal habitats. The shallower part of the shore profiles and submerged gradients will be soiled with topsoil to a depth of 300mm to promote the establishment of the micro flora and fauna which form the base of the fish food chain. Once created, the water bodies would be left to allow vegetation to colonise naturally.

4.4 Public access

4.4.1 There would be no public access to the restored quarry.

5 AFTERCARE AND LONG TERM MANAGEMENT OF THE SITE

5.1 Introduction

5.1.1 Aftercare of the site is important for the successful establishment of the vegetation. Annual maintenance meetings will be held during the 5 year statutory period, on site to review the previous year's management. Data gathered will be used to modify site-specific management as required. The annual maintenance meetings would be attended by representatives from Lightwater Quarries, the landowners, the Planning Authority, Yorkshire Wildlife Trust and any other interested nature conservation groups and any relevant ecology/ landscape consultants.

5.1.2 Aftercare will comprise the maintenance of each phase of the quarry over a statutory period of five years to ensure the successful establishment of the target habitats. The aims of the aftercare scheme are as follows:

- management of existing and new woodlands and scrub;
- repair and maintenance of post and wire fencing where necessary;
- maintenance of existing and proposed hedgerows including pruning and cutting as required;
- conservation of the flora and fauna of the newly established species rich grasslands, wetlands and woodlands through a low nitrogen input regime;
- establishment of marginal and emergent plants within the drainage basins;
- management/control of aquatic vegetation and algae;
- management/control of INNS; and
- soil (cultivation, destoning, application of amendments, such as fertilisers and lime) and, if needed, drainage management.

5.2 Management aims and objectives

5.2.1 The long-term management aims and objectives are as follows:

Conserve and develop the amenity value of the restored site to include the following objectives:

1. *Maintain and enhance where possible, the landscape and visual amenity value of the site.*

Conserve and enhance the nature conservation and biodiversity value of the restored site to include the following objectives:

1. *Establish, maintain and enhance areas of species rich grassland habitat.*
2. *Establish, maintain and enhance areas of existing and developing broadleaved woodland and scrub habitat.*
3. *Establish, maintain and enhance species rich hedgerows with hedgerow trees.*
4. *Establish, maintain and enhance the areas of developing wetland.*
5. *Control and removal of weeds and alien species.*
6. *Seek to establish progressively the various habitats on the site.*
7. *Monitor the success of the establishment of new habitats.*

5.3 Roles and responsibilities

Ownership

5.3.1 The site is owned by the Warrington family who have managed the land for generations. They will take on the long term management of the site post-aftercare and manage the habitats is accordance with this plan.

5.3.2 Lightwater Quarries will be responsible for restoring the quarry in accordance with this management plan (and any subsequent amendments and additions) and the managing the site for the 5 year statutory aftercare period. At the end of the 5 year statutory period the site will be handed back to the landowners who will continue to manage the site in accordance with this plan. Specialist input will continue to be sought to develop the details of the restoration, to prepare detailed management plans and for monitoring.

5.4 General operations

5.4.1 The following schedules of operations (Table 8 to Table 13) would be implemented from the beginning of the aftercare period and will continue to be implemented as per the following tables for the duration of the aftercare period and in the long term.

Table 8: Maintenance regime carried out on annual basis: General

Operation	Frequency
Each general inspection would include fencing, gates and other site furniture, a scavenge and litter pick (including debris and any other deleterious matter) removing all arisings to contractor's tip, leaving the site in a neat and tidy appearance.	2 visits per year.

5.5 Woodland and scrub planting

5.5.1 Woodland and scrub planting would be inspected on an annual basis and dead and diseased stock replaced. During the establishment of the planting a 1m diameter weed free area would be maintained around the plants, preferably by maintaining mulch cover to minimise herbicide use. If considered necessary, an appropriate herbicide, suitable for use close to water, would be applied to around the base of the trees, during the growing season (mid-April to end of September) to maintain the weed free area. Applications of herbicide would be assessed during the first 5 growing seasons; alternatively, grass growth would be managed by strimming vegetation during the growing season, avoiding damaging tree stems.

5.5.2 In the longer term, once the proposed woodland compartments have established, management priorities will change to concentrate on initially removing tree guards /protection and enclosure fence maintenance. A cyclical programme of thinning, felling and coppicing with some interplanting will be introduced with the aim of increasing the species and (especially) the structural diversity of the canopy, under-storey layers and a more open, dispersed woodland cover, particularly on the fringes of the woodland areas.

5.5.3 One of the potential threats to these developing woodland areas is the encroachment by non-native sycamore, which, if unchecked, may come to dominate certain sections of the woodland. Provided the development of young sycamore is prevented (by hand pulling of saplings) it is unlikely that serious encroachment will be a problem. However, appropriate regenerating native target species will be retained within the woodland to encourage a diverse age structure.

5.5.4 The trees in the woodland areas will be thinned to leave the canopy trees with an average spacing of between around 6-10m, with interspersed understorey trees; the timing of thinning will be dependent on local growth conditions of the trees. The woodland edges will have been scalloped to form sheltered areas creating a diversity of micro-climates. Scalloped areas along woodland edges attract flying invertebrates; these in turn have the potential to become prey items for bird and bat species. The scalloped and more open canopied edges of the woodland will be maintained (primarily by the selective removal of trees and scrub). Management of these areas - through cutting - will seek to prevent excessive scrub invasion of the grassland areas.

Monitoring

5.5.5 Monitoring of the condition of the trees, with minor management works to remove dead/diseased trees or improve the health of others will be carried out at least once every 5 years.

5.6 Hedgerows

5.6.1 The base of the hedgerows would be kept weed-free for at least three years to ensure a good plant establishment and growth rate. Chemical control would be undertaken as necessary but typically annually, and early in the year with weed growth monitored to determine if further applications are subsequently required.

5.6.2 Initial management would involve appropriate trimming of the establishing hedgeline in the first few years to encourage early lower branching and to discourage the apical tendency of hawthorn. Individual plant guards would be removed as soon as practical to avoid 'legginess' developing in the plants. Each successive trim would be progressively higher and wider as this would encourage further branching until the hedge reaches its required height and width.

5.6.3 The hedgerows would be maintained at a height of no less than 2m and a minimum width of 2m, with a mixture of heights and widths across the restored quarry. No fertilisers, manures or pesticides would be applied to this area.

5.6.4 The hedges will not be cut during the bird breeding season (28 February – 31 August). Mature hedgerows will be cut on a two or three year rotation. Avoiding annual cutting is better for wildlife as some species only flower on second year growth. Care will be taken to ensure that hedgerows trees are not significantly damaged during trimming.

5.6.5 Long term management and management of the hedgerows will involve the hedges being laid or coppiced to regenerate growth, improve their structural diversity and increase their stock-proofing capability. Clearance of invasive species, new planting where necessary and controlled cutting to thicken growth. Standard trees would be retained at a ratio of 4 every 200m. Standard trees would be retained as hedgerow trees.

5.6.6 Laying involves cutting stems part way through and interweaving them along the hedge, while coppicing involves cutting the stems at ground level. Coppicing is usually only used when the stems are too thick to allow laying. Laying is the preferred option at Gebdykes, as although requiring skilled labour, it has a less drastic effect on wildlife.

5.6.7 Both coppicing and laying will reduce birds' breeding opportunities in the few years immediately after management and will therefore be carried out progressively over many years rather than treating large sections of hedgerow in a single year.

Monitoring

5.6.8 Inspections in September to check for problems relating to protective fencing, integrity or intactness of hedgeline and requirements for gapping up will be carried out at least once every 5 years.

Table 9: Maintenance regime undertaken for Year 1: woodland, scrub and hedgerow planting	
Operation	**Frequency**
Top-up mulch/ translocated herbicide application	2 visits - April, June and September, plus 1 provisional application
Refirming of all plant material where necessary	1 visit – April
Replace shelters and stakes	Where necessary
Pruning of dead and diseased wood. All arisings will be removed to contractor's tip	1 visit – November-March
Replacement planting of dead/dying/diseased plants (maintain species mix specified in Table 4 and Table 5)	1 visit – in year 1 and Year 3 November-December

Table 10: Maintenance regime undertaken for Years 2 to 5: woodland and hedgerow planting	
Operation	**Frequency**
Top-up mulch/ translocated herbicide application	2 visits – April and June
Top-up mulch/ residual herbicide application	1 visit – November-March
Refirming of all plant material where necessary	1 visit – April
Replace shelters and stakes	Item where necessary
Pruning of dead and diseased wood. All arisings will be removed to contractor's tip	1 visit – November-March
Beat up planting	1 visit – November-December

Table 11: Long term maintenance regime: woodland and hedgerow planting	
Operation	**Frequency**
Inspection and replacement of tree guards and protective fencing and removal when no longer required	1 visit per year
Tree health inspection, arboricultural works and removal of dead and disease trees and shrubs	1 visit per year
Grassland management within woodland areas by strimming if a dense rank sward of grasses develops	1 visit per year
Any reinstatement will be done so in accordance with the restoration and aftercare specifications in this report	1 visit per year
Woodland thinning, felling and coppicing	To be determined during annual inspection
Hedgerow cutting	Then on 2/3 year cutting cycle, outside bird breeding season
Hedgerow laying and/or coppicing	To be determined during annual inspection

5.7 Tree management of existing trees and woodland

5.7.1 Tree management will be undertaken with the primary aim of sustaining and enhancing biodiversity on site. Where on site works are required, these would be carried out from October to February, in order to avoid the bird nesting season, unless required for safety and risk management reasons. Where safety and risk management works are undertaken during the bird nesting season, an ecologist will be consulted prior to the works, with the works undertaken under the directions of the ecologist.

5.7.2 Retaining and enhancing biodiversity on site will be primarily concentrated on retention of decaying wood habitats such as standing dead trees and deadwood in tree crowns. Where it is decided that there is deficit of such habitat on site, enhancement measures such as the creation of standing deadwood and dead branches in tree crowns will be undertaken by ring-barking trees and branches. This will be specified by an experienced arboriculturist, in order to ensure only poorer quality trees are subject to this this type of management and that the works do not increase the risk associated with such trees e.g. not to be undertaken where the trees are falling distance if medium to high targets. The retention of standing late-mature trees, that may transition into veteran trees in time, will also be a key objective for the management of the trees on site.

5.7.3 Other maintenance work would include:

- Arboricultural works to rejuvenate trees in poor condition;
- The felling and clearance of diseased trees where there is a clear risk of disease or pest transmission. This is to be only undertaken, following consultation with and under direction of the Forestry Commission and the Animal and Plant Health Agency, where appropriate;
- Creation of veteran tree features such holes, splits, cavities in existing poor quality trees to create habitat for invertebrates, nesting birds and bats;
- Limited selective thinning of trees, established groups of trees/ woodland and coppicing of selected species to introduce stand diversity and to benefit the growth of other trees and habitats; and
- Selective thinning of naturally regenerated juvenile trees to better the growth of the trees to be retained.

Monitoring

5.7.4 Monitoring of the condition of the trees and woodland will be carried out at least once every 5 years.

Table 12: Maintenance regime: Existing woodland and trees	
Operation	**Frequency**
Each general inspection visit will include an inspection of the woodland and trees to determine what management work is required.	1 visit per year

5.8 Magnesian limestone grassland

5.8.1 This would require low input management:

- No artificial or organic manures to be applied.
- No herbicides to be applied with the exception of spot treatment of any undesirable or invasive species.

5.8.2 In the second and subsequent years, management to maintain the diversity of the grassland would involve an annual cut to a height of c.50mm, undertaken each year in late Summer/early Autumn. This maintains the habitat for longer, allowing species to flower and set seed as well as providing more continual foraging resource for invertebrates. Alternatively, a single cut could be undertaken in early spring. The cut material would be removed after each mowing and could be gathered on-site and allowed to rot down naturally.

5.8.3 Alternatively, the established grassland would be grazed, ideally by sheep, on a management regime designed to encourage development of the sward and soil profile.

5.8.4 As well as being monitored, assessed and managed throughout the Aftercare Management Period, at the end of this period, an assessment would be made of how well the grassland has established.

5.8.5 Long-term management of grasslands is required to prevent natural succession and the sward becoming dominated by a few aggressive species. Noxious and invasive weeds will be effectively controlled in accordance with best practice.

Monitoring

5.8.6 Monitoring will be undertaken in order to determine if the management prescriptions are adequate in maintaining the structural and species diversity of the sward. Monitoring to take place in year 1 to assess initial success of the reseeding, and every five years thereafter. If monitoring determines that the grassland is deteriorating, then changes to the management and grazing/mowing regimes will be introduced. Monitoring options include fixed point photographs, and random and fixed point quadrats.

5.9 Agricultural land

5.9.1 Generally, grassland established on the agricultural land would be managed after the first year's growth by:

- taking a single late summer hay or silage crop a year; or
- grazed on a management regime designed to encourage development of the sward and soil profile.

5.9.2 Long-term monitoring of the species composition of the grassland and the ability to respond (with alterations to the cutting /grazing regimes) is very important and would form part of the management regime for the site.

5.9.3 For arable land, this would depend on the choice of crop and farming method used. In any case, good agricultural practice with regards to grazing management, soil cultivation, use of fertilisers, lime and pesticides will be followed. The need for agricultural drainage would be assessed two years after the fields have been created.

Table 13: Maintenance regime: Agricultural Grass seeded areas	
Operation	**Frequency**
General inspection of: Germination and the establishment of grasses until the mix has shown successful germination and establishment Surface erosion and, where necessary the requirement for intermediate grips to control run-off	2 visits per year or as required for success
Grass cutting	Twice in the first year, thereafter the fields will be grazed by sheep
Selective herbicide application or removal by hand pulling of pernicious or notifiable weeds Refer to *The Code of Practice for the Safe Use of Pesticides on Farms and Holdings [PB3528]* for regulations on herbicide application	2 visits per year before onset of seed dispersal or as required for success Site operatives will be trained to recognise the different species
Making good and reseeding dead or damaged areas	Annually
Maintenance regime: Arable crops	
Due to many options possible depending on the crop and farming system used, this will be specified following restoration. As a minimum, good agricultural practice tailored to soil condition will be followed based on advice from an experienced agronomist.	

5.10 Water bodies and wetlands

5.10.1 Management works will be carried out between September and October to minimise disturbance to wildlife.

5.10.2 Initial monitoring will take place after the first growing season. Any necessary supplementary planting will be carried out the following season (June) if the area regenerated were to be less than 50% successful. Locally sourced transplanted material or seedlings will be used.

5.10.3 Water bodies are at risk from invasion by invasive, non-native species such Canadian pondweed, Australian stonecrop etc. For this reason, it is recommended that plants are only transferred from one waterbody to another following a check by a competent ecologist. Invasive, non-native species would be controlled by hand, if herbicides are required; these will be applied by a contractor with an appropriate Certificate of Competence. The Environment Agency can provide a list of approved contractors.

5.10.4 Algal growth typically becomes excessive when the water is too nutrient-rich. The aim will be to prevent the build-up of nutrients in water bodies when they are formed, as well as minimising runoff of fertilisers from adjacent land.

5.10.5 The control of algal blooms, if required, will utilise submerged barley straw in the shallower water of the lakes, in accordance with emerging management techniques. Bales of barley straw will be loosely broken apart and placed in netting bags to allow water and air to circulate. The application rate will be 250kg of straw/ha of water (assuming a depth of approximately 1 - 2m). The straw will be applied in March – April.

5.10.6 Once vegetation is established the long term management will ensure that an area of open water is maintained. Removal of excess vegetation will be undertaken annually to ensure a varied structure. Pond clearance will be carried out during October - February when most amphibians have left the pond to over winter within terrestrial habitats. Vegetation will be left on the bank for 24 hours before removing off site.

Table 14: Maintenance regime: Water bodies and wetlands

Operation	Frequency
Each general inspection visit will include an inspection of the basins to determine if any of the management operations listed above are required. Any works required will be carried out in September to October.	2 visits per year

Removal of native and non-native invasive species (INNS)

5.10.7 The site may be vulnerable to colonisation by invasive species as listed above in section 3.5. In the event that invasive species become established and deleteriously effect the target habitats, management will be undertaken, as required, using approved control methods.

5.11 Other monitoring

5.11.1 Monitoring will focus primarily on habitats on site. With incidental sightings of wildlife (birds, butterflies etc) recorded whilst on site.

5.11.2 The results of protected species surveys will be forwarded to the LPA and any changes incorporated into relevant management plans and/or mitigation plans.

5.11.3 A full programme of protected species surveys will be incorporated into the Construction and Environmental Management Plan (CEMP) which will allow updated survey results to be to feed into site clearance and method statements and any associated licenses throughout the different phases of the development.

5.11.4 A review will be conducted in the last winter of the aftercare period. The success of the management strategies used in the aftercare period will be assessed and amendments made to the long-term management plan if necessary.

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APPENDIX 4

Flood Risk Assessment

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ENERGY AND CLIMATE CHANGE
ENVIRONMENT AND SUSTAINABILITY
INFRASTRUCTURE AND UTILITIES
LAND AND PROPERTY
MINING AND MINERAL PROCESSING
MINERAL ESTATES
WASTE RESOURCE MANAGEMENT

LIGHTWATER QUARRIES LIMITED

GEBDYKES QUARRY LANDFILL
PLANNING APPLICATION AND ENVIRONMENTAL STATEMENT

FLOOD RISK ASSESSMENT

FEBRUARY 2023

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LIGHTWATER QUARRIES LIMITED

GEBDYKES QUARRY LANDFILL
PLANNING APPLICATION AND ENVIRONMENTAL STATEMENT

FLOOD RISK ASSESSMENT

FEBRUARY 2023

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APPENDICES

DRAWINGS

1 INTRODUCTION

1.1 General

1.1.1 Wardell Armstrong LLP (WA) has been commissioned by Lightwater Quarries Limited to prepare a Flood Risk Assessment (FRA) for the proposed development of an inert landfill site at Gebdykes Quarry, Masham, North Yorkshire.

1.1.2 This report sets out the findings of the FRA required by the Local Planning Authority to support the planning application for development of the site. The assessment has been carried out in accordance with the guidance set out in National Planning Policy Framework (NPPF).

1.2 Methodology

1.2.1 The methodology for this FRA has comprised a desktop study of online mapping, existing literature and previous site investigation works. Reference has been made to relevant plans and documents including:

- North Yorkshire County Council (2011) *Preliminary Flood Risk Assessment;*
- Harrogate Borough Council with Craven District Council and Richmondshire District Council (2010) *North West Yorkshire Level 1 Strategic Flood Risk Assessment – Volume II: Technical Report;* and
- North Yorkshire County Council, City of York Council and the North York Moors National Park Authority (2016) *Minerals and Waste Joint Plan – Sustainability Appraisal Strategic Flood Risk Assessment*.

2 FLOOD RISK AND PLANNING POLICY

2.1 National Planning Policy

2.1.1 The NPPF and the accompanying Planning Practice Guidance (PPG) aim to ensure that flood risk is taken into consideration at all stages of the planning process and advocates the use of a risk-based 'Sequential Test' to preferentially locate development in areas with a low risk of flooding. Where development is necessary in high risk areas, the NPPF aims to ensure that the development is safe without increasing flood risk through the application of the Exception Test.

2.1.2 The PPG defines the levels of flood risk within England as follows.

- Flood Zone 1 – Low Probability – Land having less than a 1 in 1,000 annual probability of river or sea flooding.
- Flood Zone 2 – Medium Probability – Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding.
- Flood Zone 3a – High Probability – Land having a 1 in 100 or greater annual probability of river flooding; or having a 1 in 200 or greater annual probability of sea flooding.
- Flood Zone 3b – Functional Floodplain – Land where water has to flow or be stored in times of flood.

2.1.3 The PPG states that a site-specific FRA is required for all new development proposals located in Flood Zones 2 and 3, and for any proposal of 1 hectare or greater regardless of its flood zone classification. The flood zones as described above are shown on the Environment Agency's Flood Map for Planning, available online.

2.1.4 Table 2 of the PPG classifies development types based on their vulnerability to flooding, ranging from 'Essential Infrastructure' which has to be operational in times of flood, through 'Highly Vulnerable' (e.g., emergency service stations), 'More Vulnerable' (e.g., residential dwellings and establishments), 'Less Vulnerable' (e.g., offices/retail), to 'Water Compatible' development (e.g. open space, docks, marinas and wharves).

2.1.5 Based on Table 2 of the NPPG, the proposed inert landfill development is classified as a 'Less Vulnerable' development.

2.1.6 Table 3 of the PPG indicates which 'vulnerability classes' are acceptable in each of the Flood Zones, and when the Exception Test should be applied. This is reproduced as Table 1 below.

Table 1: Flood Risk Vulnerability and Flood Zone 'Compatibility'

Flood Zone	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
1 (>0.1%)	✓	✓	✓	✓	✓
2 (0.1 – 0.5%)	✓	Exception Test	✓	✓	✓
3a (>0.5%)	Exception Test	×	Exception Test	✓	✓
3b (>5%)	Exception Test	×	×	×	✓

2.1.7 The Environment Agency's Flood Map for Planning shows that the site is wholly located within Flood Zone 1 (see Figure 1). Based on Table 3, the 'Less Vulnerable' development is appropriate within Flood Zone 1.

Figure 1. Environment Agency Flood Map for Planning

2.2 Application of the Sequential and Exception Test

2.2.1 The Sequential Test, as set out in the NPPG, aims to steer developments to areas with the lowest risk of flooding (i.e., Flood Zone 1 where possible). As the proposed development is located wholly within Flood Zone 1, it is considered that the Sequential Test is passed.

2.2.2 The Exception Test should be applied after the Sequential Test has been applied in circumstances when 'More Vulnerable' development and 'Essential Infrastructure' cannot be located within Flood Zones 1 or 2, or 'Highly Vulnerable' development cannot be located within Flood Zone 1. As the proposed development has passed the Sequential Test, the Exception Test is not required.

3 SITE SETTING

3.1 Site Description and Location

3.1.1 A summary of the site and its characteristics is provided in Table 2.

Table 2: Site Location Summary	
Site Name	Gebdykes Quarry
Site Address	Land off Limekiln Lane, near Masham, North Yorks, HG4 4BT
Site Area (ha)	c. 33.7 ha (quarry) c. 10.7 ha (development area)
National Grid Reference	SE 23844 82202
Existing Land Use	Mineral extraction
Proposed Land Use	Inert Landfill
Local Planning Authority	North Yorkshire
Sewerage Undertaker	Yorkshire Water

3.1.2 Gebdykes Quarry is an active magnesian limestone quarry located approximately 2km to the north-east of Masham. Southern areas of the wider Gebdykes Quarry are nearing exhaustion of the permitted reserves and this area currently forms a large void. The proposed development (referred to as 'the site' where appropriate) forms the southernmost part of this void.

3.1.3 The National Grid reference for the approximate centre of the site is SE 23844 82202 and the nearest postcode is HG4 4BT. The location of the site is shown on Drawing No. NT14834-Figure 1.1 *'Location Plan'.*

3.1.4 The proposed development is bounded to the north by operational areas of Gebdykes Quarry, to the east by Halfpenny House Lane (B6268), to the south and west by undeveloped agricultural land.

3.1.5 The site is approximately 10.7 hectares and is irregular in shape, consisting of exposed rock, loose mineral and large stockpiles. Access to the site is from the wider Gebdykes Quarry to the north.

3.1.6 The site topography is shown on Drawing No. LQ/GDQ/MAR21-02 *'Quarry Update and Stockpile Survey 30th March 2021'*. Northern and central areas of the site contain large mounds of stockpiled mineral and topsoil which are up to 10m in height. Exposed areas of quarry floor are minimal with only haul roads passing between the mounds.

North-western areas of the site consist of side slopes extending inwards from the site boundaries and areas of rough vegetation. Side slopes in this area are generally shallower than elsewhere on site, with typical gradients of between 1 in 4 and 1 in 12.

3.1.7 Southern areas of the site have larger areas of exposed quarry floor, which are relatively flat, split across two 'tiers'. Stockpiles in these areas are generally smaller and lower in height. Side slopes in this area are steeper, with gradients of approximately 1 in 2.

3.1.8 Ground levels around the site boundaries are generally between 136mAOD and 140mAOD. Adjacent areas of quarry floor in northern and western areas of the site are between 18m and 26m lower than land at the site boundary, with elevations of approximately 118mAOD. Ground levels in central areas of the site are approximately 12m lower than land at the site boundary, with elevations of approximately 132mAOD. Ground levels in southern areas are within 4m of the surrounding ground with elevations of approximately 140mAOD.

3.2 Existing Watercourses and Waterbodies

3.2.1 The closest Main River to the site is the River Ure, which is located approximately 1.2km to the west of the site. The river flows generally south-eastwards adjacent to the towns of Masham and Ripon to join the River Nidd to become the River Ouse, approximately 35km to the south-east of the site

3.2.2 The closest watercourse to the site is a short, unnamed watercourse which extends northwards from farm buildings located approximately 0.6km to the south-west of the site. This discharges to a series of ponds located approximately 0.4km to the south-west of the site. These are assumed to be isolated, man-made waterbodies with no downstream connections to any watercourses or drainage networks.

3.3 Flood Risk Setting

3.3.1 As shown on the EA Flood Map for Planning (Figure 1), the site is located wholly within Flood Zone 1 with an annual probability of flooding of less than 1 in 1,000 (i.e., a probability of less than 0.1%). The closest areas of Flood Zone. with an annual probability of flooding of greater than 1 in 100 (i.e., a probability of greater than 1 in 100), is located approximately 1.1km to the west of the site within an area of flat ground adjacent to the River Ure.

3.4 Existing Drainage

3.4.1 Due the remote and rural nature of the area, it is assumed that there are no public or private sewers within the site area or its vicinity.

3.4.2 The existing quarry presently drains via infiltration to the underlying limestone bedrock at the base of the void with no formal drainage systems.

3.5 Ground Conditions

3.5.1 The online British Geological Survey (BGS) *'Geology of Britain Viewer'*[1] shows that the site is underlain by limestone of the Cadeby Formation. This is classified as a Principal aquifer, defined by the Environment Agency 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'*. There are no superficial deposits within the site area.

3.5.2 The Cranfield Soil and Agrifood Institute *'Soilscapes'* map[2] classifies the soils within the site as *'freely draining lime-rich loamy soils'.*

[1] BRITISH GEOLOGICAL SURVEY *'Geology of Britain Viewer'* Available at: http://mapapps.bgs.ac.uk/geologyofbritain/home.html
[2] CRANFIELD SOIL AND AGRIFOOD INSTITUTE *'Soilscapes'* Available at: http://www.landis.org.uk/soilscapes/

4 DEVELOPMENT PROPOSALS

4.1 Description of the Proposed Development

4.1.1 The proposed development comprises the creation of a new inert waste landfill ('the Site') within the southern area of the existing void of Gebdykes Quarry. Approximately 200,000 tonnes per annum of inert waste would be required to fill this area of the quarry void. The void will be lined with impermeable materials prior to landfilling, creating a landfill 'cell'. It is also proposed to develop a weighbridge and single storey portable office building within the wider Gebdykes Quarry.

4.1.2 Once sufficient inert waste has been brought into the site to achieve the required restoration profile, a 0.5m layer of topsoil, currently stockpiled within the quarry site, will be spread across the landfill cap to return the site back to agricultural use.

4.1.3 The landfilling will be conducted over five phases, commencing in the north-western corner of the site and then working northwards. The landfill operations would be for a duration of 19 years, with a start date in 2023 and an end date in 2042. The restoration phase will extend for an additional two years beyond completion of the landfilling.

4.1.4 The proposed phases are shown in Figure 2 below and ES Figures 3.1 to 3.5. The proposed restoration phase is shown on ES Figure 3.6 *'Restoration'*.

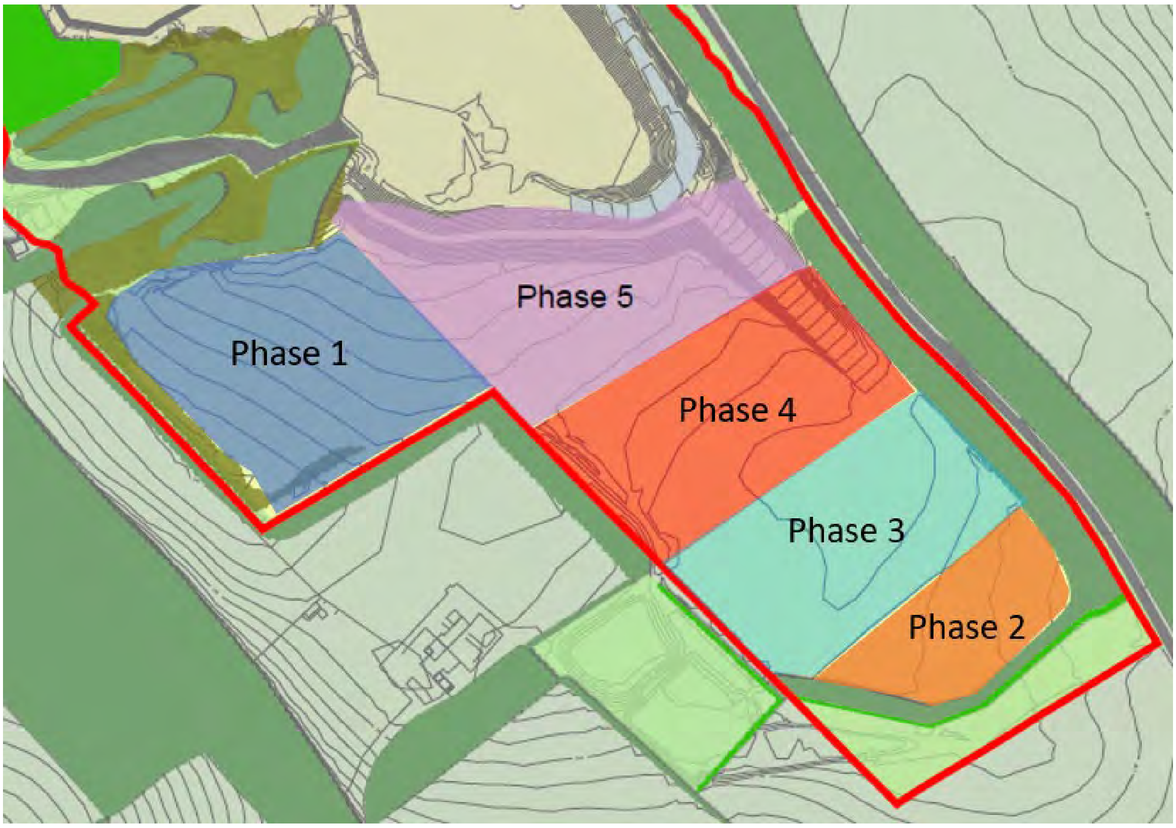

Figure 2. Landfill Phases

Phase 1

4.1.5 Landfilling will commence in a 3.49ha area in the north-western corner of the site as shown on ES Figure 3.1 *'Phase 1 Plan'*. Landfilling will raise ground levels to a maximum of approximately 145mAOD at the western site boundary, which matches the existing elevation of the adjacent land to the west. Following completion of the landfilling, ground levels will fall north-eastwards into the quarry area at a gradient of approximately 1 in 20, before falling steeply at a gradient of approximately 1 in 3 to the base of the void situated at 118mAOD. Stockpiles within other areas of the site will be removed and the base of the void will be generally flat.

Phase 2

4.1.6 The area of landfilling will cover an area of approximately 1.37 hectares in the southernmost extent of the site as shown in Figure 2 and on ES Figure 3.2 *'Phase 2 Plan'*. Landfilling will raise ground levels to a maximum of 143mAOD to match the existing ground levels adjacent to the void in the south and west of the site. The raised ground levels will fall generally south-eastwards at a maximum gradient of approximately 1 in 30 to a minimum of elevation of 140mAOD at the south-eastern corner of the site. Ground levels at the northern extent will fall steeply north-westwards to the base of the void at a gradient of 1 in 3, to a minimum elevation of 118mAOD.

4.1.7 Restoration works will commence in the Phase 1 area, with the landfill material being recontoured and covered with a layer of topsoil. Limestone grassland vegetation will then be introduced across the flatter areas of the restored ground. The side slopes extending into the void will be left as bare ground.

4.1.8 Ground outside of the existing quarry void will remain undeveloped. Additional tree planting along southern and eastern site boundaries in this area commenced in 2020.

Phase 3

4.1.9 The area of landfilling will be located to the north-west of Phase 2 and will cover an area of approximately 2.20 hectares as shown in Figure 2 and on ES Figure 3.3 *'Phase 3 Plan'.* The completed profile will be relatively flat, falling from a maximum elevation of 144mAOD at the centre of the restored area to a minimum of 143mAOD in the south-eastern corner to match ground levels within the Phase 2 area, with a maximum gradient of 1 in 30. Ground levels at the northern extent of the Phase 3 landfill area will fall steeply north-westwards at gradients of 1 in 3 to a minimum of 118mAOD at the base of the void.

4.1.10 Areas within Phase 2 will undergo restoration works, with topsoil and grassland reinstated.

Phase 4

4.1.11 The area of landfilling will be located to the north-west of Phase 3 and will cover an area of approximately 1.97 hectares, as shown in Figure 2 and on ES Figure 3.4 *'Phase 4 Plan'*. The completed profile will fall north-westwards from a maximum elevation of 144mAOD, initially at a gradient of approximately 1 in 30, before falling steeply at gradients of 1 in 3 to the base of the void at 118mAOD. There will also be a narrow 2m deep valley adjacent to the western site boundary with side slopes of approximately 1 in 3. This retains an existing topographical feature in this area.

4.1.12 The upper reaches of a permanent access road, which will link the base of the quarry void to the peak of the restored area, will be constructed adjacent to the eastern boundary. This road will be approximately 20m wide with a gradient of approximately 1 in 10.

4.1.13 Areas of Phase 3 will undergo restoration works, with topsoil and grassland reinstated.

Phase 5

4.1.14 This irregular-shaped parcel of land will extend between Phase 1 and 4, replacing the steep sideslopes in these areas. This will cover an area of approximately 2.64 hectares as shown in Figure 2 and on ES Figure 3.5 *'Phase 5 Plan'*. Following the completion of landfilling, ground levels will fall northwards and north-eastwards continuing the fall of the restored ground within Phases 1 and 4 at a maximum gradient of approximately 1 in 20. Ground levels at the edge of the restored area will fall steeply north-eastwards in two tiers towards the base of the quarry void at a gradient of 1 in 3.

4.1.15 The access road will extend along the eastern boundary of Phase 5, to a minimum elevation of 125mAOD to join an access road extending around the southern and eastern boundaries of the adjacent quarry void.

4.1.16 Areas of Phase 4 will undergo restoration works, with topsoil and grassland reinstated.

Restoration

4.1.17 Restoration works will be ongoing throughout the works, with completed areas within previous phases being overlain by restoration soils and reseeded. The completed post-restoration layout is shown on ES Figure 3.6 *'Restoration'*.

5 FLOOD RISK

5.1 Flood Risk to the Development

5.1.1 The main sources of flooding identified within the NPPF are rivers, tidal waters and the sea, surface water, groundwater, sewers and drains, and artificial sources such as canals and reservoirs.

5.1.2 The presence of a potential flooding source does not necessarily translate into a high risk of flooding. Table 3 below summarises the potential flood sources and the related flood risk posed to the site.

Table 3: Sources of Flood Risk

Flood Source	Presence at Site	Potential Risk at Site	Description
Rivers (*fluvial flooding*)	Y	Very Low	Located within Flood Zone 1 with no unmodelled watercourses in the vicinity
Tidal	N	n/a	-
Groundwater	Y	Very Low	Base of existing void is over 2m above water table
Surface Water Flooding (*pluvial flooding*)	Y	Very Low	Permeable bedrock and few areas of elevated risk within the site
Sewer	N	n/a	No sewers within the site area
Artificial	N	Very Low	No risk of reservoir flooding or impounded bodies of water in the vicinity

Historical Flooding Incidents

5.1.3 The *'Harrogate BC: Historical Flood Events'* map in the North Yorkshire Strategic Flood Risk Assessment (SFRA) shows that there have been no historical flooding incidents in the vicinity of the site.

5.1.4 The North Yorkshire Preliminary Flood Risk Assessment (PFRA) also does not refer to any historical flooding events in the vicinity of the site.

Fluvial Flooding

5.1.5 The Environment Agency *'Flood Map for Planning'* (see Figure 1) shows that the site is located wholly within Flood Zone 1, defined as an annual probability of fluvial flooding of less than 1 in 1,000 (i.e., less than 0.1%).

5.1.6 The closest area of Flood Zone 3 is located adjacent to the River Ure approximately 800m to the west of the site. This land is situated at approximately 70mAOD, approximately 62m lower than the lowest ground levels within the site area.

5.1.7 There are no unmodeled Ordinary Watercourses in the vicinity of the site which could present an additional risk of fluvial flooding. Based on the available information, there risk of fluvial flooding is considered to be **VERY LOW.**

Tidal Flooding

5.1.8 The risk of tidal flooding is discounted due to the distance from tidally-influenced watercourses and the sea.

Groundwater Flooding

5.1.9 Flooding can occur when prolonged rainfall causes the groundwater table to rise above ground level. Groundwater flooding most often occurs at the same time as flooding from other sources such as overland flow.

5.1.10 It is stated in the North West Yorkshire SFRA that *'the Environment Agency indicated that they do not consider flooding from groundwater to be a significant issue in the SFRA area'*.

5.1.11 Historic groundwater monitoring at Gebdykes Quarry recorded groundwater elevations of between approximately 114mAOD and 105mAOD within the site area. These levels are a minimum of 4m below the existing ground levels within the site. Groundwater levels are shown on Drawing No. NT14621-Figure 2 *'Groundwater Contour Plot August 2020'* and NT14621-Figure 3 *'Groundwater Contour Plot January 2021'.*

5.1.12 Furthermore, the void will be lined with a clay liner prior to infilling works. This will limit any pathways for groundwater emergence within the landfilling area.

5.1.13 Based on the available information, the risk of groundwater flooding at the proposed development is considered to be **VERY LOW**. This risk will reduce further as ground levels are increased during infilling works.

Surface Water Flooding (Pluvial Flooding)

5.1.14 Surface water flooding often occurs during intense rainfall when water is unable to soak into the ground or enter drainage systems and runs quickly overland resulting in local flooding.

5.1.15 The Environment Agency's 'Extent of Flooding from Surface Water' map, shown in Figure 3, shows that the majority of the site is at a 'Very Low' risk of surface water flooding (defined as a less than 1 in 1000 (0.1%) chance of flooding in any year).

5.1.16 Small areas in the north-western corner of the site are shown to be at a 'High' risk of surface water flooding (defined as a greater than 1 in 30 (3.3%) annual probability of flooding). A comparison of Figure 3 to the site topography shows that these areas are coincident with localised depressions where runoff generated within the site area could accumulate, and are not indicative of a risk of flooding to the wider site area.

5.1.17 Figure 3 also shows that there are no significant areas with an elevated risk of surface water flooding in the vicinity of the site, with only small areas of elevated risk to the north and west of the site.

Figure 3. Environment Agency Surface Water Flood Risk Mapping

5.1.18 The EA 'Surface Water Flood Risk: Water Velocity in a Low Risk Scenario' map, included as Figure 3 below, shows the direction and velocity of surface water runoff during a 1 in 1000 year storm event. As shown on Figure 4, there are few pathways for any surface water flooding generated in off-site areas to enter the site area. Surface water runoff from small area of land adjacent to the western site boundary may potentially flow towards the site, however, it is expected that this would disperse within the area of woodland at the site boundary. Furthermore, based on the size of this area in comparison to the 10.7 hectare site, it is considered that the volume of runoff generated would have minimal impact upon the site.

Figure 4. Environment Agency Surface Water Flood Velocity Mapping

5.1.19 Based on the available information, the risk of surface water flooding at the proposed development is considered to be **VERY LOW.**

Sewer Flooding

5.1.20 There are no public or private sewers within the site area and due to the remote rural location of the site, it is assumed that there are no public or private sewer networks in the vicinity of the site. The risk of sewer flooding is, therefore, discounted.

Artificial Sources

5.1.21 Artificial sources of flooding include reservoirs, canals and any other impounded water body which is elevated above the level of the site. Flooding can occur when the impounding structures such as dams and embankments fail, when culverts become blocked, or during extreme rainfall events when the waterbodies overflow.

5.1.22 The Environment Agency 'Flood Risk from Reservoirs' map shows that the site is not at risk of flooding from reservoirs and there are no canals or impounded water bodies within the vicinity of the site.

5.1.23 Based on the available information, the risk of flooding from artificial sources is, therefore, considered to be **VERY LOW.**

5.2 Flood Risk from the Proposed Development

5.2.1 New development can pose a risk of flooding to neighbouring properties and areas downstream of the site, often as a result of an increase in impermeable area which has the effect of increasing the rate and volume of surface water runoff. In addition, climate change can be expected to cause an increase in rainfall intensity and surface water runoff over the lifetime of the development.

5.2.2 Flood risk can also be increased as a result of new development if the development reduces the floodplain storage area or alters flood flow paths, ultimately displacing flood water and resulting in an increased risk to the surrounding area.

Fluvial Flooding

5.2.3 As the site is located wholly within Flood Zone 1, there will be no impact on floodplain storage or fluvial flood flows as a result of the proposed development.

Surface Water Runoff

5.2.4 The limestone bedrock and topsoil in the vicinity of the site is relatively freely draining. Undeveloped agricultural land outside of the quarry void will drain via a combination of evaporation, uptake by vegetation and by infiltration, with surface water percolating through the 'freely draining lime-rich loamy soils' to the underlying bedrock.

5.2.5 Exposed bedrock away from trafficked areas of the quarry void will also be relatively freely draining with a portion of surface water runoff dispersing via infiltration to the bedrock. Areas of the quarry floor which are crossed by plant and other site vehicles will, however, be well-compacted and infiltration will be relatively minimal.

5.2.6 Following completion of the landfilling works, infilled areas will be covered by freely-draining topsoil and vegetated. The combination of infiltration to topsoil and uptake by the vegetation will reduce the rate and volume of surface water runoff in restored areas compared to the present situation in operational, trafficked areas of the site and areas of ongoing landfilling.

5.2.7 The infiltration rate within restored areas of the site will be dependent upon the final composition of the infill material and, therefore, cannot be confirmed at this stage. It is also, therefore, not possible to confirm whether drainage within the restored areas will provide betterment to the pre-development scenario where rainfall infiltrates to agricultural land and the underlying bedrock.

5.2.8 It is, therefore, proposed to take a precautionary approach and assume that the rate and volume of surface water runoff will increase following the completion of restoration works when compared to the pre-development scenario.

Climate Change

5.2.9 Climate change can also be expected to cause an increase in rainfall intensity during the lifetime of the proposed development and, therefore, surface water runoff rates and volumes will increase and will require mitigation.

5.2.10 In assessing the potential flood risk at the site over the lifetime of the development climate change must, therefore, be taken into account. Climate change allowances have been based on the guidance set out in the NPPF Technical Guidance[3], which has been reproduced in Table 4 (below).

Table 4. Peak Rainfall Intensity Allowance

	Increase in Rainfall Intensity		
	2015 to 2039	**2040 to 2069**	**2070 to 2115**
Upper End	10%	20%	40%
Central	5%	10%	20%

5.2.11 For a 'Less Vulnerable' development located within Flood Zone 1, the guidance states that the central allowance is appropriate. It is proposed that the operational period extends to 2042 and based on Table 4, the rainfall intensity can be expected to increase by 10%. The restored site will be a permanent feature and based on Table 4, the rainfall intensity can be expected to increase by 20%.

5.3 Flood Risk Mitigation Measures

Surface Water Management

5.3.1 The risk of surface water flooding to areas downstream of the site may increase as a result of development during extreme storm events due to increased rates and volumes of surface water runoff. To mitigate this increased risk it is proposed that formal surface water management is incorporated into the design of the site to attenuate for all storm events up to and including the 1 in 1000 year event, including an allowance for climate change.

[3] ENVIRONMENT AGENCY (2016) *Guidance Flood Risk Assessments: Climate Change Allowances*

5.4 Residual Risk

5.4.1 There is always a possibility of a storm event that exceeds the design standards of the proposed flood risk management measures for new developments. Potential risks include the exceedance of the surface water attenuation facilities during extreme storm events.

5.4.2 The proposed development will be designed to manage any potential exceedance events, with overland flood flows directed away from the site boundaries into the wider quarry site where feasible.

5.4.3 In southern areas of the site, where the topography of the restored ground will prevent exceedance flows from being directed towards the main quarry site, exceedance flows can be expected to disperse within adjacent woodland and undeveloped agricultural land to the south of the site (shown on Drawing No. LQ/GDQ/MAR21-02 *'Quarry Update and Stockpile Survey 30th March 2021'*), which is controlled by the applicant, without risk to off-site properties.

6 SURFACE WATER DRAINAGE STRATEGY

6.1 Overview

6.1.1 Surface water runoff from the development will be controlled on site to ensure that there is no increase in the risk of flooding to areas downstream of the site and within the development itself for the design storm event.

6.1.2 The Planning Practice Guidance (PPG) stipulates a hierarchy for the disposal of surface water which should be followed as part of any surface water drainage design. This hierarchy is as follows:

1. into the ground (infiltration);
2. to a surface water body;
3. to a surface water sewer, highway drain or another drainage system;
4. to a combined sewer.

6.1.3 In accordance with this hierarchy, it is proposed to disperse surface water runoff from the proposed development via infiltration to the underlying bedrock with no discharge off site.

6.1.4 Whilst the infill material will be inert and should have no contaminants present, it is proposed that a precautionary approach is taken. Surface water runoff from the operational areas of the site will be prevented from infiltrating directly into the underlying bedrock without confirmation that there is no contamination.

6.1.5 It is proposed, therefore, that surface water runoff that has come into contact with inert materials, is intercepted and diverted to a large lagoon to the north of the void area. The lagoon will be lined by a 1m thick layer of engineered clay, with no pathway for infiltration. Generally, surface water runoff from the following areas will be diverted to the lagoon:

- Direct runoff from operational landfill phases;
- Direct runoff from unrestored materials in completed phases;
- Overland flow from restored areas entering operational landfill areas;
- Runoff retained above ground percolating through inert underlying materials to emerge within the void.

6.1.6 Water within the lagoon will be tested for contamination. Any contaminated water will be isolated and mitigative measures to treat or remove the water will be undertaken. Uncontaminated water will be pumped as required to areas of quarry void outside of the development area (within the wider quarry site) where it will infiltrate to ground.

6.1.7 Surface water runoff from the base and side slopes of all other areas of the development, which has not been in contact with inert landfill material, will be retained within the base of the void and allowed to disperse naturally via infiltration and evaporation. Water may also be discharged to the void or pumped to the wider quarry where required.

6.1.8 The proposed base level of the site, and wider quarry, is approximately 20m below the surrounding land. There are, therefore, no pathways for surface water runoff to flow out of the void and no risk of flooding to areas downstream of the site.

6.2 Attenuation Estimates

6.2.1 The volume of surface water runoff generated during extreme storm events in each phase of the works has been calculated using Causeway's 'Flow' software. As runoff which has been in contact with inert materials will be intercepted and not able to combine with runoff from the base and sideslopes within the wider development, the attenuation volumes have been calculated separately.

6.2.2 For the purposes of this assessment, areas of operational landfill and completed areas awaiting restoration will be considered to be wholly impermeable ground to provide a 'worst case' scenario.

6.2.3 It is considered that the exposed bedrock in the base of the void outside of active landfill areas will be relatively permeable where it is uncompacted by crossing plant, as per the existing situation within the wider quarry. This permeability will remain until the ground is covered by the engineered liner prior to landfilling. To provide a worst case scenario, however, calculations are based on the exposed bedrock in the base and side slopes of the void being wholly impermeable, with no infiltration to ground. This would simulate a scenario where the base of the operational area is fully compacted.

6.2.4 The gently sloping, restored areas overlying the landfill have a runoff coefficient applied to them as these will not act as a wholly impermeable surface, with the vegetation and underlying soils intercepting and dispersing a proportion of overland flows and so reducing the rate and volume of runoff during a storm event. These coefficients have been determined using the National Coal Board guidance[4] for the

[4] NATIONAL COAL BOARD (1982) *Technical Management of Water in the Coal Mining Industry*

design of spoil tip drainage schemes, which is considered appropriate to apply to runoff from restored quarries.

6.2.5 The nomogram, taken from the guidance and shown in Figure 5 below, assumes a gradient of 1 in 20 across restored areas. The 'sandy loam' soil type is considered the most appropriate based on the description of the local soils on the Cranfield Soil and Agrifood Institute *'Soilscapes'* mapping. The coefficient of 0.41 is then applied to the total area to estimate the 'contributing area'. To provide a 'worst case' scenario, all side slopes will be treated as unvegetated impermeable ground.

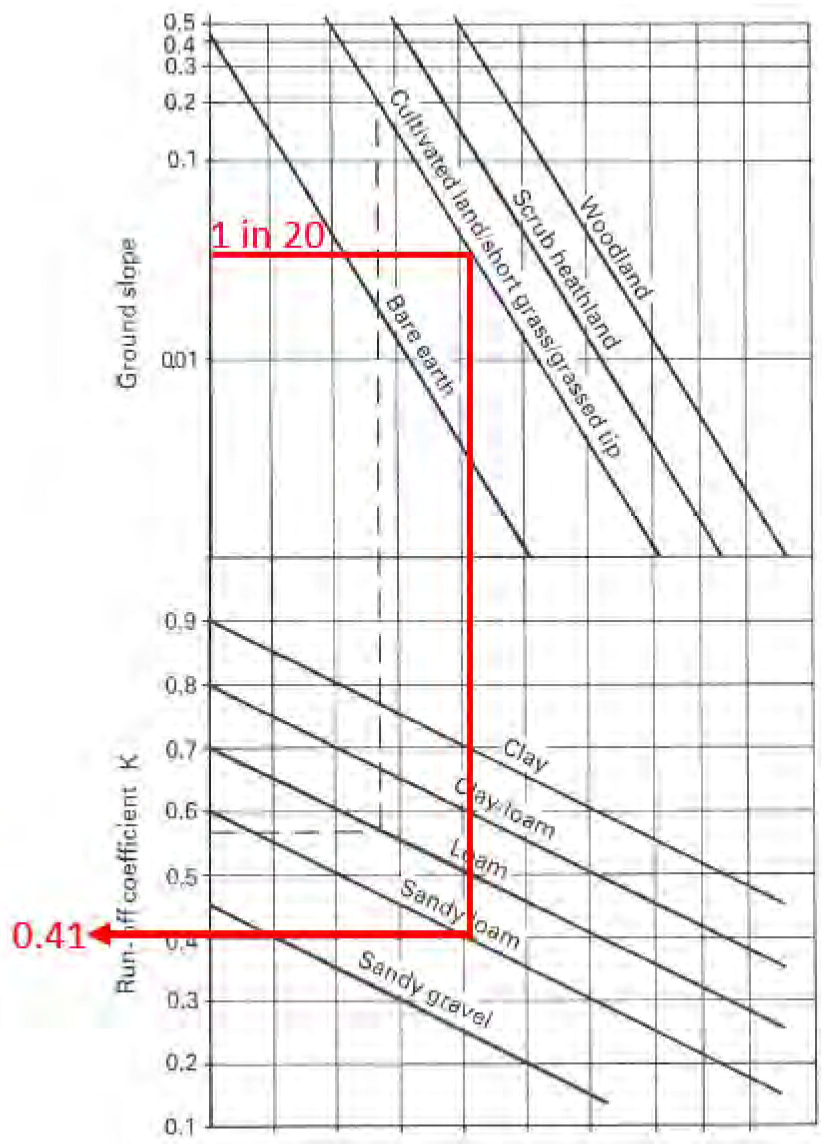

Figure 5. Runoff Coefficient from Restored Areas (reproduced from UK Coal 'Nomogram to Determine the Runoff Coefficient')

6.2.6 A proportion of surface water runoff retained within restored areas can be expected to infiltrate into the topsoil and underlying ground. As this water percolating through the underlying material will not be able to progress beyond the clay liner at the base of the void and so will remain within the void, an infiltration rate has not been applied to the attenuation estimates for restored areas.

Phase 1

6.2.7 The proposed surface water management plan for Phase 1 is shown on Drawing No. NT14834-008 *'Phase 1 Surface Water Management Plan'*. All ground levels within the operational Phase 1 area will fall north-eastwards towards the wider quarry site. Surface water runoff will be intercepted by a drainage channel and diverted into the lagoon located outside of the development.

6.2.8 Surface water runoff from the base and sideslopes outside of the Phase 1 area will be retained in low-lying unlined areas of the void to disperse naturally, or discharged to the lagoon or wider quarry area if necessary.

6.2.9 The unlined basal areas are situated approximately 1m below the ground levels of the wider quarry located immediately adjacent to the north. Due to the size of the base of the void, there is minimal risk that surface water runoff could be generated in such volumes that the boundary of the site would be overtopped.

6.2.10 The volumes of surface water runoff generated within the site area during Phase 1 are included in Appendix 1 and summarised in Table 5 below. The proposed surface water management plan is shown on Drawing No. NT14834-008 *'Surface Water Management Plan (Phase 1)'*.

Table 5. Surface Water Attenuation Calculations: Phase 1

	Area (ha)	**Surface Water Attenuation m^3**	
		1 in 30 (+5%)	**1 in 100 (+5%)**
Quarry Base and Side slopes (non-operational)	7.49	5305	6609
Phase 1 (Landfilling)	3.24	2295	2859
Total	**10.73**	**7600**	**9468**

- Areas of landfilling which have yet to undergo restoration are treated as impermeable
- 5% climate change allowance used for 1 in 100 and 1 in 1000 year storm event (appropriate for developments present until 2039)
- Runoff from **red** areas will be discharged to the lined lagoon. Runoff from **green** areas will disperse naturally.

Phase 2

6.2.11 The proposed surface water management plan for Phase 2 is shown on Drawing No. NT14834-009 *'Phase 2 Surface Water Management Plan'*. Runoff from the restored Phase 1 area will continue to be intercepted and diverted into the lined lagoon area. Runoff from the steep side slopes at the edge of the Phase 2 landfilling area will also be intercepted and diverted to the lagoon via a new drainage channel/trench.

6.2.12 The completed landfill profile in Phase 2 will fall southwards towards the site boundaries creating a potential pathway for surface water to flow off site. It is proposed that this runoff is intercepted upstream of the site boundary by vegetated swales or drainage ditches and conveyed towards a dry detention basin in the south-eastern corner of Phase 2. Surface water runoff will be retained and allowed to disperse naturally by evaporation, uptake by vegetation and infiltration. The detention basin will be sized to attenuate for the 1 in 100 year (+5% climate change) storm event. An overflow route will be included to convey water towards the main void if the capacity of the detention basin becomes exceeded in an extreme scenario. There would, therefore, be no pathway for runoff retained within the detention basin to flow off site.

6.2.13 Runoff from the base and sideslopes of the void away from operational areas will be retained within the base of the quarry void and allowed to disperse naturally with no pathway into the wider quarry area.

6.2.14 Attenuation calculations are provided within Appendix 1 and summarised in Table 6 below.

Table 6. Surface Water Attenuation Calculations: Phase 2

	Area (ha)	**Surface Water Attenuation m^3**	
		1 in 30 (5%)	**1 in 100 (+5%)**
Quarry Base and Side Slopes (Non-Operational)	4.69	3322	4139
Phase 1 Restored Area	2.45 ***1.00***	708	882
Phase 1 Unrestored Area	0.79	560	697
Phase 2 Operational (South Draining)	1.60	1133	1412
Phase 2 Operational (North Draining)	1.20	850	1059

Table 6. Surface Water Attenuation Calculations: Phase 2			
	Area (ha)	Surface Water Attenuation m^3	
		1 in 30 (5%)	1 in 100 (+5%)
Total	***9.73***	**6573**	**8089**

- ***Italicised*** values indicate contributing areas where runoff coefficients from Figure 3 have been applied to restored areas
- Areas of landfilling which have yet to undergo restoration are treated as impermeable
- 5% climate change allowance used for 1 in 100 and 1 in 1000 year storm event (appropriate for developments present until 2039)
- No infiltration rate is applied to calculations for restored areas
- Runoff from **red** areas will be discharged to the lined lagoon. Runoff from **green** areas will disperse naturally

Phase 3

6.2.15 The restored areas of Phase 1 and the majority of the Phase 3 landfill profile will fall towards the void. Runoff from these areas will be intercepted and discharged to the lined lagoon. An existing land drain in the Phase 3 area, situated adjacent to the western site boundary, will be retained to assist with the conveyance of runoff northwards into the void.

6.2.16 The restored Phase 2 area and an the remainder of the Phase 3 landfill profile will fall south-eastwards. The vegetated swales or drainage ditches installed during Phase 2 will be extended to intercept the additional runoff from Phase 3 to convey this to the dry detention basin located within the Phase 2 area.

6.2.17 Attenuation calculations are provided within Appendix 1 and summarised in Table 7 below. The proposed surface water management plan is shown on Drawing No. NT14834-010 *'Surface Water Management Plan (Phase 3)'*.

Table 7. Surface Water Attenuation Calculations: Phase 3			
	Area (ha)	Surface Water Attenuation (m^3)	
		1 in 30 (5%)	1 in 100 (+5%)
Quarry Base and Side Slopes (Non-Operational)	2.40	1700	2118
Phase 1 Restored	2.45 ***1.00***	708	882
Phase 1 Unrestored	0.79	560	697

Table 7. Surface Water Attenuation Calculations: Phase 3

	Area (ha)	Surface Water Attenuation (m³)	
		1 in 30 (5%)	1 in 100 (+5%)
Phase 2 Restored (South Draining)	1.61 ***0.66***	467	582
Phase 3 Landfilling (North Draining)	2.13	1509	1879
Phase 3 Landfilling (South Draining)	1.35	956	1191
Total	***8.33***	**5900**	**7349**

- ***Italicised*** values indicate contributing areas where runoff coefficients from Figure 3 have been applied.
- Areas of landfilling which have yet to undergo restoration are treated as impermeable .
- 5% climate change allowance used for 1 in 100 and 1 in 1000 year storm event (appropriate for developments present until 2039).
- No infiltration rate is applied to calculations for restored areas.
- Runoff from **red** areas will be discharged to the lined lagoon. Runoff from **green** areas will disperse naturally.

Phase 4

6.2.18 Surface water runoff from the restored Phase 1 area, the northern portion of Phase 3 and the operational Phase 4 landfilling area will drain towards the base of the void and will be intercepted and diverted to the lined lagoon.

6.2.19 The restored Phase 2 and southern portion of restored Phase 3 will continue to drain southwards towards the existing dry detention basin. The swales will be extended to allow a greater portion of Phase 3 to drain to the detention basin. The capacity of the basin, retained from Phase 3 will be sufficient to attenuate for two consecutive 1 in 100 year storm events.

6.2.20 Runoff from non-operational areas will be retained within the void and allowed to disperse naturally.

6.2.21 Attenuation calculations are contained in Appendix 1 and summarised in Table 8 below. The proposed surface water management plan is shown on Drawing No. NT14834-011 *'Surface Water Management Plan (Phase 4)'*.

Table 8. Surface Water Attenuation Calculations: Phase 4

	Area (ha)	Surface Water Attenuation (m³)	
		1 in 30 (5%)	1 in 100 (+5%)
Quarry Base and Side Slopes (Non-Operational)	0.70	467	618
Phase 1 Restored	2.43 ***1.00***	708	882
Phase 1 Unrestored	0.81	574	715
Phase 2 Restored (South Draining)	1.61 ***0.66***	467	582
Phase 3 Restored (South Draining)	2.17 ***0.89***	630	785
Phase 4 Landfilling	3.01	2132	2656
Total	***7.07***	**4978**	**6238**

- ***Italicised*** values indicate contributing areas where runoff coefficients from Figure 3 have been applied
- Areas of landfilling which have yet to undergo restoration are treated as impermeable
- 5% climate change allowance used for 1 in 100 and 1 in 1000 year storm event (appropriate for developments present until 2039)
- No infiltration rate is applied to calculations for restored areas
- Runoff from **red** areas will be discharged to the lined lagoon. Runoff from **green** areas will disperse naturally.

Phase 5

6.2.22 Surface water runoff from Phase 2 and the southern portion of Phase 3 will continue to drain southwards towards the detention basin in the south-eastern corner of the site. Surface water runoff from all other areas of the site will drain northwards and be directed towards the lined lagoon.

6.2.23 Attenuation calculations are contained in Appendix 1 and summarised in Table 9 below. As this phase will extend beyond 2039, a climate change factor of 10% has been applied to calculations, as shown in Table 4.

6.2.24 The proposed surface water management plan is shown on Drawing No. NT14834-012 *'Surface Water Management Plan (Phase 5)'*.

Table 9. Surface Water Attenuation Calculations: Phase 5

	Area (ha)	Surface Water Attenuation (m^3)	
		1 in 30 (10%)	1 in 100 (+10%)
Phase 1 Restored	2.43 ***0.99***	735	915
Phase 2 Restored (South Draining)	1.61 ***0.66***	490	610
Phase 3 Restored (South Draining)	2.17 ***0.89***	660	823
Phase 4 Restored	1.93 ***0.79***	586	730
Phase 5 Landfilling	2.59	1922	2394
Total	***5.92***	**4393**	**5472**

- ***Italicised*** values indicate contributing areas where runoff coefficients from Figure 3 have been applied
- Areas of landfilling which have yet to undergo restoration are treated as impermeable
- 10% climate change allowance used for 1 in 100 and 1 in 1000 year storm event (appropriate for developments present beyond 2039)
- No infiltration rate is applied to calculations for restored areas
- Runoff from **red** areas will be discharged to the lined lagoon.

Post-Restoration

6.2.25 The site will continue to drain as per Phase 5, with Phases 2 and 3 draining southwards to the detention basin in the south-east corner of the site, and all other areas draining northwards to attenuated within the permanent lined lagoon. The lined lagoon in Phase 5 will be reshaped as part of the permanent restoration scheme. As the restored site will be a permanent feature, a climate change allowance of 20% has been applied to attenuation calculations (see Table 4). Calculations are contained in Appendix 1 and summarised in Table 10 below.

6.2.26 The proposed surface water management plan is shown on Drawing No. NT14834-013 *'Surface Water Management Plan (Post-Restoration)'*.

Table 9. Surface Water Attenuation Calculations: Post-Restoration			
	Area (ha)	Surface Water Attenuation (m³)	
		1 in 30 (10%)	1 in 100 (+10%)
Phase 1 Restored	2.43 ***0.99***	801	998
Phase 2 Restored (South Draining)	1.61 ***0.66***	534	666
Phase 3 Restored (South Draining)	2.17 ***0.89***	720	898
Phase 4 Restored	1.93 ***0.79***	639	797
Phase 5 Landfilling	2.59 ***1.06***	858	1069
Total	***4.39***	**3552**	**4428**

- ***Italicised*** values indicate contributing areas where runoff coefficients from Figure 3 have been applied
- 20% climate change allowance used for 1 in 100 and 1 in 1000 year storm event (appropriate for developments present beyond 2039)
- No infiltration rate is applied to calculations for restored areas
- Runoff from **red** areas will be discharged to the permanent lined lagoon in the north. All other areas will discharge to the detention basin in the south-east

6.3 Water Quality

6.3.1 As there are no pathways for surface water runoff to flow off-site, there is no risk of mobilised silt and suspended solids impacting on areas downstream of the site during the operational phases.

6.3.2 Surface water runoff from operational landfill areas will be intercepted and retained within a lined lagoon, and only able to disperse within the wider quarry once it is confirmed that there are no contaminants present.

6.3.3 Surface water runoff from other areas of the development will be dispersed by infiltration to the ground. The maximum groundwater level is estimated to be approximately 114mAOD (as shown on Drawing No. NT14621-Figure 3 *'Groundwater Contour Plot January* 2021'), which is approximately 4m below the ground level in this area of the quarry. It is considered that this provides a sufficient thickness of unsaturated bedrock for surface water runoff from the site to percolate through and the potential for the contamination of groundwater is minimal.

6.3.4 All plant will be refuelled within designated areas in the existing mineral processing area outside of the development and not within the site area. The risk of fuel and other chemical spillages within the development areas are, therefore, low, and there will be procedures in place to treat any accidental spillages within the workings. Furthermore, as all operations will take place above the water table, there will be no direct pathway for any spillages to enter into the groundwater.

6.3.5 The mobilisation of silt and suspended solids from landfilling areas and restored areas can be reduced with the use of shallow cut-off trenches installed coincident with the topography. These trenches will prevent surface water runoff from flowing unimpeded over long distances, gathering momentum and increasing the rate of erosion. The trenches will also ensure any mobilised sediment is retained close to it source, preventing large accumulations of sediment in downstream areas. Additional sediment management measures such as strawbales, rock trap, silt fencing can also be used in conjunction with the cut-off trenches.

6.3.6 There will be no plant operating in restored areas of the site and the risk of spillages and mobilisation of silt and sediment will be minimal.

6.3.7 The vegetation within restored areas will filter overland flows, removing a portion of mobilised silt and suspended solids.

7 CONCLUSIONS

7.1.1 This report gives details of the Flood Risk Assessment, which has been carried out in accordance with the National Planning Policy Framework. The proposed development comprises the infilling of areas of Gebdykes Quarry in Masham, North Yorkshire with inert materials, and subsequent restoration works.

7.1.2 The proposed development is located within Flood Zone 1 according to the Environment Agency's Flood Map for Planning. As the proposed development is defined as a 'Less Vulnerable' development in Table 2 of the National Planning Policy Guidance, this is considered an appropriate development within Flood Zone 1.

7.1.3 The risk of flooding from fluvial sources, surface water groundwater and sewers is considered to be Very Low.

7.1.4 Surface water drainage outside of the operational areas of the site will mimic the existing proposed during operational phases will mimic the current regime, with runoff infiltrating into the bedrock at source, or flowing overland to a low point within the quarry void to disperse naturally with no flood risk to off-site areas.

7.1.5 Due to the potential for contaminants within the inert landfill material, a precautionary approach will be taken to manage surface water runoff within operational landfill areas and from restored areas of the development.

7.1.6 Surface water runoff draining to the base of the void from these areas will be intercepted and directed to a lagoon, which will be lined giving no pathway for infiltration. Water within the lagoon will then be tested, confirming it is free of contaminants, before being pumped to the quarry void to disperse naturally.

7.1.7 In areas where topography falls away from the wider site, it is proposed that surface water runoff is intercepted and retained within an unlined detention to infiltrate within the inert materials with no risk to properties downstream of the site.

7.1.8 The risk of flooding to the site is generally considered to be Very Low, the risk of flooding to surrounding areas will not increase and there will be no impact on water quality as a result of the proposed development. It is considered, therefore, that from a flood risk and drainage perspective, the site is suitable for the type of development proposed.

APPENDICES

APPENDIX 1

Attenuation Calculations

Calculation Sheet

REF:

CLIENT:	PROJECT:	JOB NO.:	CALC. REF. NO.:
Lightwater Quarries Limited	Gebdykes Landfill	NT18434	PAGE: 1 OF 16
CALCULATION	CALC. BY:	CHECKED BY:	APPROVED BY:
Attenuation Calculations - Phase 1	(NAME AND SIGNATURE) B Griffiths	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)
	DATE: 03/09/2021	DATE:	DATE:

Rainfall Methodology	FSR
FSR Region	England & Wales
M5-60 (mm)	20.000
Ratio-R	0.300
Summer CV	☑ 0.750
Winter CV	☑ 0.840

Areas of quarry base, sideslopes and landfilling are considered to be wholly impermeable as a 'worst case'

Quarry Base and Sideslopes (non operational)

Storage Estimate		Storage Estimate	
Return Period (years)	30	Return Period (years)	100
Climate Change (%)	5	Climate Change (%)	5
Impermeable Area (ha)	7.490	Impermeable Area (ha)	7.490
Peak Discharge (l/s)	0.000	Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)		Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc	Required Storage (m³)	Calc
from	5305	from	6609
to	5305	to	6609

Phase 1 (Landfilling)

Storage Estimate		Storage Estimate	
Return Period (years)	30	Return Period (years)	100
Climate Change (%)	5	Climate Change (%)	5
Impermeable Area (ha)	3.240	Impermeable Area (ha)	3.240
Peak Discharge (l/s)	0.000	Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)		Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc	Required Storage (m³)	Calc
from	2295	from	2859
to	2295	to	2859

Calculation Sheet

REF:

CLIENT:	PROJECT:	JOB NO.:	CALC. REF. NO.:
Lightwater Quarries Limited	Gebdykes Landfill	NT18434	PAGE: 2 OF 16
CALCULATION	CALC. BY:	CHECKED BY:	APPROVED BY:
Attenuation Calculations - Phase 2	(NAME AND SIGNATURE) B Griffiths	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)
	DATE: 03/09/2021	DATE:	DATE:

Rainfall Methodology	FSR
FSR Region	England & Wales
M5-60 (mm)	20.000
Ratio-R	0.300
Summer CV ☑	0.750
Winter CV ☑	0.840

Areas of quarry base, sideslopes and landfilling are considered to be wholly impermeable as a 'worst case'

Quarry Base and Sideslopes (non operational)

Storage Estimate

Return Period (years)	30	100
Climate Change (%)	5	5
Impermeable Area (ha)	4.690	4.690
Peak Discharge (l/s)	0.000	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)		
Required Storage (m³)	Calc	Calc
from	3322	4138
to	3322	4138

Phase 1 Restored Area

Storage Estimate

Return Period (years)	30	100
Climate Change (%)	5	5
Impermeable Area (ha)	1.000	1.000
Peak Discharge (l/s)	0.000	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)		
Required Storage (m³)	Calc	Calc
from	708	882
to	708	882

Calculation Sheet

REF:

CLIENT:	PROJECT:	JOB NO.:	CALC. REF. NO.:
Lightwater Quarries Limited	Gebdykes Landfill	NT18434	PAGE: 3 OF 16
CALCULATION	CALC. BY:	CHECKED BY:	APPROVED BY:
Attenuation Calculations - Phase 2, Part 2	(NAME AND SIGNATURE) B Griffiths	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)
	DATE: 03/09/2021	DATE:	DATE:

Rainfall Methodology	FSR
FSR Region	England & Wales
M5-60 (mm)	20.000
Ratio-R	0.300
Summer CV	0.750
Winter CV	0.840

Areas of quarry base, sideslopes and landfilling are considered to be wholly impermeable as a 'worst case'

Phase 1 Unrestored Area

Storage Estimate

Return Period (years)	30	100
Climate Change (%)	5	5
Impermeable Area (ha)	0.790	0.790
Peak Discharge (l/s)	0.000	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)		
Required Storage (m³) from	560	697
to	560	697

Phase 2 Operational (South Draining)

Storage Estimate

Return Period (years)	30	100
Climate Change (%)	5	5
Impermeable Area (ha)	1.600	1.600
Peak Discharge (l/s)	0.000	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)		
Required Storage (m³) from	1133	1412
to	1133	1412

Calculation Sheet

REF:

CLIENT:	PROJECT:	JOB NO.:	CALC. REF. NO.:			
Lightwater Quarries Limited	Gebdykes Landfill	NT18434	PAGE:	4	OF	16
CALCULATION	CALC. BY:	CHECKED BY:	APPROVED BY:			
Attenuation Calculations - Phase 2 Part 3	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)			
	B Griffiths					
	DATE: 03/09/2021	DATE:	DATE:			

Rainfall Methodology	FSR
FSR Region	England & Wales
M5-60 (mm)	20.000
Ratio-R	0.300
Summer CV	☑ 0.750
Winter CV	☑ 0.840

Areas of quarry base, sideslopes and landfilling are considered to be wholly impermeable as a 'worst case'

Phase 2 Operational (North Draining)

Storage Estimate		Storage Estimate	
Return Period (years)	30	Return Period (years)	100
Climate Change (%)	5	Climate Change (%)	5
Impermeable Area (ha)	1.200	Impermeable Area (ha)	1.200
Peak Discharge (l/s)	0.000	Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)		Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc	Required Storage (m³)	Calc
from	850	from	1059
to	850	to	1059

Calculation Sheet

REF:

CLIENT:	PROJECT:	JOB NO.:	CALC. REF. NO.:
Lightwater Quarries Limited	Gebdykes Landfill	NT18434	PAGE: 5 OF 16
CALCULATION	CALC. BY:	CHECKED BY:	APPROVED BY:
Attenuation Calculations - Phase 3 Part 1	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)
	B Griffiths		
	DATE: 03/09/2021	DATE:	DATE:

Rainfall Methodology	FSR
FSR Region	England & Wales
M5-60 (mm)	20.000
Ratio-R	0.300
Summer CV	0.750
Winter CV	0.840

Areas of quarry base, sideslopes and landfilling are considered to be wholly impermeable as a 'worst case'

Quarry Base and Sideslopes (non operational)

Storage Estimate

Return Period (years)	30
Climate Change (%)	5
Impermeable Area (ha)	2.400
Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc
from	1700
to	1700

Storage Estimate

Return Period (years)	100
Climate Change (%)	5
Impermeable Area (ha)	2.400
Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc
from	2118
to	2118

Phase 1 Restored Area

Storage Estimate

Return Period (years)	30
Climate Change (%)	5
Impermeable Area (ha)	1.000
Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc
from	708
to	708

Storage Estimate

Return Period (years)	100
Climate Change (%)	5
Impermeable Area (ha)	1.000
Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc
from	882
to	882

Calculation Sheet

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REF:

CLIENT:	PROJECT:	JOB NO.:	CALC. REF. NO.:
Lightwater Quarries Limited	Gebdykes Landfill	NT18434	PAGE: 6 OF 16
CALCULATION	CALC. BY:	CHECKED BY:	APPROVED BY:
Attenuation Calculations - Phase 3 Part 2	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)
	B Griffiths		
	DATE: 03/09/2021	DATE:	DATE:

Rainfall Methodology		FSR
FSR Region		England & Wales
M5-60 (mm)		20.000
Ratio-R		0.300
Summer CV	☑	0.750
Winter CV	☑	0.840

Areas of quarry base, sideslopes and landfilling are considered to be wholly impermeable as a 'worst case'

Phase 1 Unrestored Area

Storage Estimate

Return Period (years)	30
Climate Change (%)	5
Impermeable Area (ha)	0.790
Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc
from	560
to	560

Storage Estimate

Return Period (years)	100
Climate Change (%)	5
Impermeable Area (ha)	0.790
Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc
from	697
to	697

Phase 2 Restored (South Draining)

Storage Estimate

Return Period (years)	30
Climate Change (%)	5
Impermeable Area (ha)	0.660
Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc
from	467
to	467

Storage Estimate

Return Period (years)	100
Climate Change (%)	5
Impermeable Area (ha)	0.660
Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc
from	582
to	582

Calculation Sheet

REF:

CLIENT:	PROJECT:	JOB NO.:	CALC. REF. NO.:
Lightwater Quarries Limited	Gebdykes Landfill	NT18434	PAGE: 7 OF 16
CALCULATION	CALC. BY:	CHECKED BY:	APPROVED BY:
Attenuation Calculations - Phase 3 Part 3	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)
	B Griffiths		
	DATE: 03/09/2021	DATE:	DATE:

Rainfall Methodology	FSR
FSR Region	England & Wales
M5-60 (mm)	20.000
Ratio-R	0.300
Summer CV ☑	0.750
Winter CV ☑	0.840

Areas of quarry base, sideslopes and landfilling are considered to be wholly impermeable as a 'worst case'

Phase 3 Landfilling (North Draining)

Storage Estimate		
Return Period (years)	30	100
Climate Change (%)	5	5
Impermeable Area (ha)	2.130	2.130
Peak Discharge (l/s)	0.000	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)		
Required Storage (m³)	Calc	Calc
from	1509	1879
to	1509	1879

Phase 3 Landfilling (South Draining)

Storage Estimate		
Return Period (years)	30	100
Climate Change (%)	5	5
Impermeable Area (ha)	1.350	1.350
Peak Discharge (l/s)	0.000	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)		
Required Storage (m³)	Calc	Calc
from	956	1191
to	956	1191

Calculation Sheet

REF:

CLIENT:	PROJECT:	JOB NO.:	CALC. REF. NO.:
Lightwater Quarries Limited	Gebdykes Landfill	NT18434	PAGE: 8 OF 16
CALCULATION	CALC. BY:	CHECKED BY:	APPROVED BY:
Attenuation Calculations - Phase 4 Part 1	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)
	B Griffiths		
	DATE: 03/09/2021	DATE:	DATE:

Rainfall Methodology	FSR
FSR Region	England & Wales
M5-60 (mm)	20.000
Ratio-R	0.300
Summer CV	☑ 0.750
Winter CV	☑ 0.840

Areas of quarry base, sideslopes and landfilling are considered to be wholly impermeable as a 'worst case'

Quarry Base and Sideslopes (non operational)

Storage Estimate		Storage Estimate	
Return Period (years)	30	Return Period (years)	100
Climate Change (%)	5	Climate Change (%)	5
Impermeable Area (ha)	0.700	Impermeable Area (ha)	0.700
Peak Discharge (l/s)	0.000	Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)		Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc	Required Storage (m³)	Calc
from	496	from	618
to	496	to	618

Phase 1 Restored

Storage Estimate		Storage Estimate	
Return Period (years)	30	Return Period (years)	100
Climate Change (%)	5	Climate Change (%)	5
Impermeable Area (ha)	1.000	Impermeable Area (ha)	1.000
Peak Discharge (l/s)	0.000	Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)		Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc	Required Storage (m³)	Calc
from	708	from	882
to	708	to	882

Calculation Sheet

REF:

CLIENT:	PROJECT:	JOB NO.:	CALC. REF. NO.:
Lightwater Quarries Limited	Gebdykes Landfill	NT18434	PAGE: 9 OF 16
CALCULATION	CALC. BY:	CHECKED BY:	APPROVED BY:
Attenuation Calculations - Phase 4 Part 2	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)
	B Griffiths		
	DATE: 03/09/2021	DATE:	DATE:

Rainfall Methodology	FSR
FSR Region	England & Wales
M5-60 (mm)	20.000
Ratio-R	0.300
Summer CV	0.750
Winter CV	0.840

Areas of quarry base, sideslopes and landfilling are considered to be wholly impermeable as a 'worst case'

Phase 1 Unrestored

Storage Estimate

Return Period (years)	30
Climate Change (%)	5
Impermeable Area (ha)	0.810
Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc
from	574
to	574

Storage Estimate

Return Period (years)	100
Climate Change (%)	5
Impermeable Area (ha)	0.810
Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc
from	715
to	715

Phase 2 Restored (South Draining)

Storage Estimate

Return Period (years)	30
Climate Change (%)	5
Impermeable Area (ha)	0.660
Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc
from	467
to	467

Storage Estimate

Return Period (years)	100
Climate Change (%)	5
Impermeable Area (ha)	0.660
Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc
from	582
to	582

Calculation Sheet

REF:

CLIENT:	PROJECT:	JOB NO.:	CALC. REF. NO.:
Lightwater Quarries Limited	Gebdykes Landfill	NT18434	PAGE: 10 OF 16
CALCULATION	CALC. BY:	CHECKED BY:	APPROVED BY:
Attenuation Calculations - Phase 4 Part 3	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)
	B Griffiths		
	DATE: 03/09/2021	DATE:	DATE:

Rainfall Methodology		FSR
FSR Region		England & Wales
M5-60 (mm)		20.000
Ratio-R		0.300
Summer CV	☑	0.750
Winter CV	☑	0.840

Areas of quarry base, sideslopes and landfilling are considered to be wholly impermeable as a 'worst case'

Quarry Base and Sideslopes (non operational)

Storage Estimate		Storage Estimate	
Return Period (years)	30	Return Period (years)	100
Climate Change (%)	5	Climate Change (%)	5
Impermeable Area (ha)	0.890	Impermeable Area (ha)	0.890
Peak Discharge (l/s)	0.000	Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)		Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc	Required Storage (m³)	Calc
from	630	from	785
to	630	to	785

Phase 1 Restored

Storage Estimate		Storage Estimate	
Return Period (years)	30	Return Period (years)	100
Climate Change (%)	5	Climate Change (%)	5
Impermeable Area (ha)	3.010	Impermeable Area (ha)	3.010
Peak Discharge (l/s)	0.000	Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)		Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc	Required Storage (m³)	Calc
from	2132	from	2656
to	2132	to	2656

Calculation Sheet

REF:

CLIENT: Lightwater Quarries Limited	PROJECT: Gebdykes Landfill	JOB NO.: NT18434	CALC. REF. NO.: PAGE: 11 OF 16
CALCULATION	CALC. BY:	CHECKED BY:	APPROVED BY:
Attenuation Calculations - Phase 5 Part 1	(NAME AND SIGNATURE) B Griffiths	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)
	DATE: 03/09/2021	DATE:	DATE:

Rainfall Methodology	FSR
FSR Region	England & Wales
M5-60 (mm)	20.000
Ratio-R	0.300
Summer CV	0.750
Winter CV	0.840

Areas of quarry base, sideslopes and landfilling are considered to be wholly impermeable as a 'worst case'

Phase 1 Restored

Storage Estimate		Storage Estimate	
Return Period (years)	30	Return Period (years)	100
Climate Change (%)	10	Climate Change (%)	10
Impermeable Area (ha)	0.990	Impermeable Area (ha)	0.990
Peak Discharge (l/s)	0.000	Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)		Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc	Required Storage (m³)	Calc
from	735	from	915
to	735	to	915

Phase 2 Restored (South Draining)

Storage Estimate		Storage Estimate	
Return Period (years)	30	Return Period (years)	100
Climate Change (%)	10	Climate Change (%)	10
Impermeable Area (ha)	0.660	Impermeable Area (ha)	0.660
Peak Discharge (l/s)	0.000	Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)		Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc	Required Storage (m³)	Calc
from	490	from	610
to	490	to	610

Calculation Sheet

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REF:

CLIENT:	PROJECT:	JOB NO.:	CALC. REF. NO.:
Lightwater Quarries Limited	Gebdykes Landfill	NT18434	PAGE: 12 OF 16
CALCULATION	CALC. BY:	CHECKED BY:	APPROVED BY:
Attenuation Calculations - Phase 5 Part 2	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)
	B Griffiths		
	DATE: 03/09/2021	DATE:	DATE:

Rainfall Methodology	FSR
FSR Region	England & Wales
M5-60 (mm)	20.000
Ratio-R	0.300
Summer CV	☑ 0.750
Winter CV	☑ 0.840

Areas of quarry base, sideslopes and landfilling are considered to be wholly impermeable as a 'worst case'

Phase 3 Restored (South Draining)

Storage Estimate

Return Period (years)	30	100
Climate Change (%)	10	10
Impermeable Area (ha)	0.890	0.890
Peak Discharge (l/s)	0.000	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)		
Required Storage (m³)	Calc	Calc
from	660	823
to	660	823

Phase 4 Restored

Storage Estimate

Return Period (years)	30	100
Climate Change (%)	10	10
Impermeable Area (ha)	0.790	0.790
Peak Discharge (l/s)	0.000	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)		
Required Storage (m³)	Calc	Calc
from	586	730
to	586	730

Calculation Sheet

REF:

CLIENT: Lightwater Quarries Limited	PROJECT: Gebdykes Landfill	JOB NO.: NT18434	CALC. REF. NO.: PAGE: 13 OF 16
CALCULATION	CALC. BY:	CHECKED BY:	APPROVED BY:
Attenuation Calculations - Phase 5 Part 3	(NAME AND SIGNATURE) B Griffiths	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)
	DATE: 03/09/2021	DATE:	DATE:

Rainfall Methodology	FSR
FSR Region	England & Wales
M5-60 (mm)	20.000
Ratio-R	0.300
Summer CV	0.750
Winter CV	0.840

Areas of quarry base, sideslopes and landfilling are considered to be wholly impermeable as a 'worst case'

Phase 5 Landfilling

Storage Estimate

Return Period (years)	30
Climate Change (%)	10
Impermeable Area (ha)	2.590
Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc
from	1922
to	1922

Storage Estimate

Return Period (years)	100
Climate Change (%)	10
Impermeable Area (ha)	2.590
Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc
from	2394
to	2394

Calculation Sheet

REF:

CLIENT:	PROJECT:	JOB NO.:	CALC. REF. NO.:
Lightwater Quarries Limited	Gebdykes Landfill	NT18434	PAGE: 14 OF 16
CALCULATION	CALC. BY:	CHECKED BY:	APPROVED BY:
Attenuation Calculations - Post Restoration Part 1	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)
	B Griffiths		
	DATE: 03/09/2021	DATE:	DATE:

Rainfall Methodology	FSR
FSR Region	England & Wales
M5-60 (mm)	20.000
Ratio-R	0.300
Summer CV	0.750
Winter CV	0.840

Areas of quarry base, sideslopes and landfilling are considered to be wholly impermeable as a 'worst case'

Phase 1 Restored

Storage Estimate		
Return Period (years)	30	100
Climate Change (%)	20	20
Impermeable Area (ha)	0.990	0.990
Peak Discharge (l/s)	0.000	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)		
Required Storage (m³)	Calc	Calc
from	801	998
to	801	998

Phase 2 Restored (South Draining)

Storage Estimate		
Return Period (years)	30	100
Climate Change (%)	20	20
Impermeable Area (ha)	0.660	0.660
Peak Discharge (l/s)	0.000	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)		
Required Storage (m³)	Calc	Calc
from	534	666
to	534	666

Calculation Sheet

REF:

CLIENT: Lightwater Quarries Limited	PROJECT: Gebdykes Landfill	JOB NO.: NT18434	CALC. REF. NO.: PAGE: 15 OF 16
CALCULATION	CALC. BY:	CHECKED BY:	APPROVED BY:
Attenuation Calculations - Post Restoration Part 2	(NAME AND SIGNATURE) B Griffiths	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)
	DATE: 03/09/2021	DATE:	DATE:

Rainfall Methodology	FSR
FSR Region	England & Wales
M5-60 (mm)	20.000
Ratio-R	0.300
Summer CV	0.750
Winter CV	0.840

Areas of quarry base, sideslopes and landfilling are considered to be wholly impermeable as a 'worst case'

Phase 3 Restored (South Draining)

Storage Estimate		
Return Period (years)	30	100
Climate Change (%)	20	20
Impermeable Area (ha)	0.890	0.890
Peak Discharge (l/s)	0.000	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)		
Required Storage (m³)	Calc	Calc
from	720	898
to	720	898

Phase 4 Restored

Storage Estimate		
Return Period (years)	30	100
Climate Change (%)	20	20
Impermeable Area (ha)	0.790	0.790
Peak Discharge (l/s)	0.000	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)		
Required Storage (m³)	Calc	Calc
from	639	797
to	639	797

Calculation Sheet

REF:

CLIENT:	PROJECT:	JOB NO.:	CALC. REF. NO.:
Lightwater Quarries Limited	Gebdykes Landfill	NT18434	PAGE: 16 OF 16
CALCULATION	CALC. BY:	CHECKED BY:	APPROVED BY:
Attenuation Calculations - Post Restoration 6 Part 3	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)	(NAME AND SIGNATURE)
	B Griffiths		
	DATE: 03/09/2021	DATE:	DATE:

Rainfall Methodology	FSR
FSR Region	England & Wales
M5-60 (mm)	20.000
Ratio-R	0.300
Summer CV	☑ 0.750
Winter CV	☑ 0.840

Areas of quarry base, sideslopes and landfilling are considered to be wholly impermeable as a 'worst case'

Phase 5 Landfilling

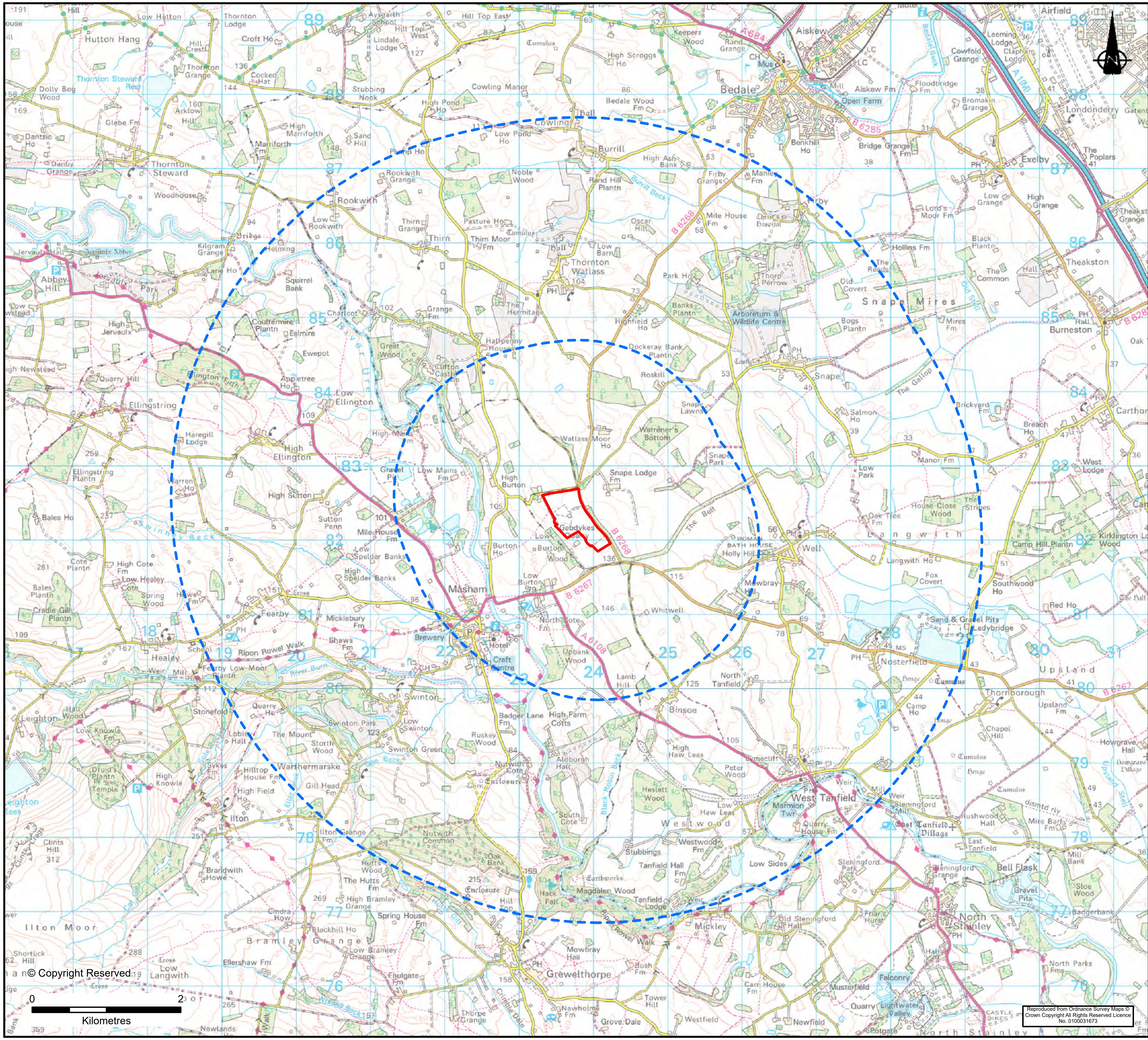
Storage Estimate

Return Period (years)	30
Climate Change (%)	20
Impermeable Area (ha)	1.060
Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc
from	858
to	858

Storage Estimate

Return Period (years)	100
Climate Change (%)	20
Impermeable Area (ha)	1.060
Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc
from	1069
to	1069

DRAWINGS



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KEY

Application Boundary

2 and 5 km Distance Buffer

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REVISION	DETAILS	DATE	DRAWN	CHK'D	APP'D
-	-	-	-	-	-

CLIENT

Lightwater Quarries

PROJECT

GEBDYKES QUARRY LANDFILL

DRAWING TITLE

FIGURE 1.1
LOCATION PLAN

DRG No.		REV
NT14834/FIGURE 1.1		A
DRG SIZE: A3	SCALE: 1:50,000	DATE: 26/07/2021
DRAWN BY: SW	CHECKED BY: BP	APPROVED BY: NB

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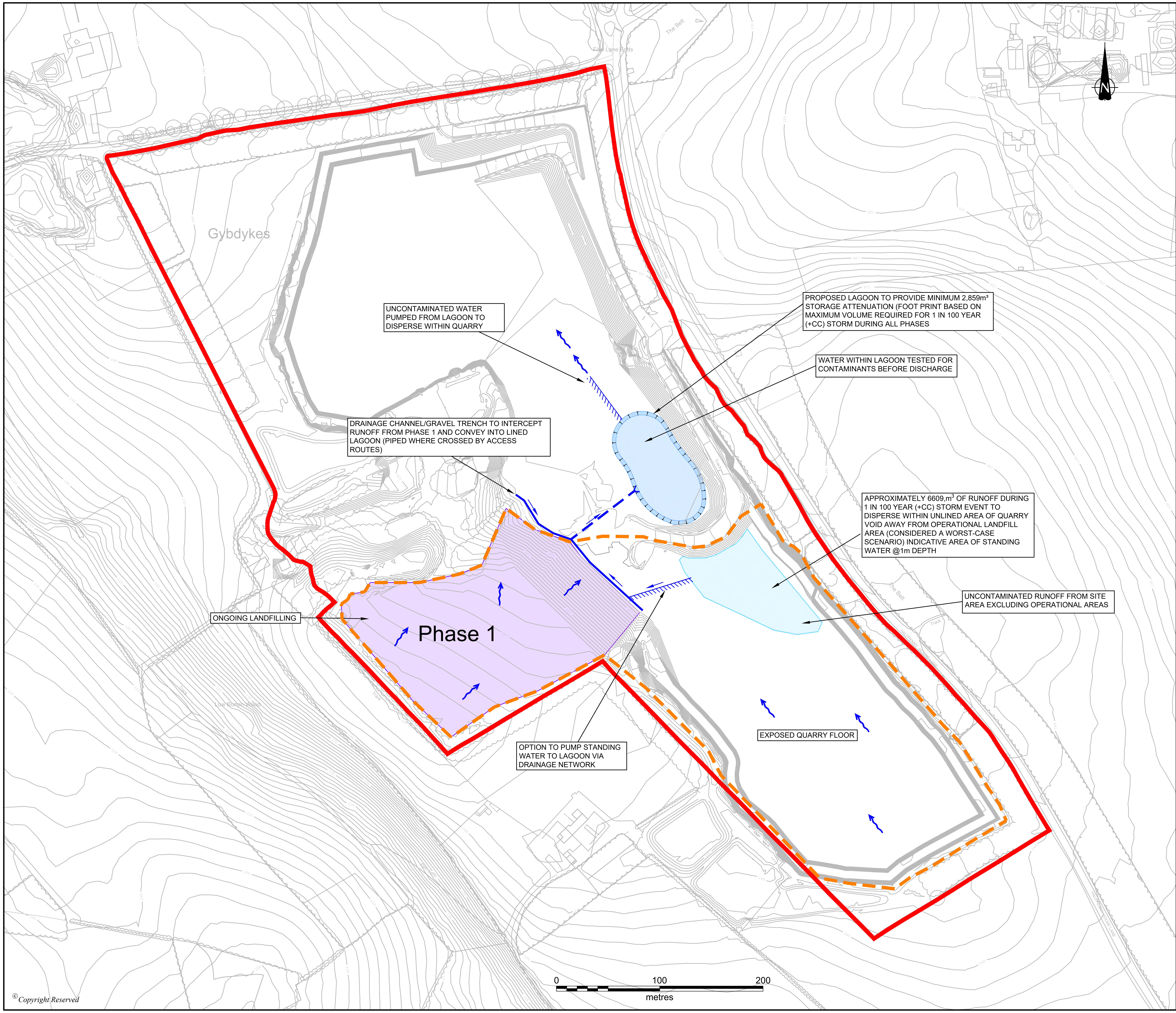

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NOTES:

1. TO BE READ IN CONJUNCTION WITH FLOOD RISK ASSESSMENT (REF NT14834 APPENDIX 8.1)
2. LAYOUT IS INDICATIVE AND SUBJECT TO DETAILED DESIGN.

KEY

- QUARRY BOUNDARY
- ACTIVE PHASE
- LANDFILL AREA
- TEMPORARY SURFACE WATER STORAGE
- FLOW DIRECTION
- PROPOSED DRAINAGE CHANNEL
- PROPOSED PIPED GRAVITY CONNECTION
- PROPOSED PUMPING ROUTE
- PROPOSED STORAGE LAGOON (LINED)

REVISION	DETAILS	DATE	DRAWN	CHK'D	APP'D
B	AMENDMENT TO TEXT	02-02-23	DR	BG	NB
A	FIRST ISSUE	20/01/23	SJB	BG	NB

CLIENT

Lightwater Quarries

PROJECT

GEBDYKES QUARRY LANDFILL

DRAWING TITLE

PHASE 1
INDICATIVE SURFACE WATER MANAGEMENT PLAN

DRG No.		REV
NT14834-008		B
DRG SIZE: A2	SCALE: 1:2,500	DATE: 03/09/2021
DRAWN BY: AB	CHECKED BY: LG	APPROVED BY: NB

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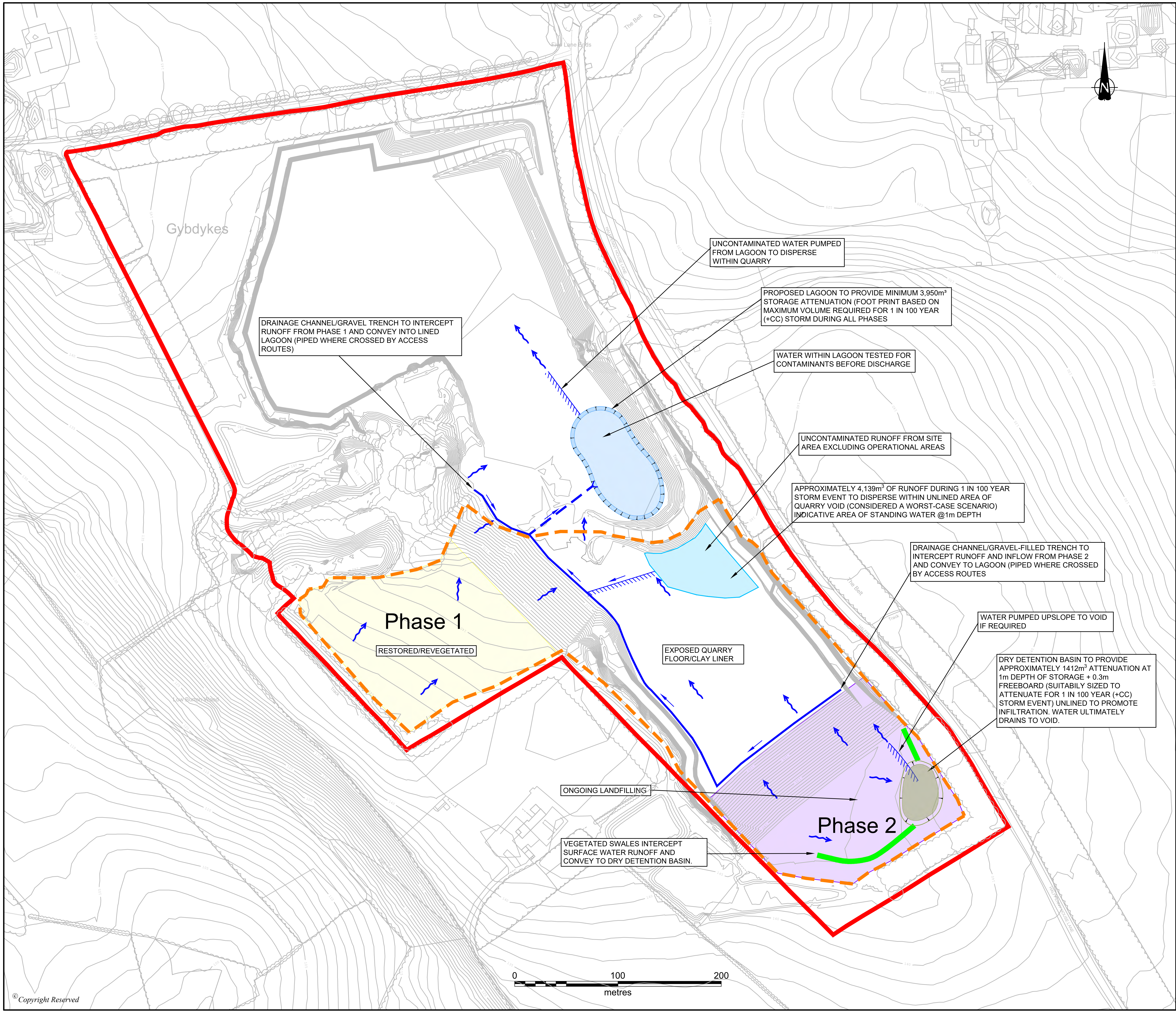
N:\NT\NT14834 - GEBDYKES QUARRY LANDFILL EIA\03 - DESIGN\AUTOCAD\NT14834-008-B SURFACE WATER MANAGEMENT PLAN [PHASE 1].DWG



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NOTES:

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2. LAYOUT IS INDICATIVE AND SUBJECT TO DETAILED DESIGN.
3. RUNOFF CO-EFFICIENT APPLIED TO RESTORED AREAS.

KEY

- QUARRY BOUNDARY
- ACTIVE PHASE
- LANDFILL AREA
- RESTORED AREA
- TEMPORARY SURFACE WATER STORAGE
- FLOW DIRECTION
- PROPOSED DRAINAGE CHANNEL
- PROPOSED PIPED GRAVITY CONNECTION
- PROPOSED PUMPING ROUTE
- PROPOSED STORAGE LAGOON (LINED)
- PROPOSED DRY DETENTION BASIN (BASED ON VOLUME OF STORAGE REQUIRED POST RESTORATION)

REVISION	DETAILS	DATE	DRAWN	CHK'D	APP'D
B	AMENDMENT TO TEXT	02-02-23	DR	BG	NB
A	FIRST ISSUE	20/01/23	SJB	BG	NB

CLIENT

Lightwater Quarries

PROJECT

Gebdykes Quarry Landfill

DRAWING TITLE

PHASE 2
INDICATIVE SURFACE WATER MANAGEMENT PLAN

DRG No.		REV
NT14834-009		B
DRG SIZE: A2	SCALE: 1:2,500	DATE: 03/09/2021
DRAWN BY: AB	CHECKED BY: LG	APPROVED BY: NB

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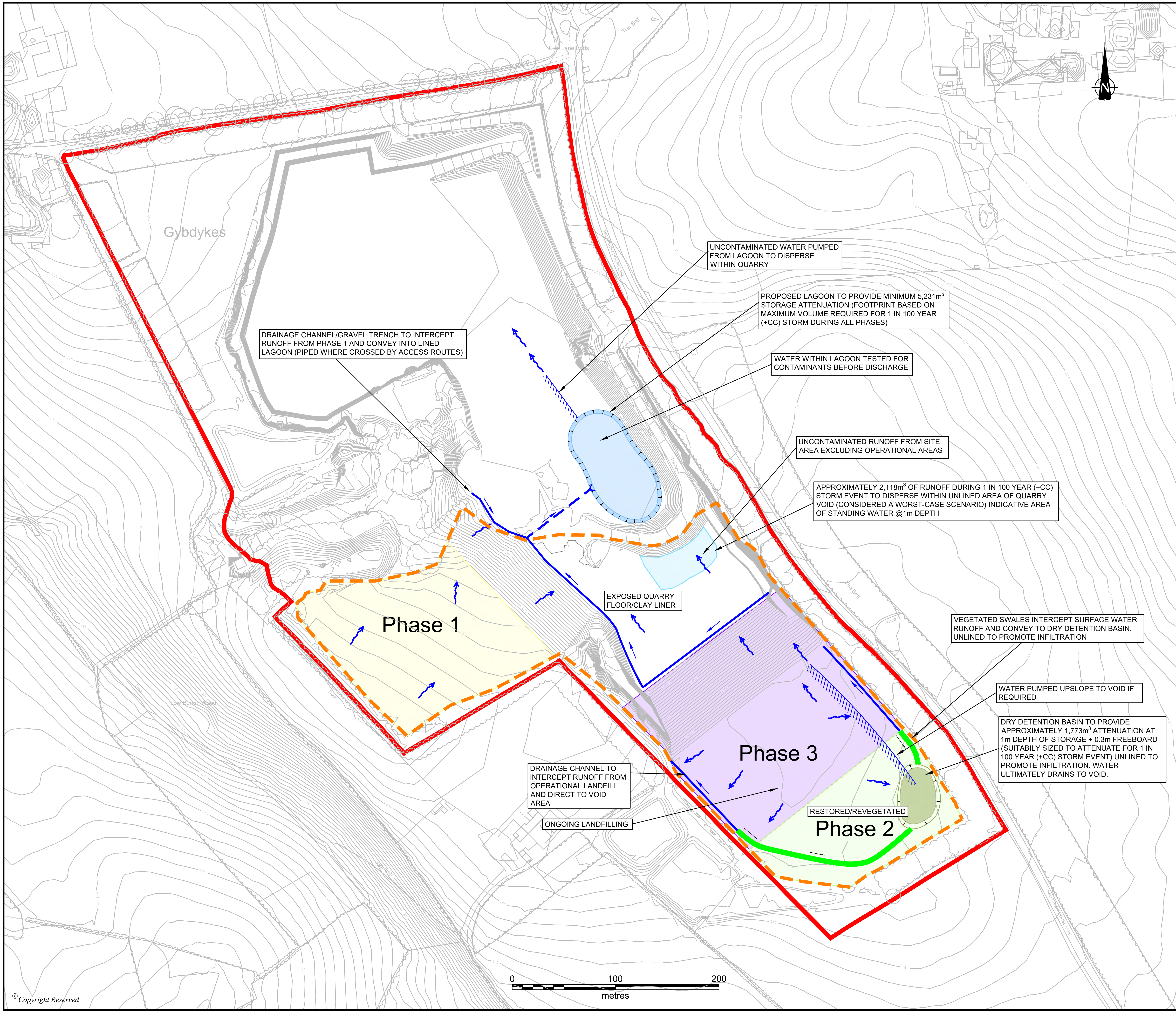
N:\NT\NT14834 - GEBDYKES QUARRY LANDFILL EIA\03 - DESIGN\AUTOCAD\NT14834-009-B SURFACE WATER MANAGEMENT PLAN [PHASE 2].DWG



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NOTES:

1. TO BE READ IN CONJUNCTION WITH FLOOD RISK ASSESSMENT (REF NT14834 APPENDIX 8.1)
2. LAYOUT IS INDICATIVE AND SUBJECT TO DETAILED DESIGN.
3. RUNOFF CO-EFFICIENT APPLIED TO RESTORED AREAS.

KEY

- QUARRY BOUNDARY
- ACTIVE PHASE
- LANDFILL AREA
- RESTORED AREA
- TEMPORARY SURFACE WATER STORAGE
- FLOW DIRECTION
- PROPOSED DRAINAGE CHANNEL
- PROPOSED SWALE
- PROPOSED PIPED GRAVITY CONNECTION
- PROPOSED PUMPING ROUTE
- PROPOSED STORAGE LAGOON (LINED)
- PROPOSED DRY DETENTION BASIN (BASED ON VOLUME OF STORAGE REQUIRED POST RESTORATION)

REVISION	DETAILS	DATE	DRAWN	CHK'D	APP'D
B	AMENDMENT TO TEXT	02-02-23	DR	BG	NB
A	FIRST ISSUE	20/01/23	SJB	BG	NB

CLIENT

Lightwater Quarries

PROJECT

GEBDYKES QUARRY LANDFILL

DRAWING TITLE

PHASE 3
INDICATIVE SURFACE WATER MANAGEMENT PLAN

DRG No. NT14834-010		REV B
DRG SIZE A2	SCALE 1:2,500	DATE 03/09/2021
DRAWN BY AB	CHECKED BY LG	APPROVED BY NB

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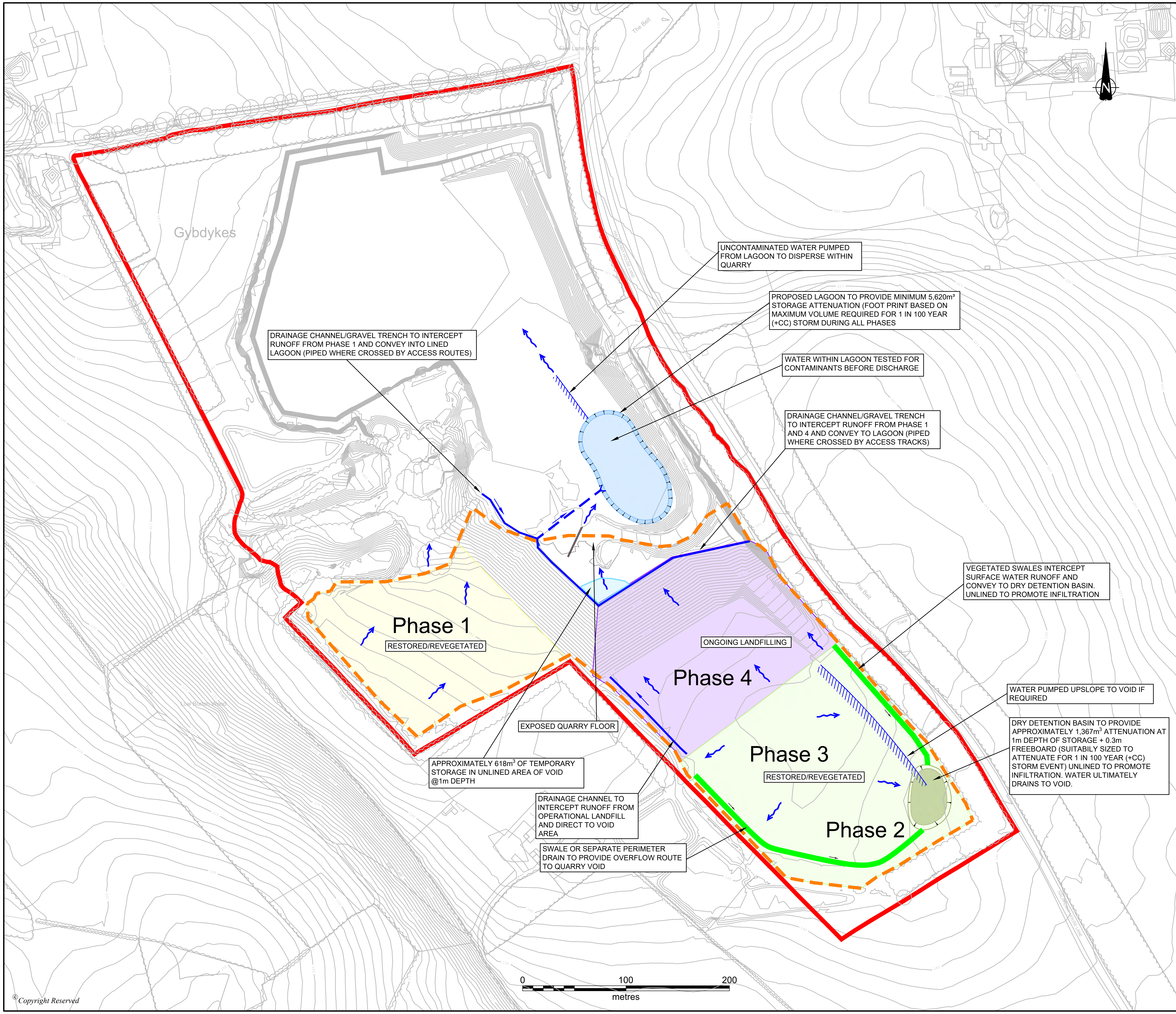
N:\NT\NT14834 - GEBDYKES QUARRY LANDFILL EIA\03 - DESIGN\AUTOCAD\NT14834-010-B SURFACE WATER MANAGEMENT PLAN [PHASE 3].DWG



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NOTES:

1. TO BE READ IN CONJUNCTION WITH FLOOD RISK ASSESSMENT (REF NT14834 APPENDIX 8.1)
2. LAYOUT IS INDICATIVE AND SUBJECT TO DETAILED DESIGN.
3. RUNOFF CO-EFFICIENT APPLIED TO RESTORED AREAS.

KEY

- QUARRY BOUNDARY
- ACTIVE PHASE
- LANDFILL AREA
- RESTORED AREA
- TEMPORARY SURFACE WATER STORAGE
- FLOW DIRECTION
- PROPOSED DRAINAGE CHANNEL
- PROPOSED SWALE
- PROPOSED PIPED GRAVITY CONNECTION
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- PROPOSED STORAGE LAGOON (LINED)
- PROPOSED DRY DETENTION BASIN (BASED ON VOLUME OF STORAGE REQUIRED POST RESTORATION)

REVISION	DETAILS	DATE	DRAWN	CHK'D	APP'D
B	AMENDMENT TO TEXT	02-02-23	DR	BG	NB
A	FIRST ISSUE	20/01/23	SJB	BG	NB

CLIENT

Lightwater Quarries

PROJECT

Gebdykes Quarry Landfill

DRAWING TITLE

PHASE 4
INDICATIVE SURFACE WATER MANAGEMENT PLAN

DRG No.	REV
NT14834-011	B

DRG SIZE	SCALE	DATE
A2	1:2,500	03/09/2021

DRAWN BY	CHECKED BY	APPROVED BY
AB	LG	NB

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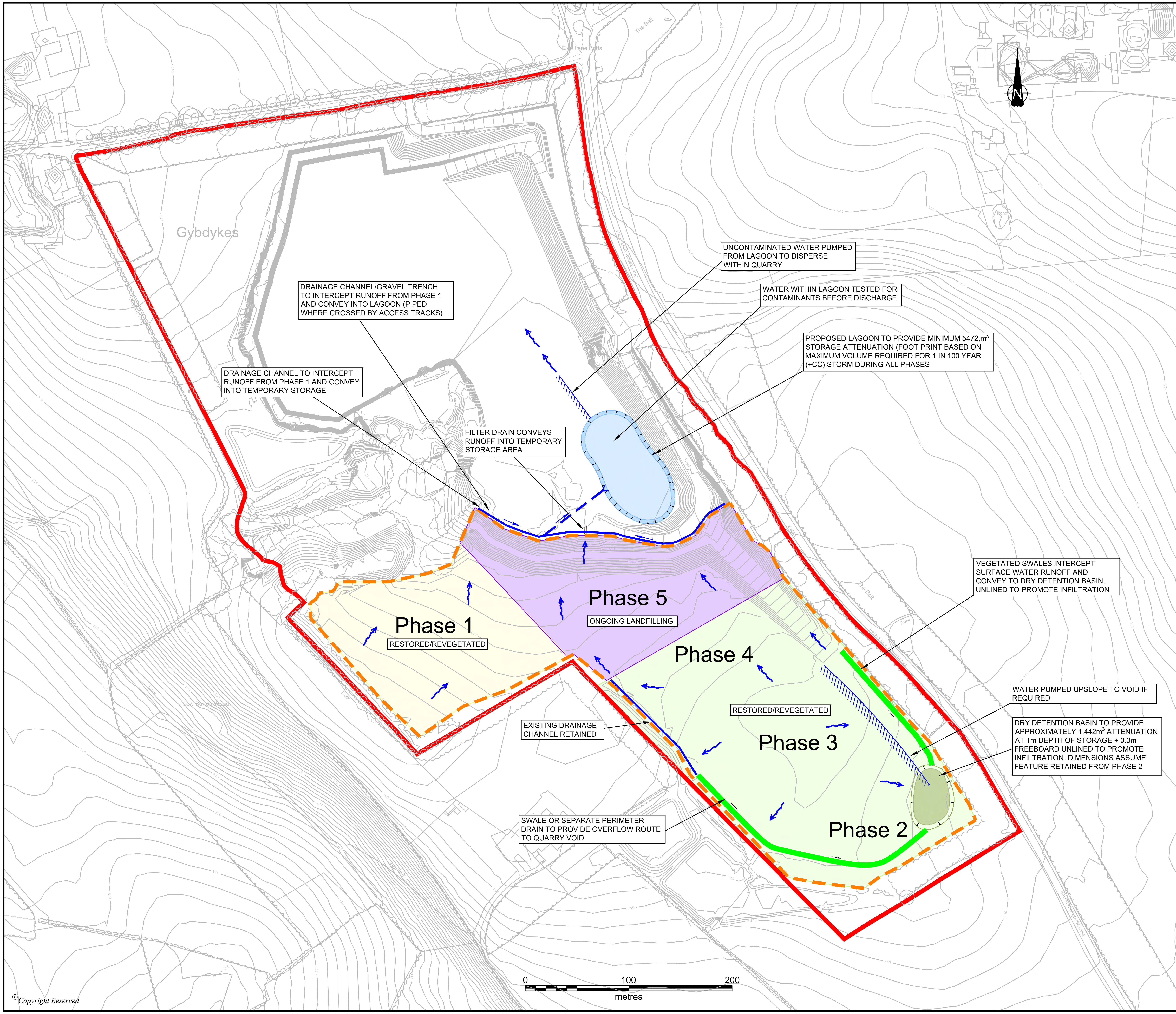

NOTES:

1. TO BE READ IN CONJUNCTION WITH FLOOD RISK ASSESSMENT (REF NT14834 APPENDIX 8.1)
2. LAYOUT IS INDICATIVE AND SUBJECT TO DETAILED DESIGN.
3. RUNOFF CO-EFFICIENT APPLIED TO RESTORED AREAS.

KEY

- QUARRY BOUNDARY
- ACTIVE PHASE
- LANDFILL AREA
- RESTORED AREA
- TEMPORARY SURFACE WATER STORAGE
- FLOW DIRECTION
- PROPOSED DRAINAGE CHANNEL
- PROPOSED SWALE
- PROPOSED PIPED GRAVITY CONNECTION
- PROPOSED PUMPING ROUTE
- PROPOSED STORAGE LAGOON (LINED)
- PROPOSED DRY DETENTION BASIN (BASED ON VOLUME OF STORAGE REQUIRED POST RESTORATION)

REVISION	DETAILS	DATE	DRAWN	CHK'D	APP'D
B	AMENDMENT TO TEXT	02-02-23	DR	BG	NB
A	FIRST ISSUE	20/01/23	SJB	BG	NB

CLIENT

Lightwater Quarries

PROJECT

Gebdykes Quarry Landfill

DRAWING TITLE

PHASE 5
INDICATIVE SURFACE WATER MANAGEMENT PLAN

DRG No.		REV
NT14834-012		B
DRG SIZE: A2	SCALE: 1:2,500	DATE: 03/09/2021
DRAWN BY: AB	CHECKED BY: LG	APPROVED BY: NB

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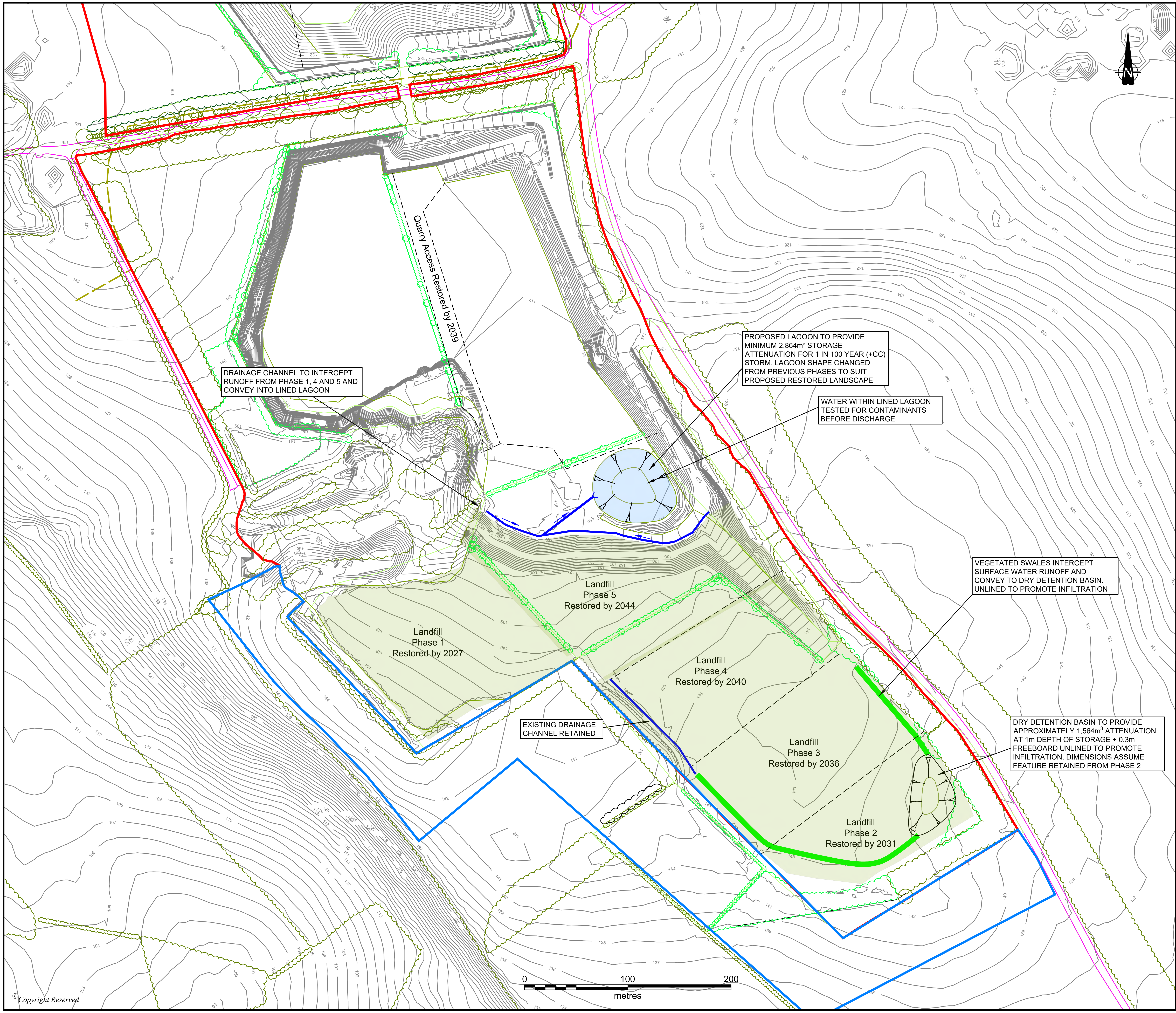
N:\NT\NT14834 - GEBDYKES QUARRY LANDFILL EIA\03 - DESIGN\AUTOCAD\NT14834-012-B SURFACE WATER MANAGEMENT PLAN [PHASE 5].DWG



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2. LAYOUT IS INDICATIVE AND SUBJECT TO DETAILED DESIGN.
3. RUNOFF CO-EFFICIENT APPLIED TO RESTORED AREAS.

KEY

- QUARRY BOUNDARY
- RESTORED AREA
- PROPOSED DRAINAGE CHANNEL
- PROPOSED SWALE
- PROPOSED PIPED GRAVITY CONNECTION
- PROPOSED STORAGE LAGOON (LINED)
- PROPOSED DRY DETENTION BASIN (BASED ON VOLUME OF STORAGE REQUIRED POST RESTORATION)

REVISION	DETAILS	DATE	DRAWN	CHK'D	APP'D
A	FIRST ISSUE	02-02-23	DR	LG	NB

CLIENT
Lightwater Quarries

PROJECT
GEBDYKES QUARRY LANDFILL

DRAWING TITLE
RESTORATION
INDICATIVE SURFACE WATER MANAGEMENT PLAN

DRG No.	REV	SUIT. CODE
NT14834-013	A	

DRG SIZE	SCALE	DATE
A2	1:2,500	24-01-23

DRAWN BY	CHECKED BY	APPROVED BY
DR	LG	NB

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N:\NT\NT14834 - GEBDYKES QUARRY LANDFILL EIA\03 - DESIGN\AUTOCAD\NT14834-013-A SURFACE WATER MANAGEMENT PLAN- RESTORATION.DWG

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Legend

- Site Boundary
- Groundwater Monitoring Boreholes,Groundwater Elevation (m AOD)
- Groundwater Contours August 2020 (m AOD)
- Groundwater Flow Direction

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D

CLIENT

Lightwater Quarries

PROJECT

Gebdykes Quarry Landfill Permit Applciation

DRAWING TITLE

Groundwater Contour Plot August 2020

DRG No. NT14621-Figure 2		REV A
DRG SIZE A3	SCALE 1:3,500	DATE March 2021
DRAWN TR	CHECKED BY AS	APPROVED BY AS

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Legend

- Site Boundary
- Other Land Under the Applicant's Control
- Groundwater Monitoring Boreholes, Groundwater Elevation (m AOD)
- Groundwater Contours January 2021 (m AOD)
- Groundwater Flow Direction

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D

CLIENT: Lightwater Quarries

PROJECT: Gebdykes Quarry Landfill Permit Applciation

DRAWING TITLE: Groundwater Contour Plot January 2021

DRG No. NT14621-Figure 3		REV A
DRG SIZE A3	SCALE 1:3,500	DATE March 2021
DRAWN TR	CHECKED BY AS	APPROVED BY AS

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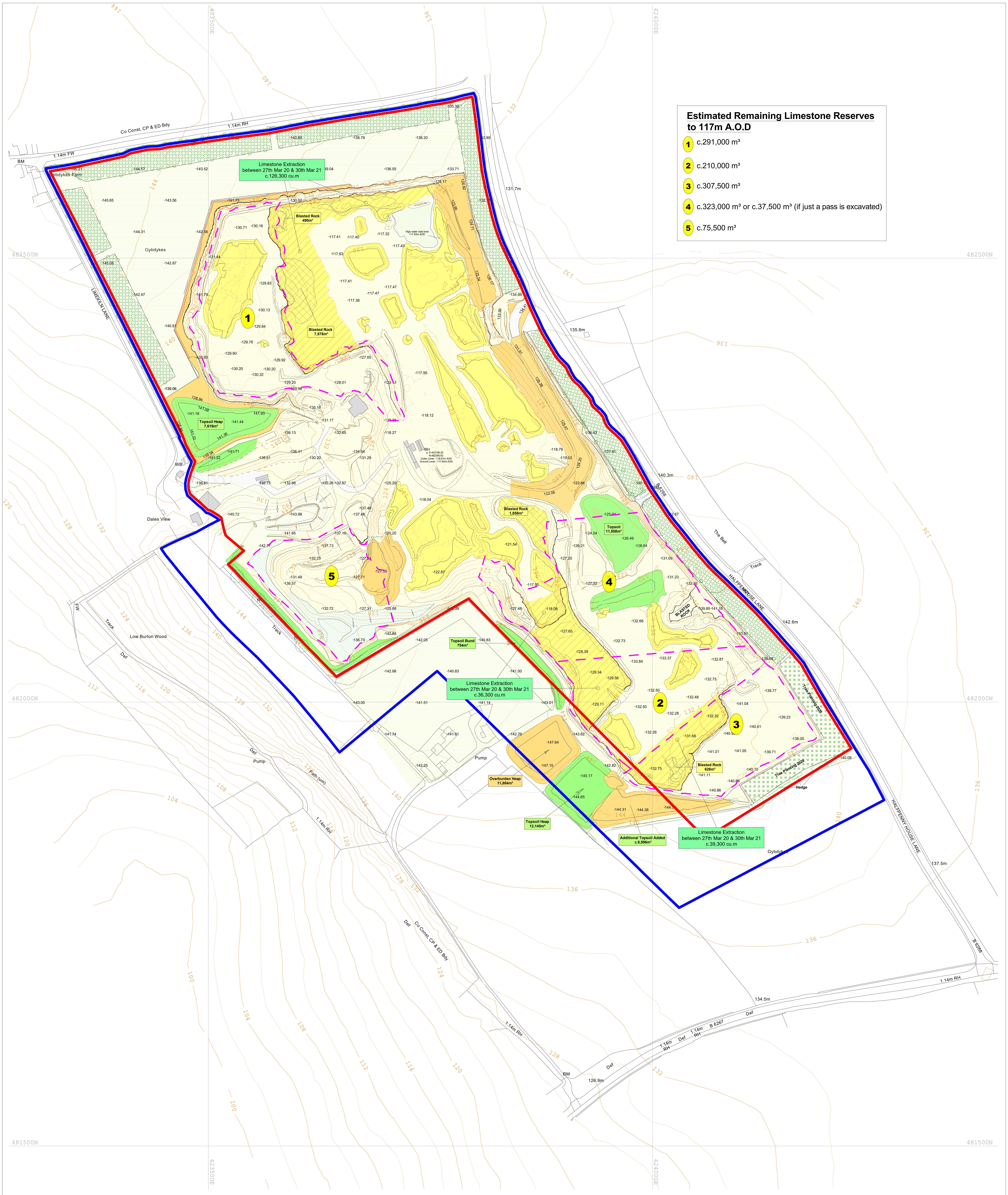

Legend:

Land Under Control of Applicant

Planning Permission Area

Limestone Reserve Areas

Top of Banking	Overhead Cable	LP	Lamp Post	BH	Borehole / Trial Pit
Bottom of Banking	1m Contour Intervals	TP	Telegraph Pole	133.92	Spot Level
Kerb - Top	OS Backcloth	EP	Electric Pole		Trees
Kerb - Channel	Building/Structure	ST	Stop Tap		Survey Control Station
Fence - Post & Wire	Verge Line	GV	Gas Valve		
Fence - Secure	Foliage Line	WL	Water Level		
Gate	Top of Rock Face	IL	Invert Level		
Track / Footpath	MH Manhole	CL	Cover Level		
Wall	IC Inspection Cover	EL	Eave Level		
Edge of Waterline	BT British Telecom Cover	RL	Ridge Level		
Hedgeline	G Gully				

REVISIONS

Date	Description	By
//	//	//
//	//	//
//	//	//
//	//	//

LINEAR surveys

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Liversedge
West Yorkshire
WF15 6DG
Tel - 01924 521862
Mob - 07884434452
e-mail - linearsurveys@gmail.com

Client

LIGHTWATER QUARRIES LTD

N

Job Title
GEBDYKES QUARRY

Project Title

Scale	Date	Drawn by	Surveyed By
1:2000@A1	MAR 2021	SW/PR	SW/PR

Dwg. title
Quarry update and stockpile survey - 30th March 2021 with reserve estimates

DWG No.
LQ/GDQ/MAR21-02

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Wheal Jane Earth Science Park
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Hyatt Regency Hotel
Office Tower
Almaty
Kazakhstan
050040
Tel: +7(727) 334 1310

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DRAWINGS

DO NOT SCALE FROM THIS DRAWING

KEY

- Application boundary
- Surrounding agricultural land
- Existing woodland, hedgerows and trees
- Agricultural grassland
- Magnesian limestone grassland
- Native hedgerow with hedgerow trees
- Woodland planting
- Scrub planting
- Drainage channels
- Swales
- Detention basins (based on volume of storage required post restoration)

REVISION	DETAILS	DATE	DRAWN	CHK'D	APP'D

CLIENT

Lightwater Quarries

PROJECT

Gebdykes Quarry Landfill

DRAWING TITLE

Figure 3.6
Restoration

DRG No.		REV
NT14834/Figure 3.6		-
DRG SIZE A2	SCALE 1:2,500	DATE 17/11/2021
DRAWN BY AB	CHECKED BY LG	APPROVED BY NB

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N:\NT\NT14834 - GEBDYKES QUARRY LANDFILL EIA\03 - DESIGN\AUTOCAD\NT14834 FIGURE 3.6 RESTORATION.DWG

DO NOT SCALE FROM THIS DRAWING

KEY

- Application boundary
- Extent of inert landfill
- Active landfill phase
- Direction of working
- Access track
- Existing quarry
- Surrounding agricultural land
- Existing woodland, hedgerows and trees
- Agricultural grassland
- Magnesian limestone grassland

REVISION	DETAILS	DATE	DRAWN	CHK'D	APP'D

CLIENT: Lightwater Quarries

PROJECT: Gebdykes Quarry Landfill

DRAWING TITLE: Figure 3.1 Phase 1

DRG No. NT14834-002		REV -
DRG SIZE A2	SCALE 1:2,500	DATE November 2021
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N:\NT\NT14834 - GEBDYKES QUARRY LANDFILL EIA\03 - DESIGN\AUTOCAD\NT14834 FIGURE 3.1 PHASE 1 PLAN.DWG

DO NOT SCALE FROM THIS DRAWING

KEY

- Application boundary
- Extent of inert landfill
- Active landfill phase
- Direction of working
- Access track
- Existing quarry
- Surrounding agricultural land
- Existing woodland, hedgerows and trees
- Agricultural grassland
- Magnesian limestone grassland
- Scrub planting
- Drainage channels
- Swales
- Dry detention basins (based on volume of storage required post restoration)

REVISION	DETAILS	DATE	DRAWN	CHK'D	APP'D

CLIENT

Lightwater Quarries

PROJECT

Gebdykes Quarry Landfill

DRAWING TITLE

Figure 3.2
Phase 2 Plan

DRG No.		REV
NT14834-003		-
DRG SIZE A2	SCALE 1:2,500	DATE November 2021
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N:\NT\NT14834 - GEBDYKES QUARRY LANDFILL EIA\03 - DESIGN\AUTOCAD\NT14834 FIGURE 3.2 PHASE 2 PLAN.DWG

DO NOT SCALE FROM THIS DRAWING

KEY

- Application boundary
- Extent of inert landfill
- Active landfill phase
- Direction of working
- Access track
- Existing quarry
- Surrounding agricultural land
- Existing woodland, hedgerows and trees
- Agricultural grassland
- Magnesian limestone grassland
- Scrub planting
- Drainage channels
- Swales
- Dry detention basins (based on volume of storage required post restoration)

REVISION	DETAILS	DATE	DRAWN	CHK'D	APP'D

CLIENT

Lightwater Quarries

PROJECT

Gebdykes Quarry Landfill

DRAWING TITLE

Figure 3.3
Phase 3 Plan

DRG No.		REV
NT14834-004		-
DRG SIZE: A2	SCALE: 1:2,500	DATE: 17/11/2021
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N:\NT\NT14834 - GEBDYKES QUARRY LANDFILL EIA\03 - DESIGN\AUTOCAD\NT14834 FIGURE 3.3 PHASE 3 PLAN.DWG

DO NOT SCALE FROM THIS DRAWING

KEY

- Application boundary
- Extent of inert landfill
- Active landfill phase
- Direction of working
- Access track
- Existing quarry
- Surrounding agricultural land
- Existing woodland, hedgerows and trees
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REVISION	DETAILS	DATE	DRAWN	CHK'D	APP'D

CLIENT

Lightwater Quarries

PROJECT

Gebdykes Quarry Landfill

DRAWING TITLE

Figure 3.4
Phase 4 Plan

DRG No.		REV
NT14834-005		-
DRG SIZE A2	SCALE 1:2,500	DATE 17/11/2021
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N:\NT\NT14834 - GEBDYKES QUARRY LANDFILL EIA\03 - DESIGN\AUTOCAD\NT14834 FIGURE 3.4 PHASE 4 PLAN.DWG

DO NOT SCALE FROM THIS DRAWING

KEY

- Application boundary
- Extent of inert landfill
- Active landfill phase
- Direction of working
- Access track
- Existing quarry
- Surrounding agricultural land
- Existing woodland, hedgerows and trees
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REVISION	DETAILS	DATE	DRAWN	CHK'D	APP'D

CLIENT

Lightwater Quarries

PROJECT

Gebdykes Quarry Landfill

DRAWING TITLE

Figure 3.5
Phase 5 Plan

DRG No.		REV
NT14834-006		-
DRG SIZE: A2	SCALE: 1:2,500	DATE: November 2021
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N:\NT\NT14834 - GEBDYKES QUARRY LANDFILL EIA\03 - DESIGN\AUTOCAD\NT14834 FIGURE 3.5 PHASE 5 PLAN.DWG

DO NOT SCALE FROM THIS DRAWING

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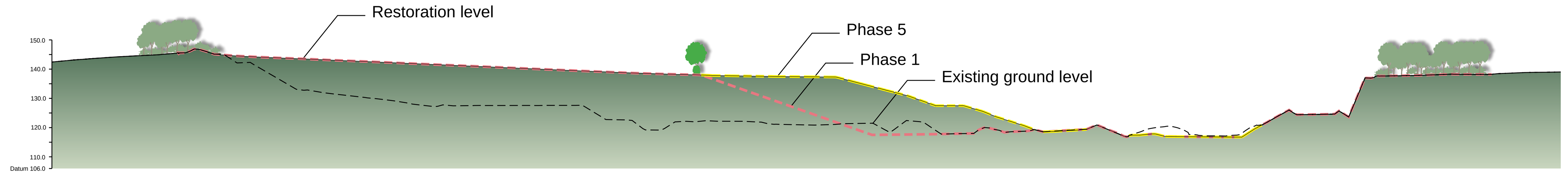
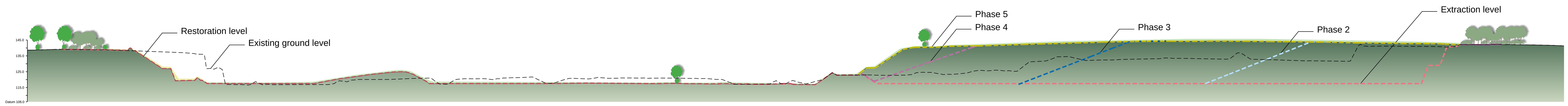
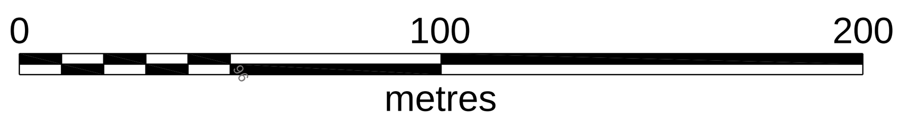
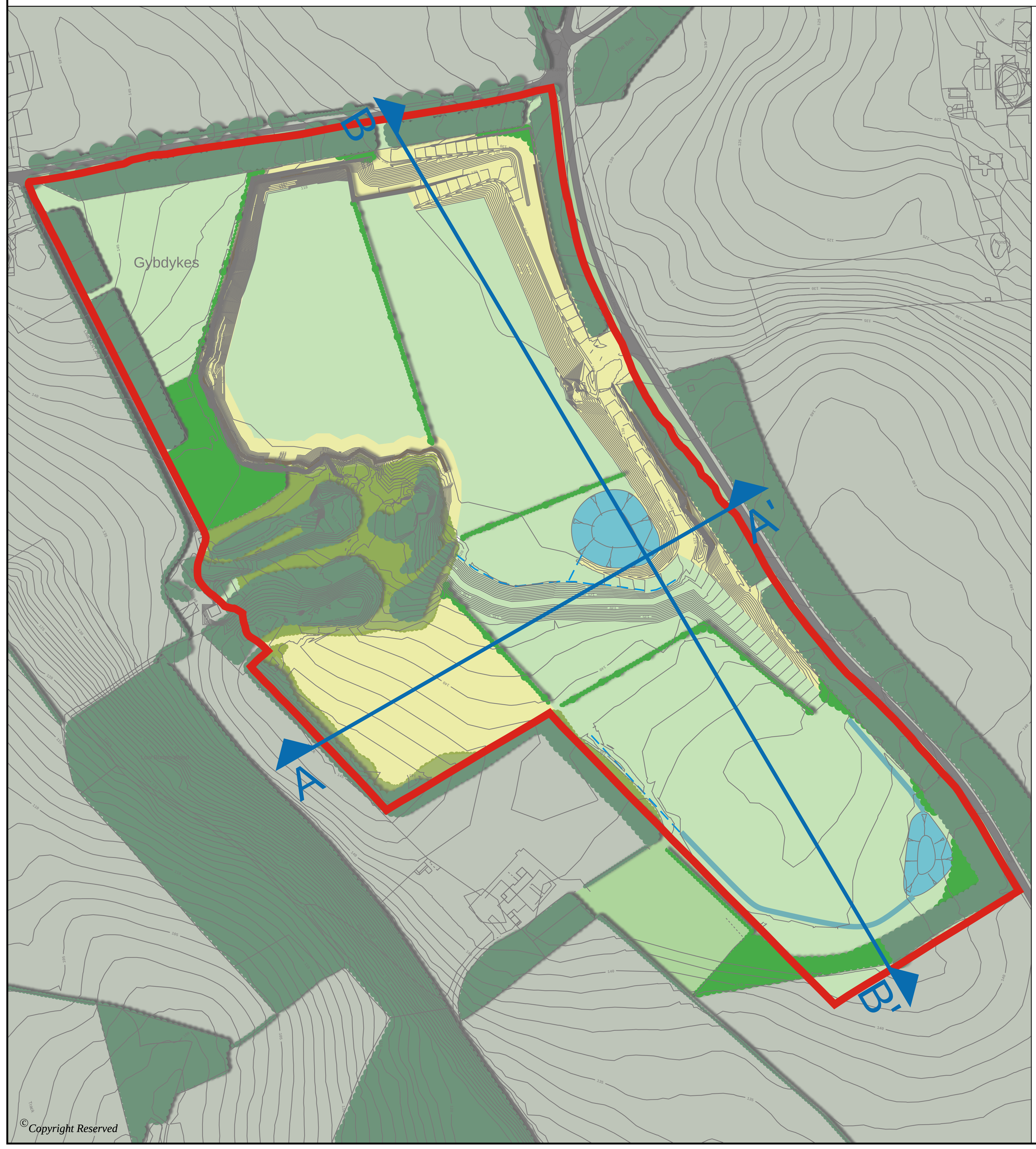


Section B - B'







REVISION	DETAILS	DATE	DRAWN	CHK'D	APP'D

CLIENT

Lightwater Quarries

PROJECT

GEBDYKES QUARRY LANDFILL

DRAWING TITLE

FIGURE 3.7
CROSS-SECTION

DRG No.		REV
NT14834/ 014		-
DRG SIZE: A1	SCALE: 1:1500	DATE: 02/12/2021
DRAWN BY: TL	CHECKED BY: LG	APPROVED BY: NB

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\\WA.LOCAL\PROJECTS\NT\NT14834 - GEBDYKES QUARRY LANDFILL EIA\03 - DESIGN\AUTOCAD\NT14834 FIGURE 3.8.DWG

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LAND AND PROPERTY
MINING AND MINERAL PROCESSING
MINERAL ESTATES
WASTE RESOURCE MANAGEMENT

LIGHTWATER QUARRIES LIMITED

APPLICATION FOR AN ENVIRONMENTAL PERMIT

GEBDYKES QUARRY LANDFILL

AMENITY AND ACCIDENT RISK ASSESSMENT

APRIL 2023

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APPLICATION FOR AN ENVIRONMENTAL PERMIT

GEBDYKES QUARRY LANDFILL

AMENITY AND ACCIDENT RISK ASSESSMENT

APRIL 2023

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APPROVED BY:

Alison Cook	Technical Director	Alison Cook

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WASTE RESOURCE MANAGEMENT

CONTENTS

TABLES

1 INTRODUCTION

1.1 Gebdykes Quarry is an operational limestone quarry located at Masham, North Yorkshire. Lightwater Quarries Limited is applying for an environmental permit to allow the landfilling of approximately 200,000 tonnes of clean inert materials per year to restore the area to original levels.

1.2 This amenity and Accident Risk assessment identifies potential environmental hazards that may arise through site activities and the mitigation measures that will be implemented. The risk assessment follows a source-pathway-receptor approach as outlined in the Environment Agency guidance '*Risk assessments for your environmental permit'*.

1.3 The site is located in a rural setting, predominantly surrounded by agricultural fields. Section 2 of this document provides details of the site location and provides a description of sensitive receptors within 2km of the site.

1.4 The accident and amenity risk assessment is provided in Section 3. This describes the potential risks from site activities, who may be affected, the mitigation measures that will be implemented and an overall calculation of possible risk.

1.5 Several sensitive habitats have been identified in close proximity to the site. Section 4 provides a Habitats Risk Assessment, demonstrating that the landfill will not have a harmful impact on nearby sensitive habitats.

2 SITE DETAILS

Site Location

2.1 The site is located off Halfpenny House Lane, Masham, North Yorkshire, grid reference SE 23770 82304. The site is located within a rural setting, bound to the west and south by fields, by Limekiln Lane to the north and northwest, and Halfpenny House Lane to the east.

2.2 Access to the site is gained from Halfpenny House Lane to the east. Limekiln Lane is located to the north, beyond which is a proposed extension area for the quarry.

Sensitive Receptors

2.3 The site is underlain by dolostone of the Cadeby Formation. The bedrock underlying the site forms a Principal aquifer.

2.4 The nearest designated habitat is Mar Field Fen SSSI, located 1.2km to the west. There are no other SSSIs, European sites, National Nature Reserves (NNR) or Local Nature Reserves (LNR) within 2km of the Site.

2.5 The River Ure is located approximately 850m to the west of the site. This is classified by the Environment Agency as a main river and flows from north to south. The EA Catchment Data Explorer gives the area of the River Ure (Ure from Thornton Stewad Beck to River Skell) to the west a Moderate Classification.

2.6 Five areas of ancient woodland are present within 2km of the site, the nearest being Low Burnton Wood, approximately 50m west of the site. An unnamed area of ancient woodland sits around 900m west of the site, and Great Wood is around 1,400m to the northwest. The remaining two are approximately 1,400m south of the site at Upbank Wood.

2.7 The receptors within 1km of the site that may be affected by fugitive emissions from the landfill are provided in table 2:1, below.

Table 2:1 Sensitive Receptors

Receptor	Distance from Site	Direction
Protected Sites		
Low Burton Wood Ancient Woodland	50m	West
Unnamed Ancient Replanted Woodland	900m	North West
Water		
Pond	370m	South West
Pond	400m	East
Unnamed watercourse	500m	East

Table 2:1 Sensitive Receptors		
River Ure	815m	West
Unnamed watercourse	900m	West
Residential		
Gebdykes Farm	Adjacent	North
East Gebdykes Farm	150m	South West
Properties on Moor Lane	330m	North East
Farm off Moor Lane	360m	North East
Snape House	390m	South East
High Burton House	550m	West
Properties off B6267	670m	South West
Commercial		
Yoredale Vets – Masham	640m	North West
Cycopath Cycles	960m	South West
Seven Meadows	670m	South West
Infrastructure		
Limekiln Lane	Adjacent	North
Halfpenny House Lane	Adjacent	East
B6268 Scroggs Lane	Adjacent	North East
B6267	270m	South
A6108	830m	South West
Leisure		
Old Station Holiday Park	950m	South West

2.8 There are no schools, hospitals, or care homes within 1km of the site.

2.9 The site will be designed to minimise potential impacts on the nearby sensitive receptors. Stringent control measures will be employed on site to ensure that there will be no harm caused to local habitats and the local populace through site activities.

3 RISK ASSESSMENT

3.1 The risk assessment presented below assesses the risks that are posed to nearby receptors from the proposed activity.

3.2 All identified hazards that could cause harm will be subject to strict preventative or control measures.

3.3 A Dust Management Plan has been developed for the site and is provided with the application, setting out how fugitive emissions will be prevented as far as possible to prevent pollution beyond the site boundary.

3.4 Staff will be trained to understand the potential environmental risks associated with the site and their role in managing those risks. An induction will also be provided for contractors, so that they are aware of any environmental requirements

Table 3.1 Amenity and Accident Risk Assessment

Hazard	Receptor	Pathway	Risk Management Techniques	Probability of exposure	Consequence	Overall risk
Dust						
Dry wastes and generation during tipping and vehicle movements	Site staff, local residents, ancient woodlands	Airborne	Vehicles delivering waste will be sheeted or covered when entering and exiting the site. A water bowser will be made available on site. The site entrance is asphalted and will be maintained to prevent the generation of significant dust emissions. During periods of hot dry weather and high winds, the site roads may be sprayed with water to prevent the generation of dust. Brushing of dusty surfaces will also be undertaken by site staff as necessary. Activities that have the potential to produce large amounts of dust will be postponed in the event of high winds. On site speed limits will be enforced to prevent the generation of dust by vehicle movements on haul roads. The quarry walls will provide screening for any potential dust that is generated.	Low – the implementation of dust management techniques will minimise the potential for dust to be blown across or beyond the site boundary.	Fugitive emissions of dust can cause disturbance and potential respiratory issues to those both on and offsite. Dust emissions may affect plants and trees within the ancient woodlands by smothering.	Low
Noise						
Noise from site plant and incoming vehicles	Site staff, local residents, ancient woodlands	Audible	Plant at the site will be fitted with noise suppression features (e.g. silencers) as appropriate. Where vehicle reversing alarms are required, "smart" reversing alarms should be utilised that produce sound at a volume relative to the background level. All plant will be maintained in accordance with manufacturer's recommendations. Particular attention will be paid to noise	Low – noise production will be minimised and controlled by good practice and monitoring by staff.	Disturbance to staff and local residents. Noise from site activities may disturb local wildlife such as birds. Sustained noise can affect the psychological health of those nearby.	Low

Table 3.1 Amenity and Accident Risk Assessment

Hazard	Receptor	Pathway	Risk Management Techniques	Probability of exposure	Consequence	Overall risk
			suppression equipment such as silencers and acoustic panels. A speed limit will be established and enforced. Site plant will be switched off if not in use. Any noise complaints will be investigated in accordance with the environmental management system and recorded within the Site Diary. The Environment Agency will be informed if necessary. Mitigation measures that are implemented will be recorded in the Site Diary. The workings hours are 07:00 – 19:00 Monday to Friday and 07:00 – 13:00 on Saturday, with no scheduled operations taking place on Sundays, Bank or Public Holidays, unless in emergencies.			
Mud						
Mud on site roads	Site staff, local residents, other road users	Tracked on vehicle wheels	The site is equipped with an asphalt site entrance road and hardcore haul roads. Regular inspections will be made of site roads and the highway outside of the site entrance. If mud is present, site staff will undertake cleaning using the water bowser and/or brushing. Vehicles will be subject to visual inspection prior to exiting the site. If necessary, vehicles will be cleaned to prevent mud being tracked onto the highway.	Low – management techniques that are to be implemented will prevent the generation and spread of mud.	Potential increased risk of road traffic accidents, annoyance road users including site staff and local residents.	Low

Table 3.1 Amenity and Accident Risk Assessment

Hazard	Receptor	Pathway	Risk Management Techniques	Probability of exposure	Consequence	Overall risk
Odour						
Odorous material within waste	Site staff, local residents	Airborne	The Inert wastes that are to be accepted present a low risk of odour. Any loads containing odour material will be rejected and removed from site at the earliest possible opportunity. Inspections for odour will be undertaken daily as part of the general site monitoring regime. If any noticeable odours are discovered, an investigation will be undertaken to determine the source and where appropriate remedial action will be undertaken.	Very low – inert wastes should not produce odour. Loads containing odorous material will be rejected from the site.	Disturbance to those on site and local residents if odour travels beyond the site boundary. Strong odours may cause staff and local residents to feel unwell.	Very low
General Risks						
Operator Error	Site staff, local residents, ancient woodlands, water bodies	Airborne, surface and / or water	Plant and equipment will be operated by suitably qualified staff only. An induction will be provided for contractors that will be working at the site. The site will be operated in accordance with an environmental management system.	Very low – staff will receive training that is suitable for their role. Contractors will be inducted by the Site Manager prior to starting work at the site.	Operator error can result in damage to site plant and equipment. Impacts of this include fire, or spills or leaks of hazardous liquids such as fuel. These can affect local human populations, surface water, groundwater, and soils. Particulates and smoke from any damaged plant may cause respiratory issues for local human populations if inhaled.	Low

Table 3.1 Amenity and Accident Risk Assessment

Hazard	Receptor	Pathway	Risk Management Techniques	Probability of exposure	Consequence	Overall risk
Failure of plant or equipment	Site staff, local residents, ancient woodlands, water bodies	Airborne, surface and / or water	Plant and equipment at the site will be subject to regular inspection and maintenance in accordance with the manufacturer's recommendations and legal requirements. Site plant will be equipped with handheld fire extinguishers. In the event that plant or equipment sustains damage or loses function, a suitably qualified engineer will be contacted as soon as possible to undertake repairs. Damaged plant will be taken out of use until the repairs have been completed. Site operations may be halted if necessary to prevent the damaged plant or equipment from causing pollution.	Low – site plant and equipment will be subject to regular maintenance. Where necessary repairs will be undertaken at the earliest possible opportunity.	Failure or damage to plant or equipment may cause disruption to site activities. Damage to plant or equipment may cause a fire, or leak / spill of hazardous liquids such as fuel. Damaged equipment may also pose a health risk. Particulates and smoke from damaged plant may cause respiratory issues for local human populations if inhaled.	Low
Pests or vermin	Site staff	Airborne, surface	The clean inert materials that are be accepted at the site are unlikely to attract pests or vermin. Daily inspections of the site will include checks for any potential infestations. If pests or vermin are identified, a pest control contractor will be contacted as soon as possible. All wastes produced by site operatives will be stored in secure, enclosed receptacles, pending offsite disposal.	Very low – it is unlikely that inert wastes will attract pests or vermin.	Annoyance to site staff or local residents. Potential spread of disease.	Very Low
Litter	Site staff, local residents, ancient woodlands	Airborne, surface	Clean inert materials only will be accepted at the site which are unlikely to pose a risk of litter. Waste will be received in covered or enclosed vehicles. Site staff will observe the tipping of wastes. If	Very low – it is unlikely that loads arriving at the site will contain litter. Site management techniques will limit the potential for any litter to	Litter can attract pests or vermin such as rats and flies. Litter may trap wildlife or cause them to choke if the litter is consumed. Complaints	Very Low

Table 3.1 Amenity and Accident Risk Assessment

Hazard	Receptor	Pathway	Risk Management Techniques	Probability of exposure	Consequence	Overall risk
			non-conforming material is discovered, it will be handpicked and stored in an enclosed receptacle awaiting removal from the site. Checks for litter will be undertaken daily as part of general site monitoring. Wastes that are produced by site operatives will be stored in secure, enclosed receptacles awaiting removal from the site.	be generated on site. The presence of litter will be identified during site inspections.	may occur if litter is carried by the wind beyond the site boundary.	
Spills or leaks of hazardous liquids	Site staff, ancient woodlands, water bodies	Surface, water	Fuel and other potentially harmful liquids that will be used in site plant will be stored in a sealed tank or container with secondary containment. Fuel storage tanks will be bunded. The bund will provide 110% of the capacity of the tank. Spill kits will be provided for use in the event of a spill or leak. Site plant will be subject to regular inspection and maintained in accordance with the manufacturer’s recommendations.	Very low - fuel will be stored in containers equipped with secondary containment. Spill kits will be provided on site.	Contact with hazardous liquids can affect human health and cause pollution of groundwater and surface water. This may impact local habitats and species if hazardous liquids enter waterbodies or permeate the ground surface.	Very low

4 HABITATS RISK ASSESSMENT

Protected Habitats and Species

4.1 Defra's MAGIC map tool (magic.defra.gov.uk) was used to identify protected habitats and species within 2km of the site.

4.2 The Mar Field Fen SSSI is located 1.2km to the west of the site. The SSSI sites on the western bank of the River Ure north of Masham, and comprises a complex of fen meadow, carr woodland and basic flush plant communities.

4.3 Two ancient woodlands (i.e. areas that have been wooded continuously since at least 1600 AD) are present within 1km of the site. Low Burton Wood is situated approximately 50m to the west. An unnamed ancient woodland is located 900m to the northwest. Both sites are classified as ancient replanted woodland, which indicates the sites have been replanted with conifer or broadleaved trees but retain ancient woodland features

4.4 An area of Woodpasture and Parkland BAP Priority Habitat is located 1.8km to the north west. Key features of this habitat may include ancient/veteran trees, grazing animals, microhabitats (eg hollowing trees, other decaying wood, rot holes, ageing bark and fallen but regenerating trees), nectar sources for invertebrates, and open grassland or heathland ground vegetation.

4.5 Defra's MAGIC Maps also indicates a number of priority bird species may be present in the area, including curlew, grey partridge, lapwing, redshank, snipe, corn bunting, tree sparrow and yellow wagtail.

4.6 A granted European Protected Species Licence for bats is located approximately 1.1km to the south east. Noise from the site may cause disturbance to roosting bats, although this is unlikely due to the distance between the site and the location of the bats

Identified Impacts

4.7 The Environment Agency guidance identifies the following potential impacts which may be caused by activities:

- Pollution form contaminated runoff;
- habitat loss caused by pollutants;
- smothering by particulates;

- disturbance by noise; and
- physical damage, for example from litter.

4.8 Contaminated run-off can also cause impacts on surface waters, including eutrophication and toxic contamination.

4.9 The site is unlikely to cause any risk of habitat loss or damage as a result of the landfill operations. The Mar Field Fen SSSI and the BAP Priority Habitat are some distance (>1km) from the site and are considered unlikely to be impacted by the landfill. Effective control of emissions to air, water and land will be in place to ensure negligible risk is caused to all sensitive habitats, including the proximal ancient woodland to the west. Protected birds are unlikely to be present on the site, due to active quarry operations.

Control of Emissions to Water

4.10 The landfill at Gebdykes Quarry will accept clean inert materials only. These have a very low leaching potential and will not generate leachate containing nutrients. The nearest major water body (River Ure) is located 1km from the site, meaning that it is at a very low risk from any unlikely contaminants resulting from the landfill.

4.11 The combination of, stringent waste acceptance procedures, containment of waste with an artificial geological barrier, and the distance from the river will ensure that no pollutants will enter the water body.

4.12 Strict pre-acceptance and acceptance procedures are in place to ensure that only inert materials are deposited on site. All loads of waste will be inspected at the weighbridge and during tipping to ensure they conform with the pre-acceptance information and the conditions of the environmental permit. Any non-conforming waste will be directed off site to an appropriately permitted facility.

4.13 The basal and side slope lining systems will be constructed in accordance with the requirements of the Landfill Directive (LFD), which requires at least a 0.5m thick layer (for artificial barriers). The permeability must be equivalent to a maximum of 1.0×10^{-7}m/s for a 1m barrier. The artificially established geological barrier will be 650mm with a permeability of equal to or less than 6.5×10^{-8}m/s, and will comprise compacted crushed and screened dolomite fines or other suitable imported material (such as clay bound quarry waste) which meets the required liner specification. This will effectively minimise the potential for leachate to infiltrate through local rocks and soils into nearby water courses, including the river Ure.

Control of Dust Emissions

4.14 Excessive dust can cause harm to wildlife and plants through smothering. Large quantities of dust may cause turbidity if discharged to a watercourse.

4.15 A Dust Management Plan has been provided for the site and included with the permit application. The plan sets out detailed measures for controlling dust. These include the following controls:

- vehicles delivering clean inert materials to the site are to be sheeted or enclosed;
- a speed limit will be in place to minimise disturbance of dust;
- the site roads will be properly maintained and will be made up with hardcore where required to minimise the formation of dust and mud;
- a bowser will be available on site and where necessary site roads and working areas will be damped down with water;
- metalled roads will be swept on a regular basis to minimise mud and debris that may be present;
- stockpiles of soil or other restoration materials will be managed to minimise windblown dust and will be grassed over where appropriate; and
- clean inert materials will be compacted as soon as possible after it has been deposited.

4.16 These control measures will ensure that emissions of dust are prevented effectively, therefore it is not considered that dust will cause any significant impact on protected habitats or species.

Control of Noise

4.17 That the landfill is unlikely to cause disturbance to the local bird population as a result of noise. The following control measures will be in place to minimise emissions of noise:

- noise levels will be in compliance with the limits set in the planning permission for the site, which will ensure noise generated by site operations will have negligible impact on nearby receptors;
- modern plant will be used where practical and regular maintenance undertaken, including maintenance related to noise emissions;

- engines on delivery vehicles or mobile plant will be switched off where appropriate to prevent excessive idling;
- haul road surfaces will be graded to ensure that they are kept as smooth as possible and of minimum gradients;
- where vehicle reversing alarms are required, they will be designed to cause the lowest practical environmental impact.

4.18 These control measures will minimise emissions of noise to acceptable levels to prevent pollution beyond the site boundary. Therefore, it is not considered that noise will cause any significant impact on sensitive habitats or species.

5 SUMMARY

5.1 The risk assessment demonstrates the proposed landfilling activity represents a low risk to any potentially sensitive receptors.

5.2 Suitably qualified staff only will be allowed to operate plant and machinery onsite, ensuring that chance of accidents or operator error are kept to a minimum.

5.3 Any potential contaminant risk will be prevented by the inert nature of the waste and strict adherence to waste acceptance procedures.

5.4 There are a number of habitats within 2km of the site. The nearest is Low Burton Wood is situated approximately 70m to the west.

5.5 As the site will accept only clean inert materials there is very little risk of any impact from pollutants leaching from the materials, excessive nutrients leaching from the materials or from litter.

5.6 Effective control measures will be in place to minimise the impacts of noise and dust, ensuring that negative environmental impacts to habitats are effectively prevented.

5.7 The management procedures that will be implemented will ensure that any risks to the environment from noise, dust, mud, litter, and odour are minimised. These control measures will be implemented via the Environmental Management System for the site and annual compliance audits will be undertaken to ensure that the measures are being implemented correctly.

5.8 Due to the inert nature of the materials and the control measures in place it is not considered that the landfill will have any significant impact on local sensitive receptors.

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LIGHTWATER QUARRIES LIMITED

APPLICATION FOR AN ENVIRONMENTAL PERMIT

GEBDYKES QUARRY LANDFILL

ENVIRONMENTAL SETTING AND SITE DESIGN

APRIL 2023

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APPLICATION FOR AN ENVIRONMENTAL PERMIT

GEBDYKES QUARRY LANDFILL

ENVIRONMENTAL SETTING AND SITE DESIGN

APRIL 2023

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1 INTRODUCTION

1.1.1 Lightwater Quarries Limited are applying to the Environment Agency for an Environmental Permit for a proposed inert landfill at Gebdykes Quarry, Halfpenny House Lane, Masham, North Yorkshire.

1.1.2 Gebdykes Quarry is an operational limestone quarry. Current restoration proposals are for a low-level restoration scheme. This is considered inappropriate for the elevated location, and there is now a preference to restore the existing void to original ground level. To facilitate this, clean inert materials are to be imported to the site and placed within the void, which will form the landfilling activity.

1.1.3 The following report has been prepared by Wardell Armstrong to provide the Environmental Setting and Site Design to support the landfill permit application. The report describes the setting of the Site in terms of its geology, hydrogeology and hydrology and explains and justifies the design of the Site.

1.1.4 Operations at the site will meet the requirements of the Environment Agency's guidance "Standards and Measures for the Deposit of Inert Waste on Land".

1.1.5 Section 2 provides details of the site location, the activities that are to be undertaken at the Site, and receptors that are present within close proximity to the Site.

1.1.6 Section 3 details the historical development of the Site and the proposed development under this permit application.

1.1.7 Pollution control measures are set out in Section 4. This includes details of groundwater, surface water, landfill gas and leachate management, basal and side slop lining, capping and restoration.

1.1.8 Section 5 characterises potential pathways for pollutants. Details are provided relating to the climatic conditions, geology, hydrology, hydrogeology and landfill gas.

1.1.9 Section 6 details potential receptors and compliance points including groundwater and surface water, landfill gas, local amenity and habitats.

1.1.10 Section 7 confirms that there is no requirement for a Site Condition Report.

1.1.11 Section 8 provides a summary of the Conceptual Site Model, covering potential sources of pollution, pathways that pollutants could follow and receptors that may be affected.

1.1.12 Section 9 provides a summary of conclusions arising from the document.

2 SITE DETAILS

2.1 Site Location

2.1.1 Gebdykes Quarry is located at Halfpenny House Lane, Masham, North Yorkshire, grid reference SE 23770 82304. The Site location and permit boundary are shown on Drawing NT14621/003. Access to the Site is gained from Halfpenny House Lane, located adjacent to the site to the east.

2.1.2 The Site is situated within a rural location, predominantly surrounded by agricultural land. Security is provided by post and barbed wire fencing in order to prevent unauthorised access and prevent livestock from accessing the Site.

2.1.3 The Site varies from 145m AOD to 117m AOD. Stockpiles of soil and overburden are generally located on the boundaries of the Site in the form of mounds. The quarry itself currently forms an open void.

2.2 Site Activities

2.2.1 The permitted activities will be limited to the landfilling of clean inert materials as set out in Table 2.1, below.

Table 2.1 Permitted Site Activities

Activity	Schedule 1 Reference under EPR2016	Waste Framework Directive Classification
Inert landfill	Not listed	D1 deposit into or onto land, e.g. landfill

2.2.2 It is intended that the site will accept approximately 200,000 tonnes of clean inert materials per annum. The total amount of inert materials to be deposited at the Site is approximately 3,600,000 tonnes.

2.3 Site Design

2.3.1 Limestone extraction will continue within the north void area, with waste infilling commencing within the southern excavation. The infill works will comprise the placement of waste in layers working up from the base of excavation to produce the agreed restoration profile.

2.3.2 The maximum depth of landfill will be 30m. A series of cross sections through the site, showing formation and levels are shown on Drawing NT14621-HRA-005. The sections show the existing profile of the quarry excavation, the proposed permit boundary and restoration profile. The final restoration profile of the landfill is that of a uniform surface, matching closely that of the original landform, with the northern edge of the landfill sloping down to the quarry floor to tie in with the existing access ramp.

2.4 Receptors

2.4.1 A number of sensitive receptors are present within close proximity to the Site. These are detailed in Table 2.2.

Table 2.2: Receptors within 500m

Receptor	Approximate Distance from Site Boundary	Direction
Residential		
Gebdykes Farm	Adjacent	North
East Gebdykes Farm	150m	South West
Snape House	390m	South East
Water bodies		
Pond	350m	South West
Unnamed watercourse	500m	East
Protected Sites		
Low Burton Wood Ancient Woodland	Adjacent	West
Infrastructure		
Limekiln Lane	Adjacent	North
Halfpenny House Lane	Adjacent	East
B6268 Scroggs Lane	Adjacent	North East
B6267	270m	South

2.4.2 There are no schools, hospitals or care homes within 1km of the site.

2.4.3 The nearest designated site is Mar Field Fen SSSI[1], located 1.2km to the west. There are no other SSSIs, National Nature Reserves (NNR), Special Areas of Conservation (SAC) or Special Protection Areas within 2km of the Site.

2.4.4 The River Ure is located approximately 850m to the west of the site. This is classified by the Environment Agency as a main river and flows from north to south. The EA Catchment Data Explorer gives the area of the River Ure (Ure from Thornton Steward Beck to River Skell) to the west a Moderate Classification.

2.4.5 Two areas of ancient woodland are present within 2km of the site.

2.4.6 The MAGIC website indicates that curlew, lapwing, redshank, grey partridge and tree sparrow may be present at or near to the Site. These birds are priority species under the Biodiversity Action Plan.

[1]DEFRA (2020) Magic Map Application [online] Accessed: March 2021
https://magic.defra.gov.uk/MagicMap.aspx

2.4.7 There are no heritage assets located within the Site Boundary. Those nearest to the Site are:

- Low Burton Hall (Grade II Listed) 630m south west of the site;
- Dovecote (Grade II Listed), 890m east of the site; and
- Burton House (Grade II Listed), 1km south west of the site;

2.4.8 The Site is located on a Principal Bedrock Aquifer. A Secondary (undifferentiated) Superficial Aquifer underlies areas of the site to the south. The Site is not located within a Source Protection Zone[1]. Further detail of the geology and hydrogeology is provided in Section 5.

3 SOURCE CHARACTERISATION

3.1 Historical Development

3.1.1 Extraction of stone from land within the vicinity of the current Gebdykes Quarry dates back to at least the 1860s. The current Gebdykes Quarry and a quarry located adjacent to the site boundary to the north west were known as "Gybdykes Quarry" at this time.

3.1.2 Gybdykes Quarry to the north west of the current site has since been worked and restored into a small, wooded area.

3.1.3 The first permission for mineral extraction at the site was granted in 1949. The permission required the following:

- All topsoil and overburden to be deposited in a level manner within the quarry workings, and the land to be returned to agriculture so far as practicable.

3.1.4 This planning permission was reviewed, resulting in a new permission (C2/97/135/0051C/MR) containing revised conditions being issued on 3 February 1998.

3.1.5 Planning permission was granted on 5 November 2001 for a northern, eastern and southern extension to Gebdykes Quarry (C2/99/135/0051D). These permitted extensions currently form the scope of the existing quarry boundary. The permission required that:

- Following mineral extraction, overburden and other waste materials should be replaced to such levels so that, after the replacement of subsoil and topsoil the contours of the restored land shall conform with the restoration contours as indicated in the application details.

3.1.6 In accordance with the planning permission, the Site is to be restored to original ground levels and for the purpose of agriculture. This is shown on drawing NT14834/Figure 3.6.

3.1.7 There are no historic landfills within 2km of the Site. The closest to the site are West Tanfield Quarries Landfill, located approximately 3.2km to the southeast, and West Tanfield Landfill, located approximately 4.5km to the southeast. Both landfills received household, commercial and industrial wastes and are now closed.

3.1.8 There are no recorded pollution incidents within 2km of the Site (the closest was located at grid reference SE 22080 80733, approximately 2.2km to the west).

3.2 Proposed Development

3.2.1 The primary purpose of the waste activity is to restore the site to its original levels by filling the void with clean inert materials, facilitating high level restoration. The Final Restoration Layout plan is provided as drawing NT14834/Figure 3.6.

3.2.2 Landfill operations will be undertaken in five distinct phases in the southern void of the quarry as shown in Drawings NT14834/Figure 3.1 – 3.5. Limestone extraction will continue within the north void area contemporary to landfilling operations in the south. The infill works will comprise the placement of clean inert waste in layers working up from the base of excavation to produce the agreed restoration profile. The calculated total void space is 3,600,000 tonnes.

3.2.3 The list of wastes that will be accepted at the site and detailed waste acceptance criteria are set out in the Operating Techniques document, included in this permit application.

3.2.4 The Environmental Permitting (England and Wales) Regulations 2016 replace the Groundwater Regulations 2009 and transpose the Groundwater Directive 1980, the Water Framework Directive 2000, and Groundwater Daughter Directive 2006. These directives require that inputs of pollutants to groundwater are either prevented or limited to avoid or control groundwater pollution. A risk screening exercise must be undertaken to assess the level of risk assessment required for the Site.

3.2.5 As the materials accepted will be inert, and by definition do not generate leachate, no leachate collection infrastructure will be required.

4 POLLUTION CONTROL MEASURES

4.1 Site Engineering

Groundwater Management Systems

4.1.1 Groundwater management is not required. The site will be worked dry, and there will be no operations below the water table.

4.1.2 Four boreholes have been installed at the Site to allow for background groundwater monitoring of the Cadeby Formation (see Drawing NT14356-HRA-001) . Boreholes BHWA03 and BHWA04 are located west of the Site, and it is proposed to retain both boreholes as upgradient monitoring boreholes. Boreholes BHWA01 and BHWA02 are located east and south-east of the Site, and it is therefore proposed to retain both boreholes as downgradient monitoring boreholes. Due to the variation in groundwater flow directions it is proposed to install an additional downgradient monitoring borehole on the southern boundary of the Site to improve the monitoring network during the operational phase (see Drawing NT14621-HRA-006). During the operational phase, groundwater monitoring is proposed on a six-month basis. Further details are provided in the Hydrogeological Risk Assessment, included as part of this permit application.

Surface Water Management System

4.1.3 The landfill will be designed to ensure that run-off has been in contact with the waste will not escape directly the exposed quarry floor, but will intercepted and diverted to a large lagoon to the north of the void area. The lagoon will be lined by a 1m thick layer of engineered clay, with no pathway for infiltration.

4.1.4 Water within the lagoon will be tested for contamination. Uncontaminated water will be pumped as required to areas of quarry void outside of the development areas (within the wider quarry site) where it will infiltrate to ground.

4.1.5 Any contaminated water will be isolated and treated to meet the permitted limits, or will otherwise be removed from site to a permitted facility. Preliminary compliance limits will be set in line with those for borehole BHWA03, as supported by the Hydrogeological Risk Assessment provided with the permit application.

4.1.6 Details of the surface water management are provided in the Operating Techniques report.

Basal Lining System

4.1.7 The landfill is to be constructed with a 650mm thick basal attenuation layer (geological barrier). This barrier will typically comprise crushed and screened dolomite fines.

4.1.8 The basal lining system will be constructed in accordance with the requirements of the Landfill Directive, which requires at least a 0.5m thick artificial barrier. The permeability must be equivalent to a maximum of 1.0×10^{-7}m/s for a 1m barrier. The basal liner will consist of re-engineered crushed and screened dolomite fines, which will be compacted to a permeability equal to or less than 6.5×10^{-8}m/s, meeting the requirements of the Landfill Directive. If there is a shortfall of dolomite fines or the material becomes otherwise inconsistent, other suitable cohesive imported material, such as clay-bound quarry waste, will be used which is able to meet the required liner specification.

4.1.9 Lining will extend up any shallower quarry side slopes in the form of a graded profile, generally not exceeding 1 in 3 (18° from the horizontal), which should provide an adequate level of stability. For steeper face profiles, lining will be contemporaneous with waste emplacement, in the form of a 3m wide bench constructed as a series of overlapping horizontally placed bunds (Christmas Tree fashion) up the face of excavation. Each lift will typically be between 2 and 3m in height, as illustrated on the Construction Cross Section - Drawing NT14621/Figure3.7. It is anticipated that the steep wall lining technique will predominate at the quarry. Further details are provided in the Stability Risk Assessment included as part of this permit application.

4.1.10 The character and composition of the inert waste stream should be comparable to the geological barrier and as such will provide support to the sidewall bund and not impact on the integrity of the lining system. This form of steep wall liner construction follows the standard approach for inert waste sites. Stability of the basal and side slope lining system is not therefore considered to be an issue at the site.

4.1.11 The landfill basal subgrade comprises limestone underlain by an extensive interbedded sequence of sandstone, grits and mudstones of the Millstone Grit Group. The potential for movement in the basal subgrade is negligible.

4.1.12 Due to the inert nature of the material it is not necessary to provide an artificial sealing liner above the geological barrier. A leachate drainage layer or leak detection system is also not necessary.

4.1.13 All engineering works will be carried out in accordance with a Construction Quality Assurance (CQA) Plan and supervised by an independent engineer to ensure that construction is carried out in accordance with the CQA Plan.

Side Slope Lining System

4.1.14 The initial side slope lining system will comprise of a crushed and screened dolomite fines bund, 2m in height and 3m in width, to connect to the existing side slope. The material with have a permeability equivalent to a maximum of 1.0×10^{-7}m/s for a 1m barrier. Subsequent side slope lining systems will be installed with each waste lift.

4.1.15 There are no anticipated problems regarding substantial failure of the side slope sub-grade. Further details are provided in the Stability Risk Assessment.

Capping

4.1.16 The Landfill Directive only requires capping where there is a need to minimise leachate formation, i.e. at hazardous and non-hazardous landfills. As the site is only going to accept inert wastes no formal cap is required.

4.1.17 To restore the site to agriculture, a restoration soil profile will be created, comprising approximately 300mm of topsoil (previously stripped from the site) over 250 mm subsoil over 600mm of quarry overburden ('Lightwater Quarries Limited – Gebdykes Quarry – Submission to Approve Details Reserved Under Conditions 8 and 35 of Planning Consent C2/99/135/0051D at Gebdykes Quarry' by David L Walker Limited dated February 2013 David L Walker Ltd).

4.1.18 No large pieces of inert material (over 150mm in size) will be included within the restoration layer.

Restoration and Aftercare

4.1.19 Upon completion of landfilling, subsoil and topsoils will be placed in accordance with the restoration contours as indicated on drawing NT14834/Figure 3.6.

4.1.20 Due to the inert nature of the materials that will be accepted at the site, the deposited material will pose a very low risk to the environment.

4.1.21 The landform of the landfill has been designed to replicate the landform of the site before the quarry was developed, it therefore ties into the surrounding landform to the east, west and south and would be at 144m AOD at the highest point in the southern section of the landfill. The northern edge of the landfill would then slope down to the quarry floor to tie in with the existing access ramp. The design restoration profile should be stable in the long term for inert waste materials imported to site.

Given the overall height of 20m of waste, the stability of the overall restoration profile is considered to warrant further assessment. Further details are provided in the Stability Risk Assessment.

4.1.22 The effects of waste mass settlement have been assessed. Unlike biodegradable wastes where settlement can be as much as 20%, there is unlikely to be any appreciable settlement of the subsoil and clays, which are likely to predominate within the inert waste stream. Providing that waste materials are adequately layered and tracked in by dozer, the estimated extent of settlement will typically be less than 5%. Much of the waste settlement will occur prior to completion of infilling, through the effects of compaction and self-weight settlement.

4.1.23 Any localised areas of increased settlement resulting from variations in waste type can usually be addressed at the time of restoration. It is considered that there is no requirement to form a pre-settlement waste profile at the site. The effect of waste mass settlement on the integrity of the lining system is considered to be minimal and will not require further consideration.

4.1.24 The risk screening process within the Stability Risk Assessment ultimately indicates there are no overriding stability issues associated with the proposed inert landfilling operations at the site, with the risk status being very low.

4.1.25 Once restoration is completed, the Site will be returned to agricultural use.

4.1.26 Surrender of the permit will largely be based on records that were collected through the operational life of the Site. These will provide the necessary evidence that only clean inert materials were accepted and deposited.

Leachate Generation and Management

4.1.27 Given the inert nature of the material and the strict pre-acceptance and acceptance procedures that will be in place for the Site it is unlikely that any leachate will be generated.

4.1.28 Rainfall moving through the Site may produce a leachate but this will not alter the existing water balance for the Site. Therefore, a water balance is not required to be undertaken.

4.1.29 It is not proposed that any leachate monitoring is undertaken due to the very low risk posed by leachate from the site.

Landfill Gas Management and Monitoring Infrastructure

4.1.30 Strict pre-acceptance and acceptance procedures will be implemented at the Site, ensuring that clean inert materials only will be deposited. As a result of this, it can be determined with a high level of confidence that biodegradation of the material will be negligible. If landfill gas is generated the amount will be insignificant. As a result of this, there will be no requirement for gas extraction at the site.

4.1.31 Internal landfill gas monitoring boreholes will be installed as each phase is being competed. Gas boreholes will be installed to the full depth of the inert material. Two gas boreholes will be constructed per hectare. This is sufficient as part of the criteria to achieve low risk surrender for inert materials. Due to the low risk of landfill gas generation there are no plans for peripheral monitoring boreholes around the site.

4.1.32 The landfill gas boreholes will be provided with adequate protection to prevent any damage. The boreholes will be maintained and monitored during the post closure period. Given the inert nature of the material it is expected that gas monitoring will continue for up to 24 months following closure.

4.1.33 The design of the boreholes will be agreed with the Environment Agency. Construction of the boreholes will be undertaken in accordance with a CQA Plan.

Surface Water Management

4.1.34 Only runoff from outside the operational areas of the Site will be allowed to infiltrate directly into the underlying bedrock, with no discharge offsite.

4.1.35 There are no surface water courses within close proximity to the site. The closest is a drain located over 650m away to the southwest.

4.1.36 As described in section 4, surface water runoff from the operational areas of the Site will be prevented from infiltrating directly into the underlying bedrock and instead intercepted and diverted to a lined lagoon to the north of the void area. Water within the lagoon will be tested to ensure parameters are within the permitted limits before being allowed to discharge to groundwater or will otherwise be treated or sent off site to a permitted facility.

4.1.37 The limits used will be in line with the compliance limits set for groundwater monitoring.

5 PATHWAY CHARACTERISATION

5.1 Climate

5.1.1 Long term monthly rainfall data (1981-2010)[2] has been obtained from the Meteorological Office for the Leeming observing site. The site is located at Royal Air Force Leeming, NGR SE 30688 89033, approximately 9.2km north east of Gebdykes Quarry. Average rainfall for this period is detailed in Table 5.1.

Table 5.1: Monthly Average Rainfall at Leeming for the Period 1981 - 2010

Month	Average Monthly Rainfall (mm)	Month	Average Monthly Rainfall (mm)
January	55.5	July	51.3
February	39.9	August	63.3
March	43.3	September	53.9
April	50	October	62.2
May	43.2	November	60.5
June	60.2	December	58.6

5.1.2 The dominant wind direction is from the south west. The monthly mean wind speeds for the location are as follows.

Table 5.2: Monthly Average Windspeed at Leeming for the Period 1981 - 2010

Month	Average Monthly wind speed at 10 m (knots)	Month	Average Monthly wind speed at 10 m (knots)
January	9.6	July	6.9
February	9.1	August	6.9
March	9.3	September	7.3
April	8.1	October	7.7
May	7.8	November	8.2
June	7.2	December	8.1

5.1.3 The weather forecast will be checked at the start of each day, and staff will be cognisant of weather conditions through the working day.

5.1.4 There are a number of properties and a farm located to the north east and north west of the site. These may be affected in the event that high amounts of dust are generated, although this is unlikely due to the stringent control measures that will be implemented. Details relating to the control of dust emissions are provided in the Amenity and Accident Risk Assessment and Dust Management Plan, included in this permit application.

5.1.5 Gas is not expected to be generated from clean inert materials accepted at the site.

[2] Meteorological Office (2021) UK Climate Averages Leeming [online] Accessed: March 2021 https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gcwuvhmch

5.2 Geology

Overview

5.2.1 The geological setting of the Site and surrounding area is described below based on published British Geological Survey (BGS) 1:50,000 Scale mapping and information provided by a 2019 Site Investigation by Wardell Armstrong. Four boreholes were drilled and installed around the Site to understand local geology/hydrogeology and provide a baseline groundwater monitoring network. The locations of these are shown on drawing NT14621-HRA-001.

Superficial Deposits

5.2.2 Published BGS 1:50,000 scale mapping indicates that superficial deposits in the form of Glacial Till (diamicton) are present towards the south of the Site, although superficial deposits are absent from the majority of the Site.

5.2.3 BGS Online mapping[3] shows that there is a small area of superficial deposits to the north east of the site (Head - Clay, Silt, Sand and Gravel)

5.2.4 The 2019 Site Investigation recorded superficial deposits (described as brown/yellow sandy gravel) in borehole BHWA4 only.

5.2.5 The lack of superficial deposits encountered in the other three boreholes across the site gives a good indication that the distribution of superficial deposits is sporadic and largely absent.

Bedrock Geology

5.2.6 The bedrock geology at the site is dominated by Dolostones of the Cadeby Formation, previously known as the Magnesian Limestone, part of the Zechstein group[3]. The upper Formation consists of cross-bedded oolitic limestones, whilst the lower beds comprise successions of domed stromatolites and dolomitized bryozoan-rich path reefs (Lott and Cooper, 2005)[4]. The bedrock was deposited in a shallow-marine environment along the western shoreline of the Zechstein sea, and dips regionally to the east/south-east.

5.2.7 The Cadeby Formation is underlain by the Permian Marl. Where the Marl is absent, the Formation is directly underlain by the Basal Permian Sands Formation, part of the

[3] British Geological Survey (2021) Geology of Britain Viewer [online] Accessed March 2021 https://mapapps.bgs.ac.uk/geologyofbritain/home.html
[4] Lott, G.K. & Cooper, A.H., 2005. The building limestones of the Upper Permian, Cadeby Formation (Magnesian Limestone) of Yorkshire. British Geological Survey Internal Report, IR/05/048, pp. 8-12

Rotliegend Group, which consists of sandstone, breccia and conglomerate (Lott and Cooper, 2005).

5.3 Soils

5.3.1 The soils overlying the Site are freely drainage lime-rich loamy soils of the Aberford soil association.

5.3.2 Due to its high drainage capacity, this type of soil may be vulnerable to leaching of nitrate to groundwater, and nutrient enrichment and silting of chalk streams and their gravel spawning beds as a result of the erosion of chalk soils.

5.3.3 A detailed MAFF soil survey was undertaken in 1995, which included the extent of quarry working at that time. The survey identified the soils to the south of Limekiln Lane as being very slightly stony medium-textured topsoil overlying medium clay loam (MCL) or medium silty clay loam (MZCL) topsoil overlying medium clay loam (MCL), medium silty clay loam (MZCL), heavy clay loam (HCL) or heavy silty clay loam (HZCL) subsoils. Weathered limestone was detected at varying depth, typically between 60 and 70 cm depth (Grade 2 land); 40 to 55 cm depth (Subgrade 3a land); and between 20 and 35 cm depth (Subgrade 3b land); the limiting factor in each case being soil droughtiness.

5.4 Hydrology

Surface Water Features

5.4.1 Ordnance Survey (OS) mapping shows that there are no surface water features within the Site boundary.

5.4.2 There are two unnamed watercourses in the surrounding area, which are both classified as Ordinary Watercourses. The first is located at Snape Lodge Farm, approximately 500m to the east of the Site, which flows in a north-east direction away from the Site. The second is located at Low Spring cottages, 900m to the west of the Site, and flows southwards away from the Site.

5.4.3 There are also two unnamed ponds within close proximity to the site. These are located approximately 400m to the east at Snape Lodge Farm and 370m south-west near Low Burton Wood.

5.4.4 There are no rivers within the Site area. The nearest is the River Ure, which is designated as a Main river by the Environment Agency. It is located approximately 815m west of the Site and flows in a southerly direction. At its nearest point to the Site, the river elevation is approximately 80m AOD.

5.4.5 The site is not located within a flood plain.

Surface Water Abstractions

5.4.6 The Environment Agency provided details of surface water abstractions within 2km of the site on 17 June 2020. These are summarised below.

Table 5.3: Surface Water Abstractions within 2km					
Licence Number	Name	Description	Use	NGR	Distance from Site
2/27/22/417	C H Greensit LTD	Agriculture	Spray Irrigation - Direct	SE23108067	1.48km South West

Surface Water Discharges

5.4.7 The Environment Agency also provided details of surface water discharges within 2km of the site. These are summarised in the table below.

Table 5.4: Surface Water Discharges within 2km					
Licence Number	Site Name	Receiving Waterbody	Discharge Volume (m^3/day) or condition	NGR	Distance from Site
S/P/1540	6 Station Bungalow	River Ure		SE2310082100	500m west
27/22/0107	Old Station Yard Holiday Park	Unnamed Tributary of River Ure	9	SE2306081050	1.25km south west
27/22/0056	Shooting Holm SPS	River Ure via a land drain	Sewage in an Emergency	SE2264081010	1.5km south west
27/22/0161	Leyburn Road CSO	Tributary of River Ure	When flow exceeds incoming	SE2258081010	1.5km south west
27/22/0162	Millgate Masham CSO	Tributary of River Ure	Flow exceeds 17.8l/s	SE2271480804	1.6km south west
27/22/0063	Masham Sewage Treatment Works	River Ure	1528	SE2308080630	1.6km south west
27/22/0132	Silver Street CSO	Tributary of River Ure	Flow exceeds 86.5l/s	SE2253880845	1.7km south west

Surface Water Quality

5.4.8 The Site is situated within two different surface waterbody catchments. The catchment divide follows the western edge of the Site and intersects the Site boundary at several points. The Site is primarily within the Ings Goit from Source to Burneston Beck Catchment (ID: GB104027068800) (Environment Agency, 2021), but to the west the Site becomes a part of the Ure from Thornton Steward Beck to River Skell Catchment (ID: GB104027069461) (Environment Agency, 2021).

5.4.9 The 2019 Environment Agency (EA) classification of the Ings Goit from Source to Burneston Beck Catchment has a chemical status of Fail and an ecological status of Moderate. The Ure from Thornton Steward Beck to River Skell Catchment has a chemical status of Fail and an ecological status of Moderate. Both surface water body catchments have a chemical status of Fail due to the presence of polybrominated diphenyl ethers (PBDE).

Flood Risk

5.4.10 According to the EA Flood Map for Planning the Site is located within Flood Zone 1, defined as having less than 1 in 1,000 annual probability of river or sea flooding.

5.4.11 According to the EA Long Term Flood Map, the Site is at very low risk from flooding from rivers, the sea and surface water.

5.4.12 The North Yorkshire County Council Strategic Flood Risk Assessment (SFRA) map confirms that the Site is 100% in Flood Zone 1, and that the Site is not at risk from the 1:20 (5%) flood event.[5]

5.4.13 Climate change to river flood risk is unlikely to affect the Site in the latter part of the plan period. Climate change effects on surface water flooding are likely to increase the extents of the areas at risk and also the depth of flooding for each event respectively.[6]

5.5 Hydrogeology

Aquifer Characteristics

5.5.1 The overlying superficial deposits of Glacial Till, where present, are classified as Secondary Undifferentiated Aquifers by the Environment Agency. The Cadeby Formation (Magnesian Limestone) is classified as a Principal Aquifer, which is defined as “geology that exhibits high permeability and/or provides a high level of water storage. They may support water supply and/or river base flow on a strategic scale”. Groundwater flow and storage within the Principal Aquifer is associated with the secondary permeability of the formation, governed by fractures, fissures and joints.

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[5] Environment Agency (2021) Long Term Flood Risk Map [online] Accessed March 2021 https://flood-warning-information.service.gov.uk/long-term-flood-risk/map

[6] North Yorkshire County Council (2016) Strategic Flood Risk Assessment [online] Accessed March 2021 https://www.northyorks.gov.uk/sites/default/files/fileroot/About%20the%20council/Partnerships/Strategic_flood_risk_assessment.pdf

5.5.2 Given the sparse cover of superficial deposits at the Site, the section of the aquifer within the Site can predominantly be considered as unconfined. It would be expected that the Permian Marl, where present, would act as a basal aquitard or potentially a leaky aquitard where fractures are present. It would not be expected to be in hydraulic continuity with the overlying aquifer.

5.5.3 A Hydrogeological Cross Section is provided as NT14621-HRA-005.

Groundwater Elevation

5.5.4 Groundwater elevation monitoring has been undertaken at four locations around the Site (boreholes BHWA01-BHWA04) and at BH8 within the centre of the existing quarry void.

5.5.5 Groundwater level monitoring commenced in December 2019, initially using manual dips. Absolute water level elevations in metres above ordnance datum (m AOD) were calculated by reducing water levels against surveyed datums. Subsequently, continuous data loggers were installed in July 2020, recording data hourly. Continuous groundwater elevation data was compensated using an on-site barometric logger.

5.5.6 Table 5.5 shows the manually recorded groundwater elevations from the boreholes around the Site.

Table 5.5: Manual Groundwater Elevation Measurements - The Site										
Date and measurer	**Dip Level (m BTOC)**					**Groundwater Elevation (m AOD)**				
	BH WA01	**BH WA02**	**BH WA03**	**BH WA04**	**BH8**	**BH WA01**	**BH WA02**	**BH WA03**	**BH WA04**	**BH8**
Casing Elevation (mAOD)	*141.53*	*141.28*	*138.43*	*138.67*	*124.8*[1]	*141.53*	*141.28*	*139.43*	*138.67*	*124.8*
23/12/19 LQ	Dry	34.3	25.5	22.7	-	Dry	107	114	116	-
06/02/20 LQ	Dry	34.6	24.5	22.0	-	Dry	106.7	114.9	116.7	-
07/04/20 LQ	34.7	29.8	22.7	19.9	-	106.83	111.5	116.7	118.8	-
06/05/20 LQ	34.5	32.7	22.7	20.3	-	107.03	108.6	116.7	118.4	-
03/06/20 LQ	34.6	34.6	22.9	20.7	-	106.93	106.7	116.5	118	-
09/07/20 WA	35.1	35.4	22.9	21.2	-	106.43	105.9	116.5	117.5	-
19/08/20 WA	35.4	36.1	23.6	21.8	-	106.13	105.2	115.8	116.9	-
15/09/20 WA	36.2	36.6	24.6	22.5	-	105.35	104.7	114.8	116.2	-
13/10/20 WA	36.4	36.3	24.8	23.5	-	105.13	105	114.6	115.2	-
17/11/20 WA	36.5	36.0	24.9	22.7	9.5	105.03	105.3	114.5	116	115.3
16/12/20 WA	36.4	35.8	24.8	22.5	8.0	105.13	105.5	114.6	116.2	116.8
26/01/21 WA	35.4	29.7	23.5	20.3	6.2	106.13	111.6	115.9	118.4	118.6

Note
LQ - Lightwater Quarries (the Client)
WA - Wardell Armstrong
m BTOC – Metres Below Top of Casing
m AOD – Metres Above Ordnance Datum
- No measurement recorded
[1] Google Earth Pro, 2020. Gebdykes Quarry, Beadle. 54°14'07.91"N, 1°38'13.99"W.

5.5.7 Groundwater elevation data (December 2019 to January 2020) for the Site is presented in the Hydrogeological Risk Assessment.

5.5.8 Manual groundwater dip levels measured between December 2019 and April 2020 demonstrate that groundwater elevations rose, in response to winter rainfall recharge, peaking in April 2020. Between April 2020 and September 2020, groundwater elevations have shown a general decline. From September 2020 to January 2021, groundwater elevations have again risen, in response to increased levels of precipitation. Groundwater elevations would be expected to be at their highest in February or into spring, in response to winter rainfall events.

5.5.9 Groundwater elevations in the limestone can fluctuate by several meters. The largest fluctuation in groundwater elevations has been observed in borehole BHWA02, varying by over 6m. Within the northern extension area, located to the north of the Site, groundwater elevations have been consistently shown to be highest in borehole BH2, with a maximum recorded elevation of 124.2m AOD in January 2021.

5.5.10 A sufficient water column was maintained in all boreholes throughout the ongoing baseline groundwater monitoring, providing validity to the quality of groundwater sample obtained.

Groundwater Flow

5.5.11 The groundwater elevation data indicates that the hydraulic gradient generally follows a north west to south east orientation across the Site, coinciding with the dip of the Limestone beds. The direction of groundwater flow fluctuates across the Site dependant on groundwater elevation; flow is orientated more easterly during the groundwater low in August 2020, and more southernly during the groundwater high.

5.5.12 The hydraulic gradient has remained relatively consistent throughout groundwater elevation monitoring. The hydraulic gradient was calculated as 0.022 in August 2020 during the groundwater low, and as 0.021 in January 2021 during the groundwater high.

5.5.13 Boreholes BHWA04 and BHWA03 are located hydraulic upgradient of the Site, whilst boreholes BHWA01 and BHWA02 are located downgradient of the Site. Groundwater elevations have consistently been lowest in borehole BHWA02, east of the Site, with the lowest recorded elevation of 104.9m AOD in September 2020.

5.5.14 Groundwater flow within the Cadeby Formation is dominated by secondary permeability, a combination of flow within fractures, fissures, and joints. There is a minor component of intergranular storage, however this low is due to the low intrinsic permeability of the Limestone.

Groundwater Abstractions

5.5.15 The Environment Agency confirmed on 29 June 2020 that there are a number of groundwater abstractions within 2km of the Site. Details of these are as follows.

Table 5.6: Groundwater Water Abstractions within 2km

Licence Number	Name	Description	Use	NGR	Distance from Site
2/27/23/391	W H Greensit & Sons	Agriculture	Spray Irrigation - Direct	SE243828	0.52km east
2/27/22/010	Tarmac Aggregates Ltd	Industrial, Commercial and Public Services	Dust Suppression General Use Relating to Secondary Category (Medium Loss) Mineral Washing	SE2168782582	1.64km west
2/27/22/475	The Black Sheep Brewery PLC	Industrial, Commercial And Public Services	General Use Relating To Secondary Category (Medium Loss)	SE22388110	1.8km south west
2/27/22/475	The Black Sheep Brewery PLC	Industrial, Commercial And Public Services	General Use Relating To Secondary Category (Medium Loss)	SE22418112	1.83 south west
NE/027/0022/050	T & R Theakston Ltd	Industrial, Commercial And Public Services	Drinking, Cooking, Sanitary, Washing, (Small Garden) - Commercial/Industrial /Public Services	SE2228880778	1.86km south west
NE/027/0022/050	T & R Theakston Ltd	Industrial, Commercial And Public Services	Process Water	SE2228880778	1.86km south west
2/27/23/729/R01	Websters (Farmers) Ltd	Agriculture	Spray Irrigation - Direct	SE2599381259	1.89km south east
2/27/22/051	T & R Theakston Ltd	Industrial, Commercial and Public Services	General Use Relating to Secondary Category (Medium Loss)	SE223810	1.95km south west
2/27/22/017	T & R Theakston Ltd	Industrial, Commercial and Public Services	General Cooling (Existing Licences Only) (Low Loss)	SE222807	1.95km south west

Groundwater Discharges

5.5.16 There are two discharges to groundwater within 2km of the Site, details of which are included in Table 3.3.

Table 5.7: Groundwater discharges within 2km					
Licence Number	**Effluent Type**	**Receiving Waterbody**	**Discharge Volume (m^3/day)**	**NGR**	**Distance from Site**
NE/254/0759/002	Sewage - not water company	Land	1.5	NZ39200 22600	1.13km south west
NE/253/1027/001	Sewage - not water company	Land	0.75	NZ38700 24800	1.41km north west

Groundwater Quality

5.5.17 Groundwater underlying the Site resides entirely within the SUNO Magnesian Limestone groundwater body (ID: GB40401G701800) and is monitored by the Environment Agency. In 2019, the groundwater body was classified as having a chemical status of 'Good' and a quantitative status of 'Good'.

5.5.18 Groundwater quality sampling has been carried out by Wardell Armstrong between August 2020 to January 2021. This consisted of six monitoring rounds. Groundwater samples were obtained from four boreholes (BHWA01-BHWA04). Physio-chemical parameters were monitored in the field using a handheld Aquaread multi-parameter probe. Groundwater quality samples were analysed by Envirolab. The results of groundwater quality monitoring are provided in the Hydrogeological Risk Assessment, included as part of this permit application.

5.5.19 Concentrations of nitrite and nitrate have been recorded in groundwater at the Site above the UK Drinking Water Standards (UK DWS). Concentrations of cadmium, copper, chromium, manganese, magnesium, nickel and zinc have been recorded in groundwater at the Site above the Environmental Quality Standards (EQS).

5.5.20 The Site is located within a Nitrate Vulnerable Zone[1].

5.5.21 The Site is located within a Drinking Water safeguard zone for surface water[1].

5.5.22 The Site is not located within a Source Protection Zone. The nearest Source Protection Zone (Zone 2) is located 2km to the south.

5.6 Landfill Gas

5.6.1 There are no historic gas monitoring boreholes around the Site, and the risk of landfill gas migration is considered to be low.

5.6.2 Waste acceptance procedures will ensure that only clean inert materials will be accepted at the site. These are unlikely to generate gas.

5.6.3 Landfill gas monitoring boreholes will be installed as the phase is being completed. Two gas boreholes will be constructed per hectare. This is sufficient as part of the criteria to achieve low risk surrender for inert materials. Due to the low risk of landfill gas generation there are no plans for peripheral monitoring boreholes around the site.

5.6.4 The landfill gas boreholes will be provided with adequate protection to prevent any damage. The boreholes will be maintained and monitored during the post closure period. Given the inert nature of the material it is expected that gas monitoring will continue for 24 months following closure.

5.6.5 In the unlikely event landfill gas is detected (i.e monitoring results detect methane >1% or carbon dioxide >5%) in an in-waste borehole during routine monitoring, then a second round of monitoring will be undertaken within a week of its detection and weekly monitoring would continue. If gas continues to be detected, the operator will install peripheral monitoring boreholes to establish if the gas is migrating, with careful consideration to nearby sensitive receptors. The operator will contact the EA to report the findings and agree appropriate actions to protect the environment.

6 RECEPTOR AND COMPLIANCE POINTS

6.1 Groundwater and Surface Water

6.1.1 Potential groundwater and surface water receptors are considered within the Hydrogeological Risk Assessment (HRA).

6.1.2 It is determined that the potential groundwater receptors are groundwater in the Principal Aquifer (Cadeby Formation) and the Secondary Undifferentiated Aquifer (Glacial Till).

6.1.3 Potential surface water receptors include the two unnamed ponds at Snape Lodge Farm 0.4km to the east of the Site, and Low Burton Wood, 0.37km to the south- west of the Site. The pond at Snape Lodge Farm is located down-hydraulic gradient of the Site, however the expected basal elevations of the pond are much higher than groundwater elevations at the Site, so it is unlikely that there is any interaction between groundwater and the pond. Additionally, there is no permanent drainage channel to the pond. Likewise, for the pond at Low Burton Wood there is also no permanent drainage channel and the pond is located upgradient up-hydraulic gradient of the Site, therefore interactions between groundwater and the pond are unlikely.

6.1.4 Other potential surface water receptors include the River Ure, located 0.9km to the west of the Site, which can be considered a sensitive receptor, as it is part of both a nitrate vulnerable water body and achieved a WFD Chemical Status of Fail in 2019 (Environment Agency, 2021). However, the River Ure is located up-hydraulic gradient and there is no known permanent drainage channel from the Site to the river.

6.1.5 The Site is designed to allow surface water to be directed to the northof the void area, where it will be captured in a lined lagoon. Collected waters will discharged to groundwater in accordance with the permit conditions, or will be sent to a permitted facility for treatment and disposal.

6.1.6 It is proposed that the four boreholes on site will be monitored on a six-month basis. Groundwater levels will be recorded, samples will be taken for chemical analysis, and the dip to base will also be recorded.

6.2 Landfill Gas

6.2.1 The residential receptors that are present within the vicinity of the site are listed within Table 2.2 The closest property is Gebdykes Farm, located adjacent to the northern boundary.

6.2.2 Landfill gas generally consists of 60% methane and 40% carbon dioxide. These are greenhouse gasses and may contribute to climate change. For this reason, the air itself is a receptor and uncontrolled releases to the atmosphere should be minimised.

6.2.3 Clean inert materials only will be accepted at the site for deposit. Thus, the potential for landfill gas generation is minimal.

6.2.4 Waste Acceptance Criteria will be implemented to ensure that the materials deposited are in accordance with the permit. Records will be kept of all materials that are accepted. Further details are provided in the Operating Techniques document, included in this permit application.

6.3 Amenity

6.3.1 Inert wastes that are accepted at the Site are unlikely to produce emissions of odour or litter. The most likely emissions to be generated are dust. Operational control measures will be implemented to prevent dust emissions. These are set out in the Operating Techniques document.

6.3.2 The compliance point will be the Site boundary. Control measures will ensure that the production of dust is prevented, ensuring that dust will not be allowed to cross the Site boundary and affect nearby receptors.

6.3.3 Levels of noise production associated with landfilling are not expected to be significantly different from the noise that is produced during quarrying activities that have been undertaken at the Site.

6.4 Habitats

6.4.1 The nearest designated site is Mar Field Fen SSSI, located 1.2km to the west. Two areas of ancient woodland are present within 2km of the site. There are no other SSSIs, National Nature Reserves (NNR), Special Areas of Conservation (SAC) or Special Protection Areas within 2km of the Site.

6.4.2 The River Ure is located approximately 815m to the west of the site.

6.4.3 Various protected bird species are reported to be present within the local area, these include curlew, lapwing, redshank, grey partridge and tree sparrow.

6.4.4 The Site will only accept clean inert materials only. These wastes are unlikely to cause odour or litter, which may trap wildlife or cause them to choke if consumed.

6.4.5 Dust and noise will be managed and controlled, as outlined in the Amenity and Accident Risk Assessment, so that it does not impact nearby sensitive habitats. Site activities are not expected to impact upon the local bird population. The inert wastes that are to be accepted will not attract pests and vermin. It is considered that the impact on local habitats will be negligible.

6.4.6 Further detail is provided in the Amenity and Accident Risk Assessment, included within this permit application.

7 SITE CONDITION REPORT

7.1.1 There is no requirement to provide a site condition report for areas that will be subject to a permanent deposit of material. The purpose of a Site Condition Report is to set out the condition of the land at permit issue so that at permit surrender it is possible to demonstrate that there has been no deterioration in the quality of the land. Clearly in the case of a permanent deposit of waste the land will not be restored to the same condition that was present at permit issue. Instead surrender of the permit will be based on records of the materials accepted and environmental monitoring carried out during the operational life of the Site and post closure to demonstrate that the clean inert material that has been deposited is not impacting and will not impact the environment.

7.1.2 Fuel and other potentially harmful liquids for use in Site plant will be stored in an appropriate tank or container with appropriate secondary containment. Bunds will have a capacity of 110% of the largest tank. Tanks or containers storing fuel or other harmful liquids will be stored upon an impermeable surface.

8 SUMMARY OF THE CONCEPTUAL SITE MODEL

8.1 Introduction

8.1.1 The findings of the desk study have been interpreted to form a Conceptual Site Model (CSM) which is discussed in the form of "Source, Pathway and Receptors" below.

8.2 Source

8.2.1 It is proposed to import clean inert materials to restore the site to original levels. The source will therefore be the inert materials that are deposited. Stringent Waste Acceptance Procedures will remove the risk at source.

8.3 Pathways

8.3.1 Pathways for potential pollutants include any route from the inert materials to the identified nearby receptors.

8.3.2 The main pathway of downward migration will be through the unsaturated zone via infiltration. Where natural faulting, fissuring and jointing is extensive, another pathway may exist leading to the rapid migration of potential pollutants through the unsaturated zone.

8.3.3 There is the potential for the migration of pollutants through the sidewall liner into the superficial aquifer (where present) and bedrock aquifer. There is also the potential migration of pollutants through basal leakage into the underlying bedrock aquifer.

8.3.4 Works will not be undertaken within close proximity to a watercourse. Monitoring of site works will be undertaken on a daily basis to identify any runoff from the Site. Once the deposited materials have been capped using the existing topsoil, runoff will be from the existing topsoil rather than the deposited inert materials.

8.3.5 No landfill gas will be generated due to the clean inert nature of the materials that are to be accepted at the site and the strict waste acceptance criteria that will be implemented.

8.3.6 The robust design of the geological barrier will minimise any migration via infiltration.

8.3.7 Dust or litter can become airborne. No litter is anticipated due to the nature of the materials to be imported. Dust will be managed at the source using the dust control measures described in the Operating Techniques.

8.4 Receptors

8.4.1 There is potential for downward migration via infiltration, therefore the superficial deposits may be a receptor.

1.1.1 The potential groundwater receptors are groundwater in the Principal Aquifer (Cadeby Formation). Down-gradient groundwater abstractions from the Cadeby Formation also represent a secondary receptor.

8.4.2 The superficial deposits (Glacial Till) are a Secondary Undifferentiated Aquifer, however these deposits are absent from the majority of the Site.

8.4.3 The nearest property is adjacent to the site to the north.

8.4.4 The site is located in a Drinking Water Safeguard Zone. The Cadeby Formation (Magnesian Limestone) that underlies the site is classified as a Principal Aquifer by the Environment Agency (DEFRA, 2021).

8.4.5 It is considered that the strict control of the sources of pollution, through waste acceptance procedures and compliance with operational techniques identified in this permit application, will provide adequate protection to sensitive receptors within close proximity of the site.

8.5 Source-Pathway-Receptor Linkages

Source

8.5.1 The most likely source of potential pollution will be the inert waste disposed during the restoration of the existing quarry void.

Pathway

8.5.2 Pathways for potential pollutant migration include any route from the inert waste (the Source) to the receptors.

8.5.3 There is a potential pathway for potential pollutants to migrate through the side wall liner into the Cadeby Formation (Principal Aquifer) or into the Glacial Till (Secondary Undifferentiated Aquifer) where present.

8.5.4 There is a potential pathway for the migration of potential pollutants via basal leakage to the underlying bedrock aquifer. Initially potential pollutants must migrate through the basal liner. The base on the landfill is above the water table in the Cadeby Formation.

8.5.5 The main pathway of downward migration will be through the unsaturated zone is via infiltration. Where the nature faulting, fissuring and jointing is extensive, another pathway may exist leading to the rapid migration of potential pollutants through the unsaturated zone.

8.5.6 Post restoration, the stripped topsoil will be replaced on the imported waste materials and planting re-established. This will reduce the infiltration of rainfall into the deposited material and reduce rainfall runoff that has the potential to contain sediment.

Receptor

8.5.7 The potential groundwater receptors are groundwater in the Principal Aquifer (Cadeby Formation). Down-gradient groundwater abstractions from the Cadeby Formation also represent a secondary receptor, including the Licenced Water Supplies 2/27/23/391 and 2/27/23/728/R01, located 0.52km east and 1.95km south east of the Site respectively, and the Private Water Supply spring located 1.95km east of the Site.

8.5.8 The superficial deposits (Glacial Till) are a Secondary Undifferentiated Aquifer, however these deposits are absent from the majority of the Site. Thin superficial deposits (<1m thick) were recorded in borehole BHWA04 only and no water strikes were recorded in these deposits.

8.5.9 Potential surface water receptors include the two unnamed ponds at Snape Lodge Farm 0.4km to the east of the Site, and at Low Burton Wood, 0.4km to the south- west of the Site. The pond at Snape Lodge Farm is located down-hydraulic gradient of the Site, however the expected basal elevations of the pond are much higher than groundwater elevations at the Site, so it is unlikely that there is any interaction between groundwater and the pond. Additionally, there is no permanent drainage channel to the pond.

8.5.10 Likewise, for the pond at Low Burton Wood there is also no permanent drainage channel and the pond is located up-hydraulic gradient of the Site, therefore interactions between groundwater and the pond are unlikely.

8.5.11 Other potential surface water receptors include the River Ure, located 0.9km to the west of the Site, which can be considered a sensitive receptor, as it is part of both a nitrate vulnerable water body and achieved a WFD Chemical Status of Fail in 2019 (Environment Agency, 2021b). However, the River Ure is located up-hydraulic gradient and there is no known permanent drainage channel from the Site to the river.

Table 8.1: Source-Pathway-Receptor Summary for Gebdykes Landfill			
Phase	**Sources**	**Pathway**	**Receptor**
Operational Phase – deposit of clean inert material	Clean inert materials	Migration through side wall liner or basal liner to bedrock	Cadeby Formation (Principal Aquifer) or into the Glacial Till (Secondary Undifferentiated Aquifer) where present
		Infiltration through unsaturated zone	
		Groundwater flow within Cadeby formation	
		Airborne	Residential properties to north east and north west, agricultural land
Post Restoration Phase	Clean inert materials	Infiltration through topsoil into deposited waste	Cadeby Formation (Principal Aquifer) or into the Glacial Till (Secondary Undifferentiated Aquifer) where present
		Groundwater flow within Cadeby formation	
		Rainfall runoff from replaced topsoil	

9 CONCLUSIONS

9.1.1 Gebdykes Quarry is a limestone quarry located at Masham, North Yorkshire. Lightwater Quarries Limited are applying for an environmental permit to allow the landfilling of approximately 200,000 tonnes of clean inert materials per year to restore the site to original levels.

9.1.2 The southern extent of the Site is to be filled in five phases, with an estimated net fill volume is 1,800,000m^3.

9.1.3 The Site will accept clean inert materials only. This means that they will not undergo any significant physical, chemical or biological transformations and will not generate leachate.

9.1.4 The landfill is to be constructed with a 650mm thick basal attenuation layer (artificial geological barrier). This barrier will comprise crushed and screened dolomite fines.

9.1.5 The basal lining system will be constructed in accordance with the requirements of the Landfill Directive, which requires artificial geological barriers to be at least a 0.5m thick. The permeability must be equivalent to a maximum of 1.0x10^{-7}m/s for a 1m barrier. The basal liner will be 650mm in thickness and will consist of re-engineered crushed and screened dolomite fines (or other suitable imported material, such as clay-bound quarry waste) which will be compacted to achieve a permeability of equal to or less than 6.5x10^{-8}m/s.

9.1.6 It is not proposed that any leachate monitoring is undertaken due to the very low risk posed by leachate from the site.

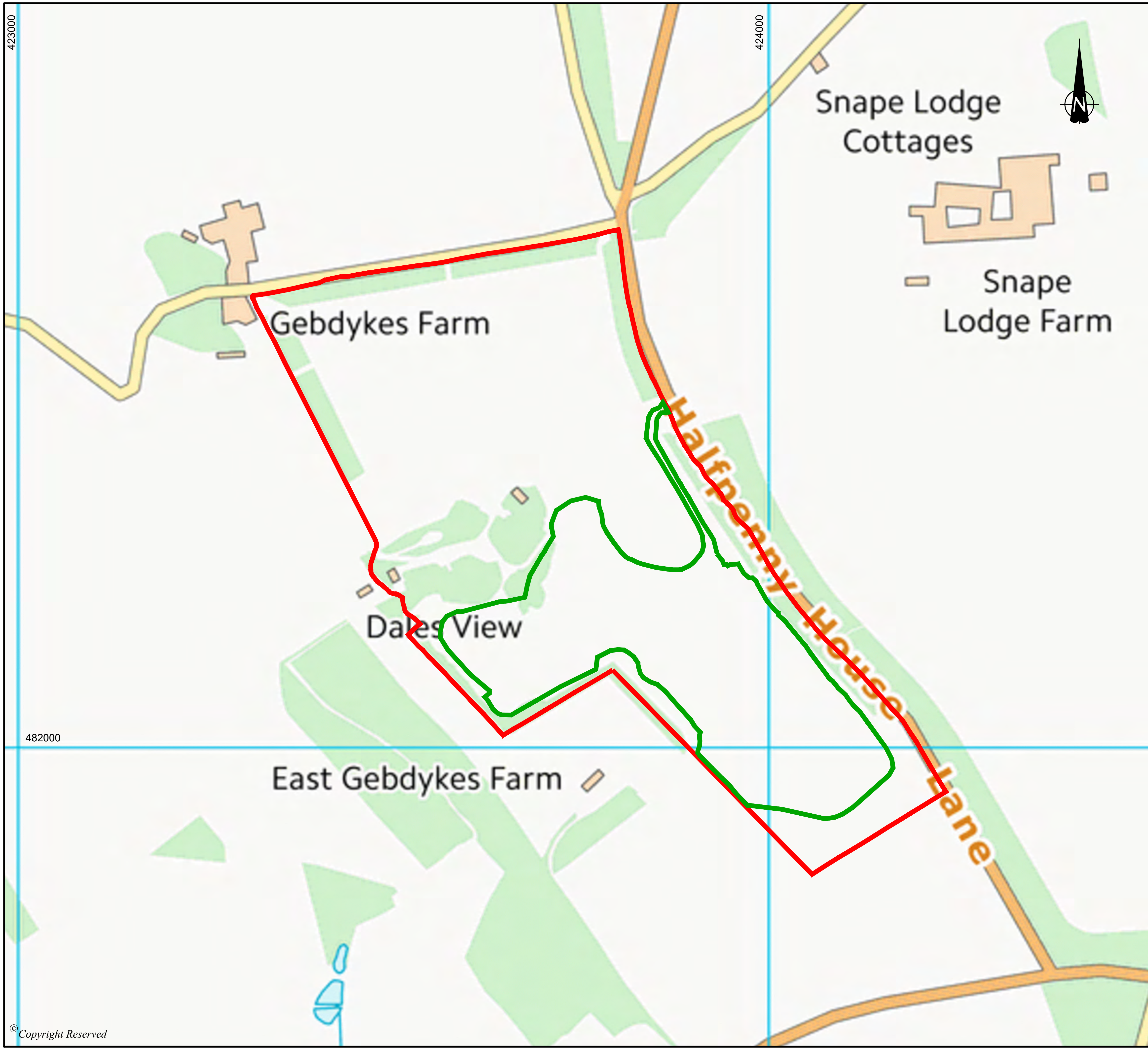
9.1.7 Internal landfill gas monitoring boreholes will be installed as the phase is being competed. Gas boreholes will be installed to the full depth of the inert material. Two gas boreholes will be constructed per hectare.

9.1.8 Runoff from outside the operational areas of the Site will be allowed to infiltrate into the underlying bedrock, while surface water runoff from the operational areas of the Site will intercepted and diverted to a large lagoon to the north of the void area for testing prior to discharge. The nearest designated site is Mar Field Fen SSSI, located 1.2km to the west. There are no other SSSIs, National Nature Reserves (NNR), Special Areas of Conservation (SAC) or Special Protection Areas within 2km of the Site.

9.1.9 A residential property is located adjacent to the site to the northwest.

9.1.10 No potential impacts on the local population, habitats or ecological receptors have been identified.

DRAWINGS



DO NOT SCALE FROM THIS DRAWING

KEY

SITE BOUNDARY

PERMIT BOUNDARY

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D
A	FIRST ISSUE	09-02-23	DR	KH	AC

CLIENT

LIGHTWATER QUARRIES

PROJECT

GEBDYKES LANDFILL
PERMIT APPLICATION

DRAWING TITLE

PERMIT BOUNDARY PLAN

DRG No.		REV	SUIT. CODE
NT14621-003		A	

DRG SIZE	SCALE	DATE
A3	1:5000	10-10-22

DRAWN BY	CHECKED BY	APPROVED BY
DR	KH	AC

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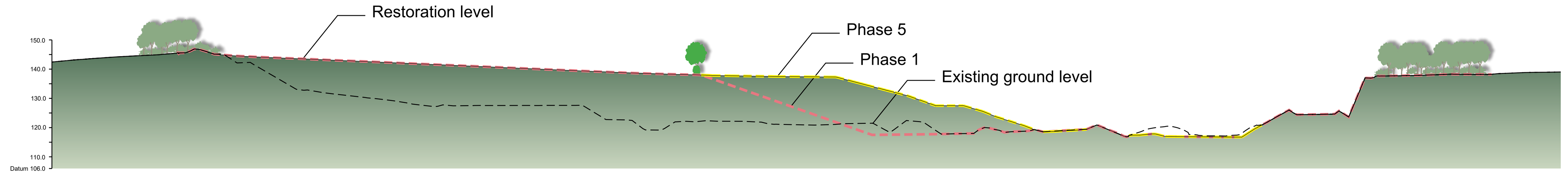
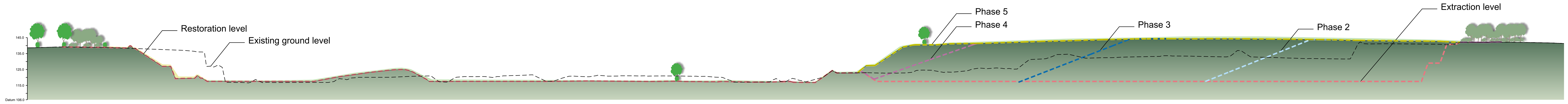
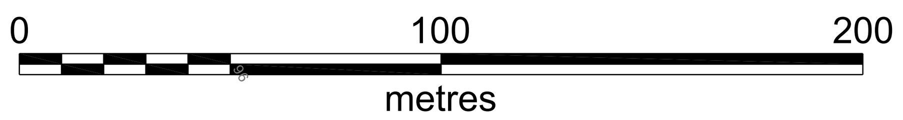
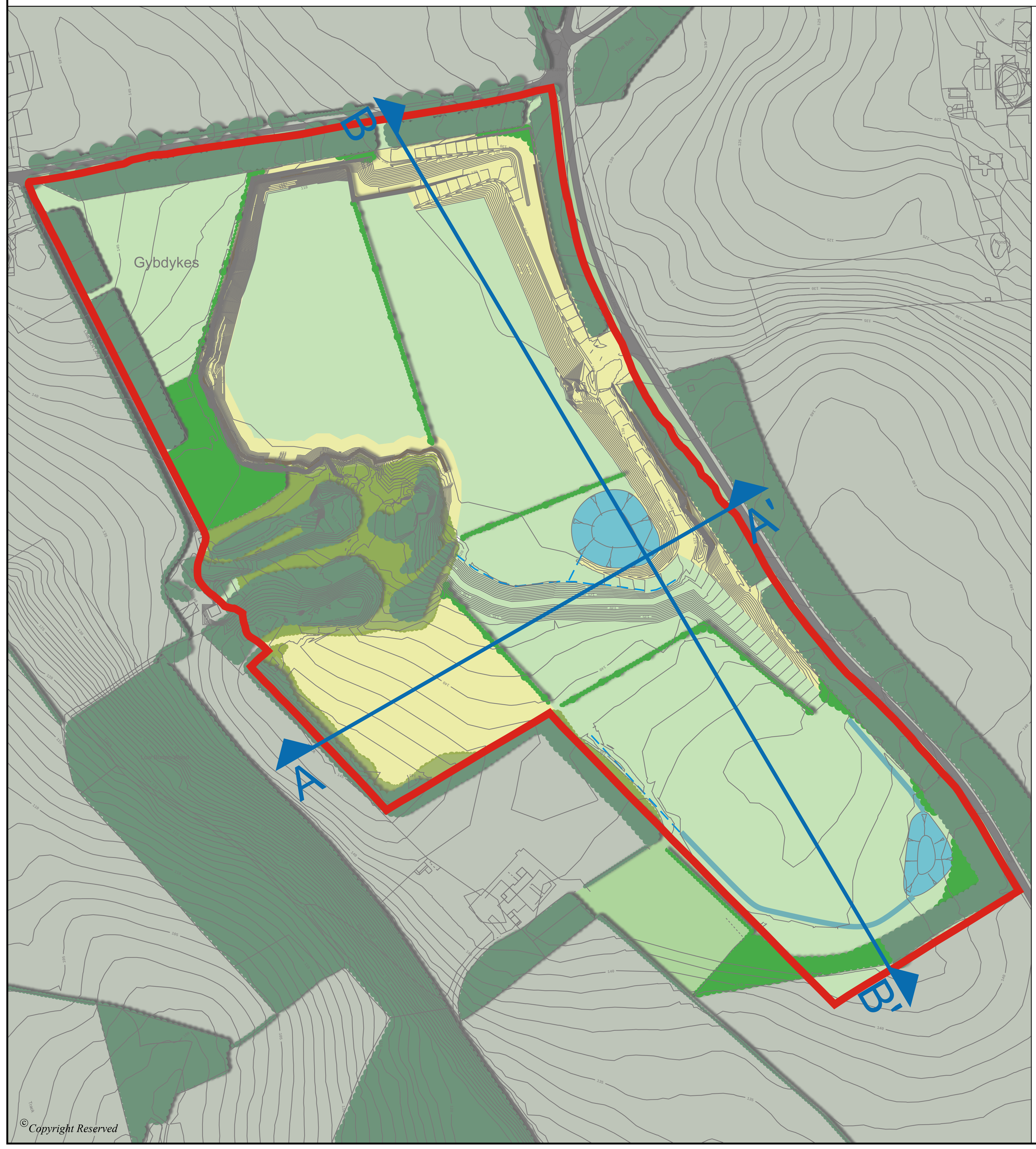
Section A - A'



Section B - B'







REVISION	DETAILS	DATE	DRAWN	CHK'D	APP'D

CLIENT

Lightwater Quarries

PROJECT

GEBDYKES QUARRY LANDFILL

DRAWING TITLE

FIGURE 3.7
CROSS-SECTION

DRG No. NT14834/ 014		REV -
DRG SIZE A1	SCALE 1:1500	DATE 02/12/2021
DRAWN BY TL	CHECKED BY LG	APPROVED BY NB

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\\WA.LOCAL\PROJECTS\NT\NT14834 - GEBDYKES QUARRY LANDFILL EIA\03 - DESIGN\AUTOCAD\NT14834 FIGURE 3.8.DWG

DO NOT SCALE FROM THIS DRAWING

KEY

- Application boundary
- Surrounding agricultural land
- Existing woodland, hedgerows and trees
- Agricultural grassland
- Magnesian limestone grassland
- Native hedgerow with hedgerow trees
- Woodland planting
- Scrub planting
- Drainage channels
- Swales
- Detention basins (based on volume of storage required post restoration)

REVISION	DETAILS	DATE	DRAWN	CHK'D	APP'D

CLIENT

Lightwater Quarries

PROJECT

Gebdykes Quarry Landfill

DRAWING TITLE

Figure 3.6
Restoration

DRG No.		REV
NT14834/Figure 3.6		-
DRG SIZE	SCALE	DATE
A2	1:2,500	17/11/2021
DRAWN BY	CHECKED BY	APPROVED BY
AB	LG	NB

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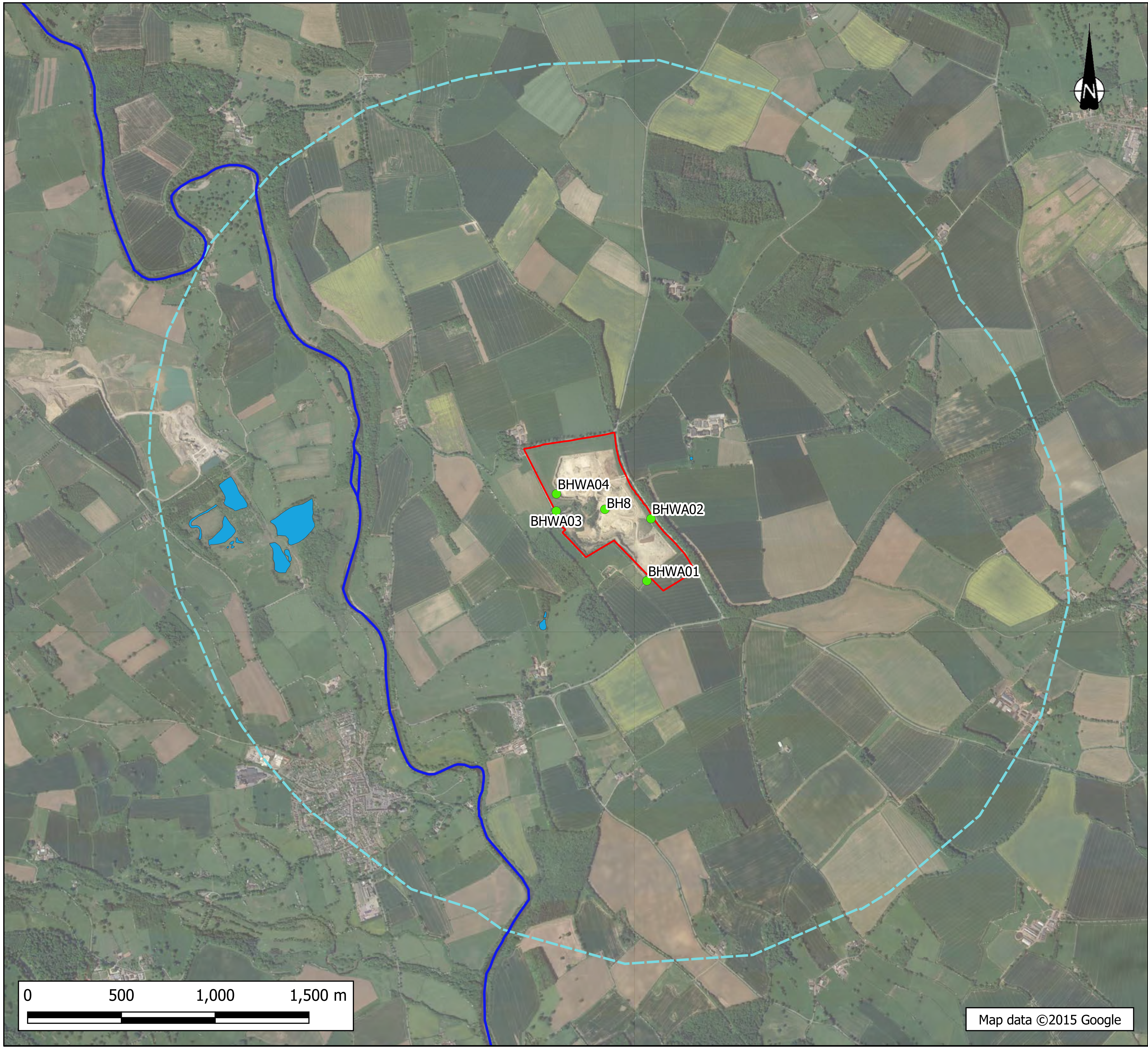
N:\NT\NT14834 - GEBDYKES QUARRY LANDFILL EIA\03 - DESIGN\AUTOCAD\NT14834 FIGURE 3.6 RESTORATION.DWG



DO NOT SCALE FROM THIS DRAWING

Legend

- Site Boundary
- 2km Site Boundary Buffer
- Ponds within Study Boundary Buffer
- River Ure
- Groundwater Monitoring Boreholes - Existing Quarry Area

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D

CLIENT

Lightwater Quarries

PROJECT

Gebdykes Quarry Landfill Permit Application

DRAWING TITLE

Borehole Location Plan

DRG No. NT14621-HRA-001		REV A
DRG SIZE A3	SCALE 1 : 20,000	DATE March 2022
DRAWN AE	CHECKED BY AS	APPROVED BY AB

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KEY

- Application boundary
- Extent of inert landfill
- Active landfill phase
- Direction of working
- Access track
- Existing quarry
- Surrounding agricultural land
- Existing woodland, hedgerows and trees
- Agricultural grassland
- Magnesian limestone grassland

REVISION	DETAILS	DATE	DRAWN	CHK'D	APP'D

CLIENT
Lightwater Quarries

PROJECT
Gebdykes Quarry Landfill

DRAWING TITLE
Figure 3.1
Phase 1

DRG No. NT14834-002		REV -
DRG SIZE A2	SCALE 1:2,500	DATE November 2021
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N:\NT\NT14834 - GEBDYKES QUARRY LANDFILL EIA\03 - DESIGN\AUTOCAD\NT14834 FIGURE 3.1 PHASE 1 PLAN.DWG

DO NOT SCALE FROM THIS DRAWING

KEY

- Application boundary
- Extent of inert landfill
- Active landfill phase
- Direction of working
- Access track
- Existing quarry
- Surrounding agricultural land
- Existing woodland, hedgerows and trees
- Agricultural grassland
- Magnesian limestone grassland
- Scrub planting
- Drainage channels
- Swales
- Dry detention basins (based on volume of storage required post restoration)

REVISION	DETAILS	DATE	DRAWN	CHK'D	APP'D

CLIENT
Lightwater Quarries

PROJECT
Gebdykes Quarry Landfill

DRAWING TITLE
Figure 3.2
Phase 2 Plan

DRG No.		REV
NT14834-003		-
DRG SIZE: A2	SCALE: 1:2,500	DATE: November 2021
DRAWN BY: AB	CHECKED BY: LG	APPROVED BY: NB

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N:\NT\NT14834 - GEBDYKES QUARRY LANDFILL EIA\03 - DESIGN\AUTOCAD\NT14834 FIGURE 3.2 PHASE 2 PLAN.DWG

DO NOT SCALE FROM THIS DRAWING

KEY

- Application boundary
- Extent of inert landfill
- Active landfill phase
- Direction of working
- Access track
- Existing quarry
- Surrounding agricultural land
- Existing woodland, hedgerows and trees
- Agricultural grassland
- Magnesian limestone grassland
- Scrub planting
- Drainage channels
- Swales
- Dry detention basins (based on volume of storage required post restoration)

REVISION	DETAILS	DATE	DRAWN	CHK'D	APP'D

CLIENT

Lightwater Quarries

PROJECT

Gebdykes Quarry Landfill

DRAWING TITLE

Figure 3.3
Phase 3 Plan

DRG No. NT14834-004		REV -
DRG SIZE A2	SCALE 1:2,500	DATE 17/11/2021
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N:\NT\NT14834 - GEBDYKES QUARRY LANDFILL EIA\03 - DESIGN\AUTOCAD\NT14834 FIGURE 3.3 PHASE 3 PLAN.DWG

DO NOT SCALE FROM THIS DRAWING

KEY

- Application boundary
- Extent of inert landfill
- Active landfill phase
- Direction of working
- Access track
- Existing quarry
- Surrounding agricultural land
- Existing woodland, hedgerows and trees
- Agricultural grassland
- Magnesian limestone grassland
- Scrub planting
- Drainage channels
- Swales
- Dry detention basins (based on volume of storage required post restoration)

REVISION	DETAILS	DATE	DRAWN	CHK'D	APP'D

CLIENT

Lightwater Quarries

PROJECT

Gebdykes Quarry Landfill

DRAWING TITLE

Figure 3.4
Phase 4 Plan

DRG No.	REV
NT14834-005	-

DRG SIZE	SCALE	DATE
A2	1:2,500	17/11/2021
DRAWN BY	**CHECKED BY**	**APPROVED BY**
AB	LG	NB

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N:\NT\NT14834 - GEBDYKES QUARRY LANDFILL EIA\03 - DESIGN\AUTOCAD\NT14834 FIGURE 3.4 PHASE 4 PLAN.DWG

DO NOT SCALE FROM THIS DRAWING

KEY

- Application boundary
- Extent of inert landfill
- Active landfill phase
- Direction of working
- Access track
- Existing quarry
- Surrounding agricultural land
- Existing woodland, hedgerows and trees
- Agricultural grassland
- Magnesian limestone grassland
- Scrub planting
- Drainage channels
- Swales
- Dry detention basins (based on volume of storage required post restoration)

REVISION	DETAILS	DATE	DRAWN	CHK'D	APP'D

CLIENT

Lightwater Quarries

PROJECT

Gebdykes Quarry Landfill

DRAWING TITLE

Figure 3.5
Phase 5 Plan

DRG No. NT14834-006		REV -
DRG SIZE A2	SCALE 1:2,500	DATE November 2021
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N:\NT\NT14834 - GEBDYKES QUARRY LANDFILL EIA\03 - DESIGN\AUTOCAD\NT14834 FIGURE 3.5 PHASE 5 PLAN.DWG

DO NOT SCALE FROM THIS DRAWING

Legend

- Proposed Monitoring Borehole Location
- Groundwater Monitoring Boreholes - Existing Quarry Area
- Ponds within Study Boundary Buffer
- Site Boundary

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D

CLIENT

Lightwater Quarries

PROJECT

Gebdykes Quarry Landfill Permit Application

DRAWING TITLE

Proposed Borehole Location Plan

DRG No. NT14621-HRA-006		REV A
DRG SIZE A3	SCALE 1:5,000	DATE March 2022
DRAWN AE	CHECKED BY AS	APPROVED BY AB

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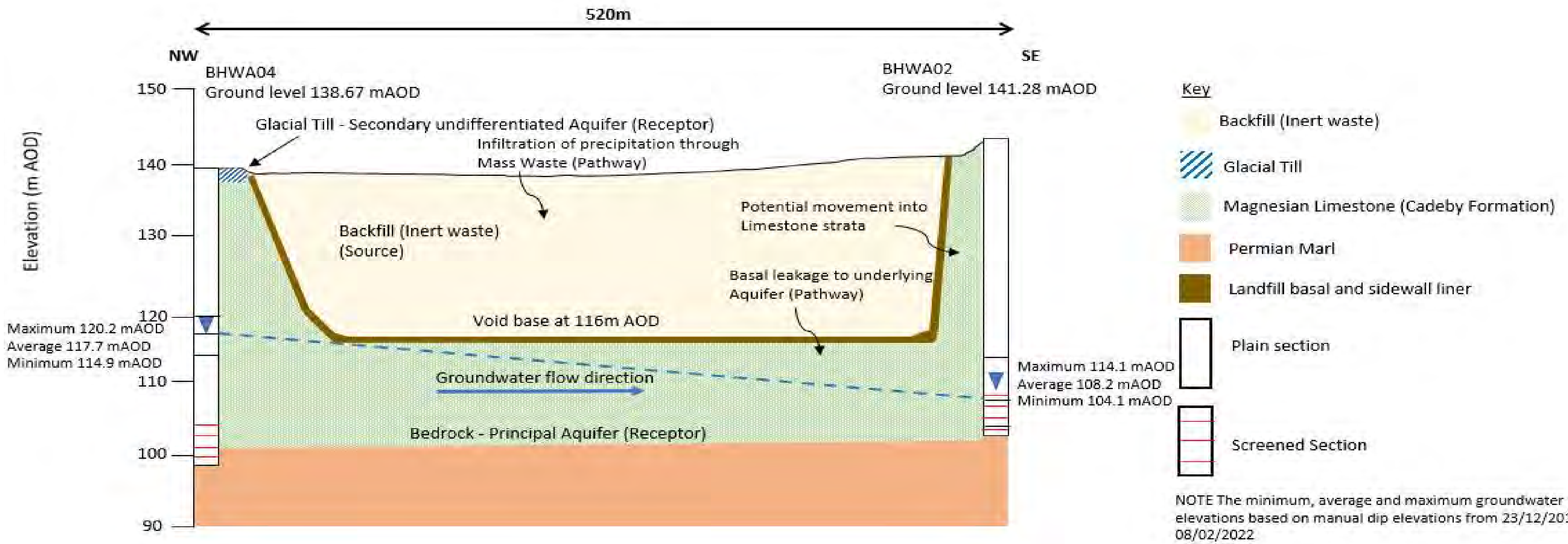

NOTE The minimum, average and maximum groundwater elevations based on manual dip elevations from 23/12/2019 to 08/02/2022

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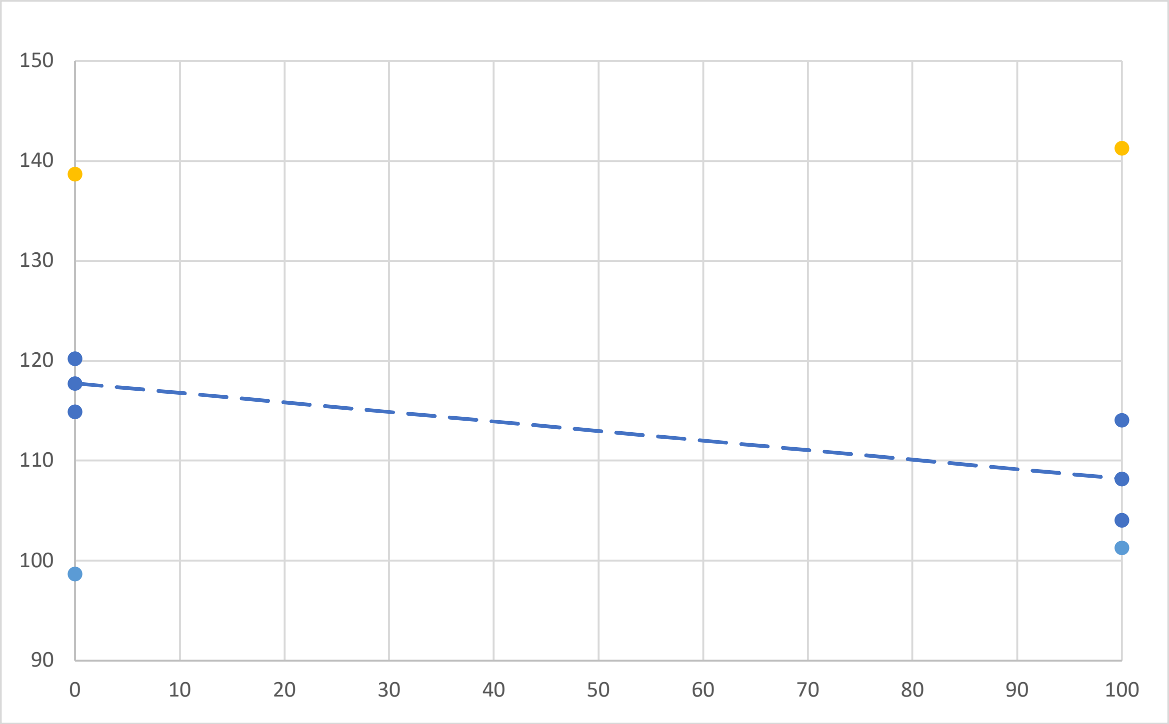
CLIENT	Lightwater Quarries		
PROJECT	Gebdykes Landfill Permit Application		
FIGURE TITLE	**Schematic Hydrogeological Cross Section**		
FIGURE NO.	NT14621-HRA-005		
DRAWN BY	CHECKED BY	APPROVED BY	DATE
TR	AS	AB	Mar-22

		min	average	max	GL	Base of hole
BHWA04	0	114.92	117.7419	120.22	138.674	98.674
BHWA02	100	104.05	108.196	114.07	141.278	101.278



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