Caulmert Limited

Engineering, Environmental & Planning Consultancy Services

Whisby Landfill Site – IBA Processing Facility

Lincwaste Limited

Environmental Permit Variation Application

Environmental Setting & Installation Design Report - Addendum

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APPROVAL RECORD

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Environmental Setting & Installation Design Report - Addendum

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1.0 INTRODUCTION

1.1 Report Context

1.1.1 Caulmert Limited have been appointed by Lincwaste Limited ('the Operator') to prepare an environmental permit variation application for Whisby Landfill Site permit ref. EPR/BW2978ID to include for the processing of Incinerator Bottom Ash (IBA) and subsequent landfilling of IBA into IBA Cells 1-4 within the boundary of the permitted installation.

1.1.2 The Operator proposes to vary their existing permit to add a 'Schedule 5.4 A(1)(b)(iii) activity for a mix of recovery and disposal of non-hazardous waste with a capacity exceeding 75 tonnes per day involving treatment of slags and ashes'. It is proposed to accept up to 70,000 tonnes per annum of IBA wastes for processing at Whisby Landfill.

1.1.3 This activity will involve processing Incinerator Bottom Ash (IBA) wastes at the site to remove ferrous and non-ferrous metals for recycling, producing an IBA Aggregate (IBAA) and disposing of the remaining IBA residues by landfilling at Whisby.

1.1.4 This ESID report has been prepared as an addendum to the original ESID report for the site to update the Conceptual Site Model (CSM) as part of this permit variation application. The existing ESID report for the site was produced by Golders Associates (UK) Ltd. in May 2004 and is attached in Appendix 1 as report ref. 03523334.501/A.0.

1.1.5 The CSM considers sources of pollution (i.e. waste) and details the site-specific Source>Pathway>Receptor linkages for risk assessments within this permit variation application. This ESID has been written in accordance with the latest Environment Agency guidance on 'What to include in your environmental setting and installation design report' published 30th January 2020 (last updated 31st October 2022).

1.1.6 The 2004 ESID report details the nearby receptors of the landfill, which have been updated as part of this permit variation in the Environmental Risk Assessment document ref. 5671-CAU-XX-XX-RP-V-0302.

1.2 Site Location & Setting

1.2.1 Whisby Landfill Site is located off Thorpe Road, Whisby, approximately 3km west of North Hykeham and 8km to the southwest of Lincoln. The area of the proposed IBA Processing Facility (hereafter referred to as 'the Site') is within the wider Whisby Landfill Site permitted area, centred on National Grid Reference SK 89647 66699. The address of the site is:

Whisby Landfill Site
Thorpe Road
Whisby
Lincolnshire
LN6 9BT

1.2.2 The area proposed for the IBA treatment and storage pad is within the proposed IBA Cell 1, to be constructed with engineered containment to standard non-hazardous landfill cell specifications and is predominantly surrounded by the existing landfill infrastructure (see attached Sirius drawing ref. WR7885 SRA 01). Landfilling of IBA wastes will start initially in IBA Cell 1, before moving on to IBA Cell 2, 3 and 4, in a phased manner (see drawing ref. WR7855/1/001 Rev 3).

1.2.3 Whisby Landfill Site is located within an agricultural setting, with water bodies associated with former sand and gravel pits surrounding the landfill site to the north, east, south and west. Tarmac Whisby Sand and Gravel Quarry is located 25m to the north and a railway line is 260m to the south.

1.2.4 The closest residential receptors are houses on Thorpe Road 415m to the northeast and Station Road 460m to the southeast. Crossing Gate Poultry Farm (and Sam's Auto Car Repairs Garage) is located 610m to the southwest and there is a row of houses on Eagle Lane 690m to the southeast. There are no schools or hospitals within 1km of the Site.

1.2.5 An indicative site location plan of Whisby Landfill Site is shown below in Figure 1. The proposed IBA Cells 1-4 and IBA Processing Facility will sit within the permitted landfill site boundary in the north-western portion of the site (inside the blue line on Figure 1).

Figure 1 - Site Location (source: Google Earth, 2023)

2.0 SOURCE TERM CHARACTERISATION

2.1 Historical Development

2.1.1 Whisby Landfill Site is a non-hazardous landfill operated by Lincwaste Limited (a wholly owned subsidiary of FCC Environment (UK) Limited) and the operation includes landfill restoration, leachate management and treatment (involving short rotation coppice) and landfill gas flaring.

2.1.2 The site is currently managed under Environmental Permit EPR/BW2978ID issued in May 2005.

2.1.3 The landfill is permitted to accept 49,900 tonnes per annum of non-hazardous waste for disposal and 50,000 tonnes per annum of wastes for restoration. The site is operated as a non-hazardous landfill.

2.1.4 Tarmac Limited (formerly Lafarge Aggregates) has been extracting sand and gravel from shallow workings at the site and surrounding areas for many years. Restoration of the ensuing voids at the Whisby Landfill Site has been by landfilling, which commenced in June 1988 within Phase 2 (Cells 1-4) and is now finished and permanently capped (see 'Capped Area' outlined in orange on attached Annual Site Plan 2023 ref. 722A165). Filling of Phases 3, 4 and 5 (Cells 1-8) commenced in 1990 and the 8 cells in this area have since been filled, permanently capped and restored (see 'Restored Area' outlined in green on attached Annual Site Plan 2023 ref. 722A165).

2.1.5 Areas A and B in the northern area of the permitted boundary are currently undeveloped. The operator proposes to vary the existing permit to include for the treatment and landfilling of Incinerator Bottom Ash (IBA) in the area that currently makes up Area A. This will involve the phased construction and subsequent landfilling of new IBA Cells 1, 2, 3 and 4.

2.2 Proposed Development

2.2.1 It is proposed to develop the undeveloped Area A by constructing four new landfill cells for mono-filling with IBA (IBA Cells 1-4). These cells will be constructed and filled in a phased manner, as per drawing ref. WR7855/1/001 Rev 3.

2.2.2 IBA Cell 1 will be constructed first, and within this new cell it is proposed to install a processing pad for the temporary storage and subsequent processing of IBA wastes prior to landfilling. Cell 1 will also be half-filled with IBA wastes up to existing surrounding ground level (minus 2m) before landfilling operations moving onto the next cell, IBA Cell 2, and then Cells 3 and 4 later on once constructed. It is proposed to keep the processing plant on the pad in IBA Cell 1 during the landfilling of Cells 1-4.

2.2.3 The IBA processing will consist of mechanical screening of the IBA to remove ferrous and non-ferrous metals and will comprise mobile sieves, overband magnets, vibrating feeder, eddy current separators and hand-sorting station (further details including specifications included

within the Operating Techniques & BAT Review report ref. 5671-CAU-XX-XX-RP-V-0301). Separated metals will be stored in designated stockpiles awaiting export off-site for recycling. IBAA will be stored in separate stockpiles awaiting export off site (see attached 'IBA Processing Pad - General Layout Plan' ref. 722A167A). The site will utilise dumper trucks for IBA deliveries to the pad and a front-loading shovel for feeding IBA wastes into the process. IBA residues post-processing will be disposed of in IBA Cells 1-4.

2.2.4 It is proposed to accept up to 70,000 tonnes per year of imported non-hazardous IBA wastes for processing at Whisby as a mix of a recovery and disposal activity, with the temporary storage of up to 140,000 tonnes of unprocessed IBA wastes at any one time. It is proposed the unprocessed IBA will be sourced from the nearby FCC-owned Eastcroft Energy from Waste (EfW) and Lincolnshire EfW sites. It is anticipated 7-8% of the IBA waste will be recovered as metals for recycling and approximately up to 20,000 tonnes per year of IBA Aggregate (IBAA) will be exported from site as a product.

2.2.5 The IBA processing plant will be stood on a flat surface within the fully engineered non-hazardous IBA Cell 1, approximately 25,000m^2 in size, constructed at Whisby Landfill Site. IBA Cell 1 will be constructed to Construction Quality Assurance (CQA) methods and in accordance with Sirius Stability Risk Assessment (SRA) ref. WR7885/SRA (see Appendix 3 of the Operating Techniques & BAT Review document ref. 5671-CAU-XX-XX-RP-V-0301, included within this application). IBA Cells 2, 3 and 4 will also be constructed to the same specifications and these will be reported to the EA in due course via submission of further CQA plans .

2.2.6 The unprocessed IBA will be sampled at the source site for analytical testing prior to arriving at Whisby. Incoming IBA will be stored in separate stockpiles awaiting test results. Once test results confirm the IBA is non-hazardous, the IBA will undergo maturation in windrows on the pad for 2-3 weeks in the open air (atmospheric carbon dioxide and rainwater being required) prior to treatment. The maturation process should result in a reduction of pH and will stabilise any heavy metal leachability of the IBA. Any IBA wastes classed as hazardous from testing will be rejected from site and sent to a suitably permitted facility.

2.2.7 As the proposed IBA processing facility is to be developed within the engineered landfill IBA Cell 1, surface water/leachate will be managed by spine drains draining to a central sump/leachate collection point. As stated within the Hydrogeological Risk Assessment Review (HRAR) (ref. 5671-CAU-XX-XX-RP-O-0309.A0.C2), leachate drainage in IBA Cell 1 (and later Cells 2, 3 and 4) will consist of spine drains as detailed on drawing ref. WR7855 01 04 (see drawing in report in Appendix 2). This reduced drainage design is considered to be suitable for IBA Cells 1-4, as the waste within these cells will consist of homogenous processed IBA materials. Due to the nature of the finer material, processed IBA materials are reported to have a higher permeability than that of traditional waste and are comparable to those reported for sand ($1.4x10^{-8}$ to $2.5x10^{-5}$)[1]. Therefore, it is considered that due to the waste type, limited leachate will be generated within these cells and the higher permeability indicates that

[1] B. Muhunthan , R. Taha & J. Said. Geotechnical Engineering Properties of Incinerator Ash Mixes. Journal of the Air & Waste Management Association. February 2012

leachate will be easily extracted. Leachate from IBA Cells 1-4 will be tankered for off-site disposal. There are no proposed discharges to surface water or sewer.

2.2.8 The main sensitive receptors will be the groundwater within the Secondary A Aquifer of the underlying superficial deposits and Secondary B Aquifer of the underlying bedrock, and the nearby surface water bodies surrounding the site. The closest human receptors to the site are workers at the adjacent Whisby Landfill Site <10m south and east, but also workers at the nearby Tarmac Whisby Sand and Gravel Quarry 25m north. The closest residential receptors are houses on Thorpe Road 415m to the northeast and Station Road 460m to the southeast. The prevailing wind direction is to the northeast. Nearby sensitive habitats include Hykeham Railway Line LWS 460m southeast and Whisby Nature Park LNR & LWS 570 east-southeast.

2.3 Source Term

2.3.1 There are no changes to the existing source term for the existing landfill cells at Whisby.

2.3.2 Due to the proposed use of Area A to infill with IBA materials, the source term for this area of the site will be significantly different to that reported within the wider area of the landfill, therefore this represents a change in the Conceptual Site Model. Within the Hydrogeological Risk Assessment Review (HRAR) (ref. 5671-CAU-XX-XX-RP-O-0309.A0.C2), the IBA Cell 1 was modelled using the EA's contaminant flux spreadsheet models for hydraulic containment landfills. Results indicated there was no significant risk to the surrounding groundwater from the leachate in IBA Cell 1, provided the cell is managed at 1m below the surrounding groundwater levels.

2.3.3 It is considered that the IBA waste types are unlikely to contain a significant proportion of rapidly degradable organic content. Ammoniacal nitrogen is also not expected to be present within significant quantities in the IBA leachate. Similarly, solvents, refined petroleum fuels or other chemicals will either be excluded based on the waste acceptance criteria or destroyed during the incineration process, prior to the production of the IBA.

2.3.4 The primary pollutants considered from IBA is chloride or sulphate, and non-hazardous and hazardous metals.

2.3.5 No other changes to Whisby Landfill Site is proposed and as such the other sources identified in the previous ESID pertaining to the landfilling of non-hazardous wastes, to which this report is an addendum, have not changed.

2.4 Control Measures

2.4.1 Control measures and strict waste acceptance procedures are already in place for the landfilling of non-hazardous wastes at Whisby Landfill Site and this be extended to cover accepting only permitted IBA wastes into the IBA processing facility and subsequent proposed landfilling of processed IBA wastes in IBA Cells 1-4. This will ensure environmental pollution is prevented and only permitted waste types are accepted.

2.4.2 Any non-conforming wastes will be rejected from site, which will include any IBA wastes tested and concluded to be hazardous.

2.4.3 All plant, vehicles and machinery used on site will be regularly checked for leaks and maintained and serviced in accordance with manufacturers guidance and a Preventative Maintenance Program.

2.4.4 Where refuelling is undertaken on site, this will be done in a designated refuelling area. The use of biodegradable oils and lubricants will be considered/used where practicable. Static machinery and plant will, where practicable, have integral drip trays of 110% of the capacity of the fuel tank.

2.4.5 All staff and contractors will be inducted into the emergency spill procedure and use the spill kits and booms provided to clean up a spillage as quickly as possible. Any storage of hazardous substances, if required, will be above ground in sealed, impervious, fully bunded tanks or containers, with 110% secondary containment.

2.4.6 Surface water/leachate will be collected within the IBA Cell collection sump and no discharge to water or sewer is proposed. Leachate will be pumped out and sent by tanker to a suitable water treatment facility.

3.0 INSTALLATION ENGINEERING

3.1 Security Infrastructure

3.1.1 The site is an active landfill site, with the new IBA Cells 1-4 benefiting from existing site security infrastructure.

3.2 Cell Construction Specification

3.2.1 The design specification for the construction of IBA Cell 1 is provided in Sirius document ref. WR7885_Rev1 (Specification for Construction of Incinerator Bottom Ash Cell 1), which is in Appendix 4 of the Operating Techniques & BAT Review document ref. 5671-CAU-XX-XX-RP-V-0301, included within this application. It is proposed IBA Cells 2, 3, and 4 will be designed to similar standards in the future.

3.2.2 This document (WR7885_Rev1), when read in conjunction with the Sirius CQA Plan document ref. WR7885_2 (attached as Appendix 2), details the requirements for the construction works to be undertaken and the quality control procedures that will be followed during construction works by the CQA Inspector, to demonstrate that the works have been undertaken in accordance with the design specification.

3.2.3 The Operator will appoint a third-party independent Construction Quality Assurance (CQA) consultant to provide supervision for the duration of the cell construction on the Operator's behalf.

3.2.4 Construction of the lining system for Cell 1 shall generally involve:

- Excavation and filling to achieve the formation levels;
- Installation of drainage geocomposite below any fill or directly below the lining system, on the as-excavated formation level;
- Installation of toe drains to discharge the backwall drainage geocomposite into the ponded area to the west of the cell;
- Installation of a 1000mm thick Engineered Clay liner on the sidewall areas, to a maximum permeability of $1x10^{-9}$ m/s;
- Construction of an intercell bund on the western edge of the cell;
- In-situ testing of the basal clay liner (in-situ clay) to ensure compliance with the Specification;
- Installation of a separation geotextile above the Engineered Clay Liner;
- Installation of leachate collection spine drains and a leachate collection/monitoring sump; and,
- Installation of a target pad.

3.2.5 Further details on the engineered fill, under cell drainage system, engineered clay liner, separation geotextile and leachate collection system are provided in Sections 4-8 of the Specification for Construction of Incinerator Bottom Ash Cell 1 document ref. WR7885_Rev1.

3.3 Engineered Landfill Cells

3.3.1 The engineering details for all the cells have been reported in the 2004 ESID and this has been updated in Table 2 below to include the proposed IBA Cells 1-4 details:

Table 2 – Summary of Engineering Details for Cells Whisby Landfill

	Phase 2	Phase 3,4,5			IBA Cells 1-4
	Cells 1-4	Cells 1-4	Cell 5	Cells 6, 7 & 8	
Basal Lining	No engineered clay	No engineered clay	1m thick engineered clay	1m thick engineered clay	1m thick engineered clay and separation geotextile above
Basal drainage	No basal drainage	No basal drainage	Gravel drainage blanket	Radial piped gravel drainage system	Spine drainage system
Side slope lining and drainage	1m engineered clay. No drainage				1m thick engineered clay. Geo-composite drainage layer with back wall drains to pump groundwater.
Cap details	Cell 1 cap: 1m engineered clay and soils	1m engineered clay and 1m cover soils	1m engineered clay and 1m cover soils	HDPE geomembrane. 1m cover soils	Inert soils cap with minimum hydraulic conductivity of $1x10^{-7}$ m/s.

3.3.2 CQA programmes were undertaken for the historic cells at Whisby Landfill, and this is summarised in Table EDID 3 of the 2004 ESID.

3.4 Basal Lining System

3.4.1 Basal lining system properties have not changed since the previous ESID and therefore remain in compliance with the Landfill Directive and continue to be appropriate.

3.4.2 IBA Cell 1 (and IBA Cells 2, 3 and 4 thereafter) will be constructed with a 1m thick engineered layer with a minimum permeability of $1x10^{-9}$ m/s and an additional separation geotextile.

3.5 Capping System

3.5.1 There are to be no changes to the existing capping regime with capping systems in Cells 1-5 in Phase 3, 4 and 5, comprising of a minimum of 1m low permeability (<$1x10^{-9}$ m/s) engineered clay and covered by minimum 1m of soils.

3.5.2 Capping systems in Phase 2 comprise of a 200mm thick soil binding layer and minimum 1m of soils.

3.5.3 Capping systems in IBA Cell 1 (and also later IBA Cells 2, 3 and 4) will consist of 1m of inert soils, with a minimum hydraulic conductivity of $1x10^{-7}$ m/s.

3.6 Restoration

3.6.1 It is necessary for the site to be completed and restored to a designated profile to ensure the long-term stability of the landfill site, to avoid unwanted differential or excessive settlement, to protect the capping integrity and for the long-term function of the environmental monitoring and management systems across the site for gas, leachate, groundwater and surface water.

3.6.2 Where the IBA Cells 1-4 are to be tipped to final levels, these will be restored in accordance with the approved planning consent.

3.6.3 Lincwaste Limited will continue to be responsible for the maintenance of all monitoring infrastructure, the final surface of the landfill, the gas extraction and the long-term control of leachate levels within Whisby Landfill Site prior to surrender of the permit.

3.7 Post-Closure Controls (Aftercare)

3.7.1 The IBA Cells 1-4 will be restored in accordance with the approved planning consent for the site..

3.7.2 The aftercare scheme for the site will include, where necessary, monitoring of surface water quality, groundwater levels and quality, leachate levels and quality and perimeter and in-waste landfill gas concentrations, to provide evidence to demonstrate there has been no deterioration of the land to enable permit surrender. Existing groundwater, leachate and gas monitoring infrastructure associated with the landfill site will be used.

4.0 GROUNDWATER MANAGEMENT & MONITORING

4.1 Groundwater Management

4.1.1 The site is operated on the basis of hydraulic containment. Groundwater is present in Area A and B (Area B is also known as the lagoon area), and therefore groundwater will be required to be pumped from the IBA Cell 1 (and also IBA Cells 2, 3 and 4) into drains on the north-western edge of the site, during the operational phase.

4.1.2 Groundwater is controlled via a sump in the northwest corner of Area A. Groundwater will be collected from a back wall drain in IBA Cell 1. A geocomposite drainage layer shall be installed against the sand and gravel side slopes on the northern and southern sides of the cell to relieve groundwater pressures and shall extend down to a drain which shall be installed beneath the base of the side slopes. The proposed groundwater management is shown on drawing ref. WR7855/01/06 (in report in Appendix 2).

4.1.3 There are no proposed pumping systems for IBA Cell 1, as the existing site pumping operation is at a lower level than the Lias Clay interface level, so the existing open lagoons and pumping systems (to the west) will be utilised for ground water control during construction.

4.2 Groundwater Monitoring Infrastructure

4.2.1 Groundwater monitoring will continue to be undertaken in accordance with the landfill Permit around the perimeter of the landfill development. This routine groundwater monitoring provides background quality data with respect to the baseline conditions prior to the proposed landfilling works.

4.2.2 There are no proposed changes to the monitoring regime, however it is noted that the mecoprop and cadmium compliance limits have not been adjusted since the reclassification of these parameters as non-hazardous in 2017 (see HRAR).

4.3 Groundwater Control or Abstraction

4.3.1 There will be no additional groundwater control or abstraction systems set up at Whisby Landfill Site as part of the IBA landfilling activities.

5.0 LEACHATE MANAGEMENT AND MONITORING INFRASTRUCTURE

5.1 Leachate Generation

5.1.1 A Hydrogeological Risk Assessment Review (HRAR) for the site was reviewed as part of this permit variation application and is included within the application documents as report ref. 5671-CAU-XX-XX-RP-O-0309.A0.C2.

5.1.2 The HRAR for Whisby Landfill Site identifies that the source of leachate generation remains the wastes deposited within the non-hazardous landfill cells, which are lined containment cells, with leachate management infrastructure and abstraction.

5.1.3 As part of this permit variation, it is proposed to undertake landfilling of IBA Cells 1-4 in the undeveloped Area A of the site. The IBA will be subject to strict waste acceptance procedures to ensure only those waste types will be used for the works.

5.1.4 IBA Cell 1 (and subsequently Cells 2, 3 and 4 once constructed) will benefit from an engineered leachate collection system which will consist of spine drains and a sump, such that leachate levels can be managed in accordance with the levels stated within the environmental permit (see HRAR for further details). Following capping, it is anticipated that rainfall infiltration into the site will greatly reduce, thus reducing leachate generation significantly.

5.2 Leachate Management

5.2.1 Leachate elevations in all cells should be maintained within the limits stipulated in the site permit in order to maintain hydraulic containment.

5.2.2 Leachate at the site is currently treated and effluent put through the SRCs and tankered off-site for disposal.

5.2.3 Leachate drainage in IBA Cell 1 will consist of spine drains as detailed on drawing ref. WR7855/01/04 (in report in Appendix 2). Leachate will be tankered off-site for disposal.

5.2.4 Leachate levels within IBA Cell 1 will be managed on the principal of hydraulic containment. Leachate levels within this cell will be required to be maintained at 1m below the surrounding groundwater levels during both the operational phase (during groundwater pumping) and the non-operational phase (following cessation of pumping and recovery in groundwater levels). This is due to the pumping of groundwater surrounding the cell affecting the surrounding groundwater levels whilst the cell is operational. Water levels have shown a rapid recovery in levels within the sand and gravel aquifer to the north of the site following the cessation of pumping.

5.3 Leachate Monitoring Infrastructure

5.3.1 It is proposed to install one leachate chamber within IBA Cell 1 (sump) for the monitoring and management of leachate levels.

5.3.2 Leachate level compliance limits have been proposed in the HRAR at 4.5mAOD (which is 1.5m above base of cell) for the operational phase (proposed to be monitored monthly) and 7.5mAOD (which is 4.5m above base of cell) for the non-operational phase (proposed to be monitored quarterly).

5.3.3 There are no proposed changes to the leachate quality monitoring requirements. IBA Cell 1 should be monitored in accordance with operational cells.

6.0 LANDFILL GAS MANAGEMENT AND MONITORING INFRASTRUCTURE

6.1 Landfill Gas Generation

6.1.1 Only IBA waste materials will be accepted into the IBA Processing Facility for treatment at Whisby Landfill Site. IBA wastes that have been processed will be landfilled into, initially, IBA Cell 1, before moving onto IBA Cells 2, 3 and 4.

6.1.2 The GasSim model was updated for the site to assess the potential gas generation at the site as a result of infilling with IBA wastes and this is presented in the Landfill Gas Risk Assessment (LRGRA) document ref. 5671-CAU-XX-XX-RP-V-0308. The model anticipates that based on the 'average' waste worst case scenario, the current gas infrastructure in place is sufficient to control current generated gas volumes.

6.1.3 The main receptors likely to be sensitive to any landfill gas generation would be properties and buildings located in fairly close proximity to the boundary of the waste deposit such as buildings associated with Whisby Landfill Site, the Tarmac Quarry to the north and nearby residential properties, the closest of which is a house on Thorpe Road 415m to the northeast of the site.

6.1.4 No gas abstraction wells or additional perimeter gas monitoring wells are proposed as part of the construction of IBA Cell 1 (and subsequent IBA Cells 2, 3 and 4).

6.2 Landfill Gas Management

6.2.1 The Landfill Gas Risk Assessment (LFGRA) produced for Whisby Landfill Site has been updated as document ref. 5671-CAU-XX-XX-RP-V-0308 and reviews the landfill gas management infrastructure and gas generation potential at Whisby Landfill Site to more accurately reflect the waste inputs and degradation rates for site.

6.2.2 Landfill Gas Management Plan in place for Whisby Landfill forms a stand-alone document for the monitoring of in-waste boreholes and perimeter migration boreholes around the entirety of the non-hazardous waste deposits at Whisby Landfill.

6.3 Landfill Gas Monitoring Infrastructure

6.3.1 Existing perimeter gas monitoring boreholes are already in place and monitored along the boundary of the site and so there is no requirement to install additional perimeter monitoring boreholes. The existing procedures in place for Whisby non-hazardous landfill are sufficient to monitor and manage any potential risk that may arise from the activities associated with the proposed permitted operations.

6.3.2 It is therefore not proposed to install in-waste monitoring boreholes within the wastes deposited due to their location within the wider landfill setting and the anticipated timescale before the permit can be surrendered.

7.0 SURFACE WATER MANAGEMENT SYSTEM

7.1 Surface Water Management

7.1.1 No discharge to water or sewer is proposed. IBA Cell 1 will be a fully engineered non-hazardous landfill cell complete with liner and spine drains, with surface water/leachate to be collected by gravity into a sump. Surface water/leachate will then get pumped out and tankered to a suitable treatment facility.

7.1.2 Surface water from Phase 2 drains into Area B to the north. Surface water from Phase 3, 4 and 5 discharges to the Pike Drain via drainage ditches on the western and northern edges. There will be no changes to the existing landfill surface water management system for the wider landfill site.

7.1.3 Surface water monitoring is carried out at 5 locations, including at the SRC ditch. There are no proposed changes to the monitoring regime.

8.0 RECEPTORS & PATHWAYS

8.1 Sensitive Receptors

8.1.1 A sensitive receptor search has been conducted of the surrounding area within 1km radius of IBA Cells 1-4 (outlined in blue in Figure 1) at Whisby Landfill Site, using Defra's Magic Maps website[2] and other publicly available sources.

8.1.2 The sensitive receptors identified are listed below in Table 1 and shown on the attached 'Sensitive Receptor Plan' drawing ref. 5671-CAU-XX-XX-DR-V-1800. The distance to each receptor is measured from the boundary of IBA Cells 1-4.

Table 1 – Summary of Sensitive Receptors within 1km of the site boundary

Receptor	Receptor Type	Distance/Direction
Secondary A Aquifer within Superficial Deposits (sand/gravel)	Groundwater	Below site
Secondary B Aquifer within Bedrock	Groundwater	Below site
Workers at Whisby Landfill Site	Industrial	<10m S and E
Surface Water Bodies/Flooded Sand and Gravel Workings	Surface water	25m E, 30m W, 110m SW, 160m W, 180m NW, 310m S, 610m E, 900m SW, 835m SE
Tarmac Whisby Sand and Gravel Quarry	Commercial / Industrial	25m N
Field Drain	Surface Watercourse	70m W
Pike Drain	Surface Watercourse	120m S
Agricultural Land	Agricultural	190m NE, 350m N, 440m E, 640m S, 700m SW, 730m W
Railway Line	Commercial / Industrial	260m S
House on Thorpe Road	Residential	415m NE
Users of Thorpe Rd / Station Rd	Public Road	425m E
Hykeham Railway Line LWS	Designated Habitat Site	460m SE
Houses/Businesses on Station Road	Residential/Commercial	460m SE
House on Thorpe Road	Residential	460m NE
The Railway Inn	Commercial	480m SE
Whisby Nature Park LNR & LWS	Designated Habitat Site/ Surface Water	570m ESE
Users of Eagle Lane / Thorpe Lane	Public Road	600m SW
Crossing Gate Poultry Farm	Agricultural / Residential	610m SW

[2] DEFRA Magic Maps 2021: https://magic.defra.gov.uk/MagicMap.aspx

Receptor	Receptor Type	Distance/Direction
Sam's Auto Car Repairs Garage	Commercial / Industrial	610m SW
Lincoln Radio Sailing Club & Lake	Recreational / Surface Water	660m SW
Row of houses on Eagle Lane	Residential	690m SE
Houses on Thorpe Road	Residential	725m NE
TFM Country Store	Commercial	760m NE
Thorpe Lane Farm	Agricultural / Residential	760m WSW
Scotland Farmhouse	Residential	1000m SW
Residence/Farm on Green Lane	Residential	1000m NW

8.1.3 The area proposed for IBA Cells 1-4 and the IBA Processing Facility is predominantly surrounded by the existing landfill infrastructure to the south and east, and sand and gravel quarrying to the north. There is agricultural land further to the north, east, south and west, and surface water bodies associated with former sand and gravel pits.

8.1.4 The closest human receptors are workers at Whisby Landfill Site <10m south and east, and also workers at Tarmac Whisby Sand and Gravel Quarry 25m north. The closest residential receptors are houses on Thorpe Road 415m to the northeast and Station Road 460m to the southeast. Crossing Gate Poultry Farm (and Sam's Auto Car Repairs Garage) is located 610m to the southwest and there is a row of houses on Eagle Lane 690m to the southeast. There are no schools or hospitals within 1km of the Site.

8.1.5 Some commercial premises have been identified on Thorpe Road including The Railway Inn 480m southeast and TFM Country Store (a pet and animal feed store) 760m northeast. Lincoln Radio Sailing Club is also located 660m to the southwest.

Designated Sites of Ecological Importance & Other Habitats

8.1.6 The Environment Agency Nature and Heritage Conservation Screen provided as part of the Basic Pre-Application Advice (Appendix 1) has identified 1 Local Nature Reserve (LNR), 8 Local Wildlife Sites (LWSs) and 2 Ancient Woodlands within 2km of the site. The closest sites within 1km are Hykeham Railway Line LWS 460m to the southeast and Whisby Nature Park LNR & LWS 570m to the east-southeast.

8.1.7 There are no Sites of Scientific Interest (SSSI), Special Areas of Conservation (SACs), Special Protection Areas (SPAs), National Nature Reserves (NNRs), Ramsar sites or Areas of Outstanding Natural Beauty (AONBs) within 2km of the site boundary.

8.2 Pathways

Geology

8.2.1 The geology, hydrology and hydrogeology of the site and area surrounding the site has been updated since the 2004 ESID and characterised from The British Geological Survey (BGS)

GeoIndex Onshore online maps portal[3], DEFRA Magic Maps online portal[4] and rivers and flood risk maps from the GOV.UK website and other sources including previous reports for the site.

8.2.2 The superficial deposits at the site comprise Pleistocene and recent drift deposits comprising sands and gravels of the Balderton Sand and Gravel Member. The sands and gravels have been removed from landfilled areas of the site and were between 7.5m and 12.5m thick prior to extraction.

8.2.3 The bedrock comprises the Scunthorpe Mudstone Formation which is interbedded mudstone and limestone (formerly named the Jurassic Lower Lias Clay).

Hydrology

8.2.4 The site is located within the Boultham Catchwater Drain Water Body[5], which has a catchment area of 43.851 km^2 and the river's overall ecological status is classified as 'moderate'.

8.2.5 The Pike Drain is located 120m south of the site, oriented in an east-west direction. A field drain is also located 70m to the west of the site which feeds into the Pike Drain.

8.2.6 Numerous flooded historic sand and gravel workings surround the site.

Flooding

8.2.7 According to the GOV.UK flood risk maps[6] the site is in a Flood Zone 1 which has a Low Probability of flooding from Rivers and the Sea. The site is at Low Risk of Flooding from Surface Water and Very Low Risk of flooding from Rivers and the Sea. The site is also unlikely to be flooded by reservoirs and groundwater.

Hydrogeology

8.2.8 The site is situated on the Balderton Sand and Gravel Member (sand and gravel) superficial deposits, which is designated a Secondary A Aquifer, defined as 'comprise permeable layers that can support local water supplies, and may form an important source of base flow to rivers'.

8.2.9 Below this is the Scunthorpe Mudstone Formation (interbedded mudstone and limestone) bedrock, which is designated a Secondary B Aquifer, defined as 'mainly lower permeability layers that may store and yield limited amounts of groundwater through characteristics like thin cracks (called fissures) and openings or eroded layers'.

[3] British Geological Survey, GeoIndex Onshore, 2023 at: https://mapapps2.bgs.ac.uk/geoindex/home.html
[4] DEFRA Magic Maps, 2023. Found online at: https://magic.defra.gov.uk/MagicMap.aspx
[5] Environment Agency Catchment Data Explorer, 2023 at: https://environment.data.gov.uk/catchment-planning/WaterBody/GB105030062380
[6] GOV.UK 'Check long term flood risk' 2023 at: https://check-long-term-flood-risk.service.gov.uk/risk and 'Flood map for planning' 2023 at: https://flood-map-for-planning.service.gov.uk

8.2.10 The site is not within a Source Protection Zone (SPZ), with the closest, a Zone III, located over 7.4 km to the east.

Groundwater Flow

8.2.11 With reference to the Hydrogeological Risk Assessment Review (HRAR) (document ref. 5671-CAU-XX-XX-RP-O-0309.A0.C2) for the site, groundwater predominantly flows towards the northwest.

8.2.12 Groundwater Quality

8.2.13 From the Hydrogeological Risk Assessment Review (HRAR) undertaken for the site as part of this permit application (ref. 5671-CAU-XX-XX-RP-O-0309.A0.C2) groundwater quality remains comparable to the previous HRAR review, with no exceedances of compliance limits throughout the review period. Overall, there has not been any discernible changes in water quality over this review period.

8.2.14 Man-made Subsurface Pathways

8.2.15 There are no changes to the man-made subsurface pathways presented in the 2004 ESID, which is the potential for boreholes to intersect the bands of limestone in the bedrock to the superficial deposits above.

Groundwater

8.2.16 The groundwater within the superficial deposits (Secondary A Aquifer) and in the bedrock (Secondary B Aquifer) has been identified as a receptor. However, the IBA Cells 1-4 for the disposal of the IBA wastes at Whisby are to be constructed as fully engineered non-hazardous lined landfill cells and the proposed IBA treatment operations will also be undertaken within IBA Cell 1. Therefore, it is not considered likely that any leachate generated will interact with the groundwater. The landfill cell will be fully lined with an impermeable liner and designed with spine drains and sump to collect leachate prior to pumping out and tankering off-site to a suitable treatment facility.

Surface Water

8.2.17 The nearest watercourse is the Pike Drain located 120m to the south of the site at its closest point.

8.2.18 The current permitted surface water discharge points and associated volumes at the landfill site will continue to be used and no revised volumes or discharge points are proposed within this permit application.

8.2.19 There are no proposed changes to the existing surface water management scheme at Whisby Landfill Site. Any surface water/leachate will be collected within the engineered landfill cell (IBA Cells 1-4) during landfilling with IBA wastes and directed via spine drains towards a

leachate collection sump. Leachate will be pumped out and tankered away to a suitable treatment facility.

8.2.20 There are no surface water discharge points proposed as part of this permit variation.

8.3 Risk Assessments

Hydrogeological Risk Assessment

8.3.1 An updated Hydrogeological Risk Assessment for the site to include for the update to the Conceptual Site Model (CSM) is provided as document ref. 5671-CAU-XX-XX-RP-O-0309.A0.C2, included within this application.

Stability Risk Assessment

8.3.2 A Stability Risk Assessment (SRA) has been undertaken by Sirius in March 2023 for the IBA Cell 1 Construction.

8.3.3 The SRA (document ref. WR7885/SRA) is attached as Appendix 3 of the Operating Techniques & BAT Review document ref. 5671-CAU-XX-XX-RP-V-0301, included within this application.

8.3.4 The SRA has addressed the stability and the integrity of the waste containment system, and the stability of the IBA waste mass during the construction of IBA Cell 1 and subsequent infilling works at Whisby Landfill Site.

8.3.5 The impact of the construction (and infilling) of IBA Cell 1 on the stability of the existing surface water lagoon dam (immediately to the east of the site, separating the lagoon from the landfill) was also assessed, including the impact on the stability of the lagoon dam as a result of a 'rapid draw-dawn event' (of the water level in lagoon).

8.3.6 The assessments have indicated acceptable factors of safety for the stability and integrity of the proposed landfill containment system, and the associated infilling, provided the identified recommendations listed in the conclusions are followed.

Amenity & Accidents Risk Assessment

8.3.7 An Environmental Risk Assessment (ERA) has been undertaken as part of this permit application which considers the amenity and accident risks to receptors as a result of the proposed operations at the new IBA Cell 1 (processing and storage of IBA and landfilling of IBA). The ERA is included as document ref. 5671-CAU-XX-XX-RP-V-0302.

8.3.8 Amenity issues that may affect receptors from this type of operation are potentially nuisances caused by dust, noise or mud deposited on roads. There are very few residential properties located near to the site, with the closest located 415m to the NE. There are no schools or hospitals within 1km of the site boundary.

8.3.9 The closest human receptors will be workers at the adjacent Tarmac Whisby Sand and Gravel Quarry 25m to the north, however these receptors will be less sensitive to dust, noise and mud due to similar industrial operations occurring at their site. Flora and fauna in nearby habitats may be sensitive to dust and disturbance by noise, however the closest protected habitats are over 460m to the southeast (Hykeham Railway Line LWS) and not downwind of the prevailing wind conditions of the site (typically prevailing to the northeast). Control measures for dust, noise, mud and other fugitive emissions will be in place at the site and will ensure amenity nuisances are kept to a minimum to protect nearby sensitive receptors.

8.3.10 A Noise Impact Assessment (ref. UK.17811589/00) was undertaken by Bureau Veritas as part of the planning application for the proposed activities and it was concluded that the noise impact of the site operations would be below the Lowest Observed Adverse Effect Level at the nearest residential receptors, and that operational traffic generated by the development would have negligible noise impacts on off-site receptors.

Landfill Gas Risk Assessment

8.3.11 The Landfill Gas Risk Assessment (LFGRA) for the site has been updated as part of this permit variation as document ref. 5671-CAU-XX-XX-RP-V-0308.

8.4 Weather Monitoring

8.4.1 As part of the monitoring procedures in the Dust & Emissions Management Plan and Odour Management Plan for the site, the operator should check the weather forecast daily to ensure risks to receptors and operations are managed accordingly to reduce risk of dust and odour causing an impact. In particular, wind speed and direction should be checked, as dust, particulates and odour can be entrained in the wind and travel towards sensitive receptors.

8.4.2 Any meteorological data necessary for the review of post-closure monitoring data will be collected as part of the monitoring exercise.

8.5 Amenity Monitoring

8.5.1 The conceptual site model for the site indicates the IBA processing, storage and landfilling activities could have the potential to cause fugitive emissions, such as dust, and other amenity nuisances such as noise, vibration and odour. These risks have been assessed in the Environmental Risk Assessment report ref. 5671-CAU-XX-XX-RP-V-0302.

8.5.2 The control measures in place at the site will ensure risks to receptors will remain low. Control measures will be regularly reviewed by site management and daily site inspections will ensure that the risk of amenity nuisances and accidents being caused by the proposed activities are kept low. Any incidents or complaints received will be recorded in the site diary and control measures reviewed to reduce reoccurrence.

9.0 REFERENCES

- Environment Agency, 30th January 2020 (last updated 29 June 2023) guidance: 'Landfill operators: environmental permits - What to include in your environmental setting and installation design report', found at: https://www.gov.uk/guidance/landfill-operators-environmental-permits/what-to-include-in-your-environmental-setting-and-installation-design-report

- The Environmental Permitting (England and Wales) Regulations 2016. Found at: www.legislation.gov.uk

DRAWINGS

722M132	**Environmental Monitoring Plan**
722A165	**Annual Site Plan 2023**
WR7855/1/001 Rev 3	**Proposed IBA Pad & Cells Development**
722A167A	**IBA Processing Pad – General Site Layout**
WR7885 SRA 01	**IBA Cell 1 Construction**

NOTES:

1. ALL DIMENSIONS IN MILLIMETRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM.

2. DO NOT SCALE FROM THIS DRAWING.

3. ANY ANOMALIES IDENTIFIED WITH THE DETAILS SHOWN ON THIS DRAWING ARE TO BE BROUGHT TO THE ATTENTION OF FCC ENVIRONMENT (UK) LIMITED PRIOR TO CONSTRUCTION WORKS COMMENCING.

LEGEND:

- Ownership Boundary
- Landfill Gas Monitoring Point
- Landfill Gas Surface Monitoring Probe
- Combined Gas/ Groundwater Monitoring Point
- Gas Flare Stack
- Landfill Gas Extraction Point
- Landfill Gas Extraction/ Leachate Monitoring Point
- Condensate Unit (Knock-out Pot)
- Gas Manifold
- Groundwater Monitoring Borehole
- Groundwater Pumping Point
- Surface Water Monitoring Point
- Leachate Collection Point
- Leachate Monitoring Point
- Leachate Recirculation Point
- Leachate Collection Sump
- Leachate Discharge Sampling Point
- Leachate Detection Point
- Underdrainage Monitoring Point
- Settlement Monitoring Point
- Drain/ Dewatering Tank
- Valve
- As-built Cell Footprint
- Wells no longer monitored.

Revision:	Date:	Description:	By:	Chk:
A	10.06.15	Additional landfill gas extraction points added	BS	GB
B	24.05.16	Labels amended	BS	GB
C	04.11.16	LW2.1B & LW2.6B added. BH1/13-BH5/13 removed	BS	GB
D	05.02.21	W0037, W0038, W0040, W0045, W0046, W0047, W0052, W0053, W0056 & W0060 removed, Site survey updated.	BS	CF
E	02.07.21	LW2.4A added	BS	BB

Reference files:
Information taken from plans:

Site Survey: 722J3020

FCC Environment (UK) Limited
6 Sidings Court, White Rose Way, Doncaster, DN4 5NU

Site:

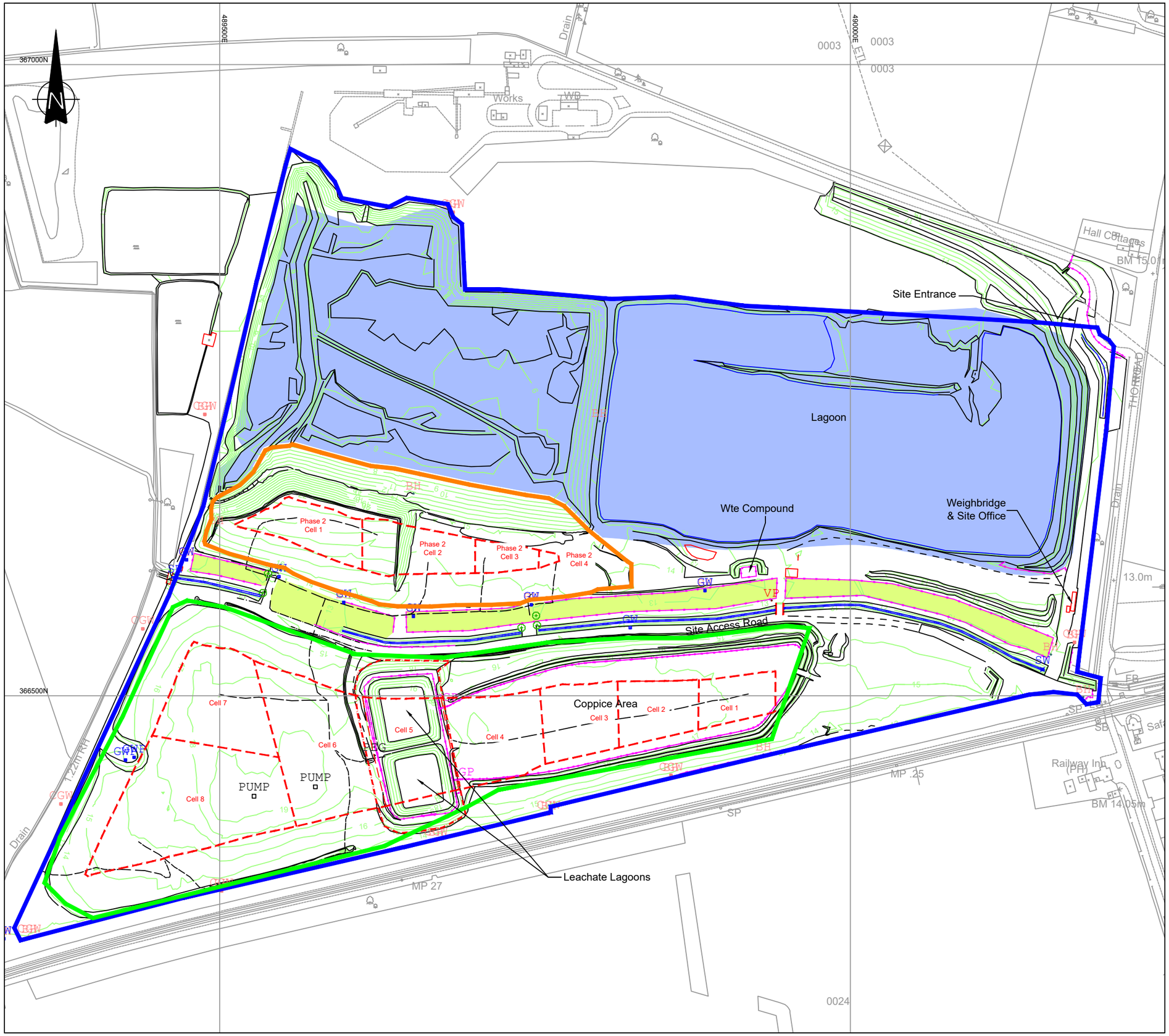
WHISBY
LANDFILL SITE

Drawing Title:

Environmental Monitoring Plan

Drawn By:	Checked By:	Date:	Scale:	Paper Size:
BS	BB	02.07.21	1:2250	A2
Status:	Revision:	Drawing No:		Plan Number:
FINAL	E	722M132		PLAN 4

Last Saved By: Ben.Stocks Date: 2-Jul-21 Plot By: ben.stocks Date: 2-Jul-21



NOTES:

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LEGEND:

- Ownership Boundary
- Capped Area
- Restored Area
- Latest Available Ground Contours
- As-built Cell Footprint
- Tax Information Area

Revision:	Date:	Description:	By:	Chk:
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

Reference files:
Information taken from plans;

Site Survey:	722J3071
Proposed Area:	722K2000
Cell Footprints:	722B023 & 722B024
Areas Model:	722A3072

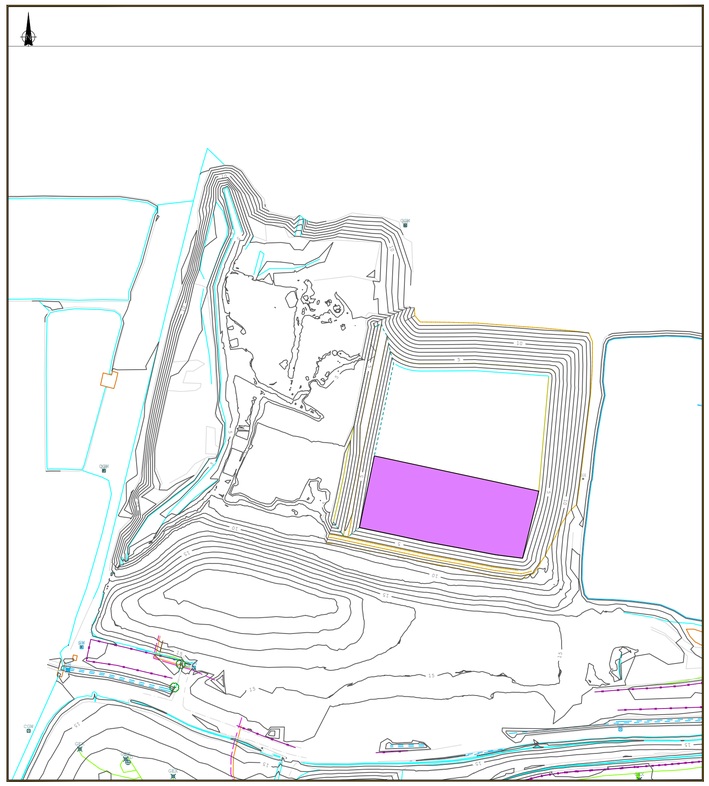
FCC Environment (UK) Limited
3 Sidings Court, White Rose Way, Doncaster. DN4 5NU

Site:
WHISBY
LANDFILL SITE

Drawing Title:
Annual Site Plan 2023

Drawn By:	Checked By:	Date:	Scale:	Paper Size:
BS	LH	24.01.23	1:3000	A3

Status:	Revision:	Drawing No:	Plan Number:
FINAL	-	**722A165**	**PLAN 2**



CELL 1 & IBA PAD - 2023 WORKS
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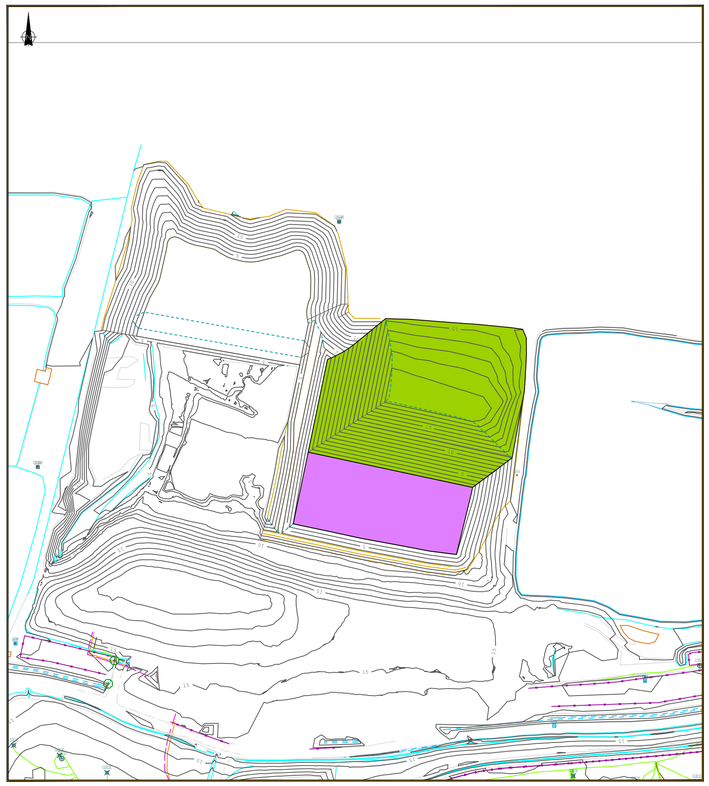
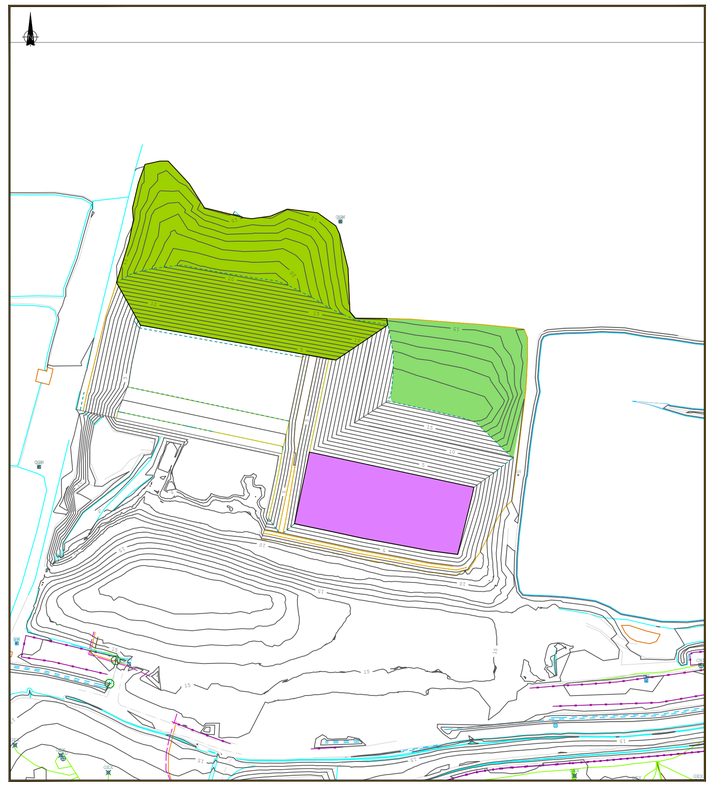
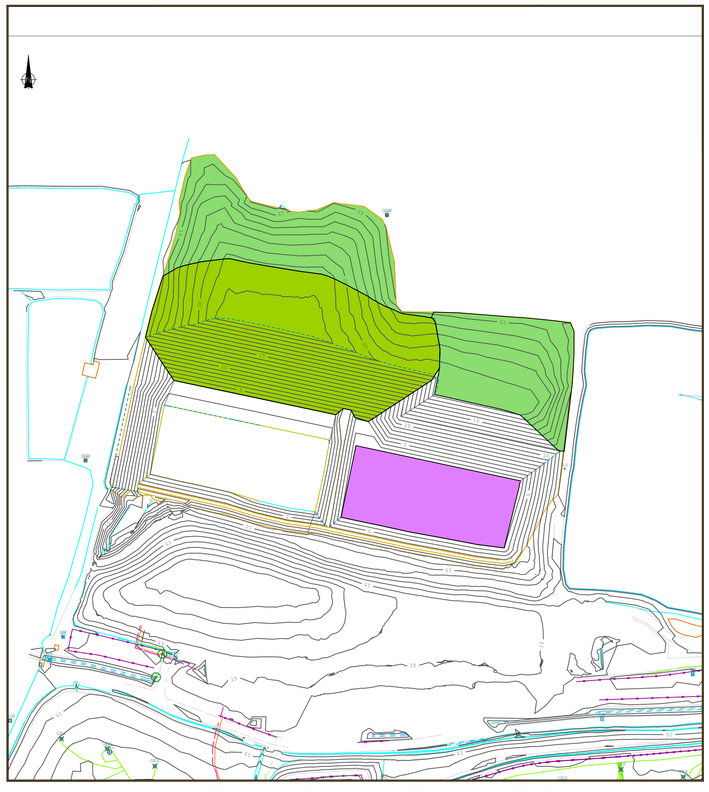


PROPOSED CELL 1 FILLED, CELL 2 ENGINEERED
SCALE 1:1250



PROPOSED CELL 1 RESTORED, CELL 2 FILLED & CELL 3 ENGINEERED
SCALE 1:1250



PROPOSED CELL 1 & 2 RESTORED, CELL 3 FILLED & CELL 4 ENGINEERED
SCALE 1:1250

PROPOSED CELL 1, 2 & 3 RESTORED, CELL 4 FILLED - IBA PAD IN CELL 1 RE-PURPOSED
SCALE 1:1250

PROPOSED CELL 1, 2, 3 & 4 RESTORED - IBA PAD FILLED
SCALE 1:1250

NOTES

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LEGEND

- IBA PAD
- RECENT CELL FILLED TO POST SETTLEMENT LEVELS
- OLDER CELL(S) FILLED TO POST SETTLEMENT LEVELS

REV	DESCRIPTION	DATE	BY
3	CELL REFERENCES AMENDED	28/06/2023	JE
2	COMPLETE RE-MODEL FOR ALTERNATIVE SEQUENCE	21/11/2022	JE
1	COMPLETE RE-MODEL TO ACHIEVE MINIMUM FINAL EARTHWORKS BALANCE	13/9/2022	JE

CLIENT

FCC Environment

FCC Environment (UK) Limited
Ground Floor West, 900 Pavilion Drive, Northampton Business Park, Northampton, NN4 7RG

Sirius Environmental
4245 Park Approach, Thorpe Park, Leeds. LS15 8GB. 0113 264 9960

JOB TITLE

WHISBY LANDFILL SITE

DRAWING TITLE

PROPOSED IBA PAD & CELLS DEVELOPMENT

DRAWN	DATE	APPROVED	DATE
J.E	01/09/2022	A.K	06/09/2022

SCALE	SHEET	DRAWING NUMBER	REVISION
1:1000	A1L	WR7855/1/001	3

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LEGEND:

- Contours
- Proposed Leachate Collection Point
- Site Acces Road
- IBA Storage & Processing Area
- Plant Site Area
- Pre-Processing Stockpiles
- Post-Processing Metals Stocks
- Post-Processing IBA Storage
- Mobile Dust Suppression System

Revision:	Date:	Description:	By:	Chk:
-	-	-	-	-
-	-	-	-	-
A	15.06.23	Area's revised	BS	MP

Reference files:
Information taken from plans;
Plan: WR7855 01 02

FCC Environment (UK) Limited
3 Sidings Court, White Rose Way, Doncaster. DN4 5NU

Site:
WHISBY LANDFILL SITE

Drawing Title:
IBA Processing Pad - General Layout

Drawn By:	Checked By:	Date:	Scale:	Paper Size:
BS	MP	15.06.23	1:750	A3

Status:	Revision:	Drawing No:	Plan Number:
FINAL	A	**722A167**	-

NOTES

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4. FOR SECTION DETAILS SEE DRAWING WR7885 01 03

LEGEND

- SITE SURVEY
- PROPOSED TOP OF LINER
- PROPOSED TOP OF FORMATION / INSITU CLAY BELOW CLAY / OVERBURDEN INTERFACE
- PROPOSED LEACHATE COLLECTION POINT
- AREA OF PROPOSED DRAINAGE GEOCOMPOSITE
- GROUND WATER CONTROL FRENCH DRAIN/CULVERT
- SRA SECTION LOCATIONS

REV	DESCRIPTION	DATE	BY

CLIENT

FCC Environment

FCC Environment (UK) Limited
6 Sidings Court, White Rose Way, Doncaster. DN4 5NU

Sirius Environmental

4245 Park Approach, Thorpe Park, Leeds. LS15 8GB. 0113 264 9960

JOB TITLE

WHISBY LANDFILL SITE
IBA CELL 1 CONSTRUCTION

DRAWING TITLE

SRA SECTION LOCATIONS TOP OF LINER LAYOUT

DRAWN	DATE	APPROVED	DATE
JC	03/03/2023	A.K	03/03/2023

SCALE	SHEET	DRAWING NUMBER	REVISION
As Shown	A1L	WR7885 SRA 01	0

L [redacted] WING PROPOSED TOP OF LINER WITH STABILITY SECTION[redacted]S

APPENDIX 1

2004 Environmental Setting and Installation Design (Section A)
report ref. 03523334.501

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REPORT ON

SECTION A
ENVIRONMENTAL SETTING AND INSTALLATION DESIGN
WHISBY LANDFILL SITE

Submitted to:

Lincwaste Limited
Waste Recycling Group Limited
3 Sidings Court
White Rose Way
Doncaster
South Yorkshire
DN4 5NU

DISTRIBUTION:

10 copies	-	Environment Agency
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2 copies	-	Golder Associates (UK) Ltd

May 2004

03523334.501/A.0

REPORT ISSUE FORM

Version Code	A.0	***Issue Date***	3 May 2004

Document Title	**Section A** **Environmental Setting and Installation Design** **Whisby Landfill Site** 03523334.501
Comments	Formatted by PS
List of Authors	H Culshaw
Client	Lincwaste Limited
Client Reference	
Project Manager Approval	J Lightfoot (name) (signature)
Reviewer	J Lightfoot (name) (signature)

Report Distribution

Name	*No. Copies*
Lincwaste Limited	5
Environment Agency	10
Golder Associates (UK) Ltd	2

Definition of Version Code:
D. Applied during initial drafting of the report before it has been reviewed.
C. Applied after the report has been reviewed but before it has been approved by the Project Manager.
B. Applied after the Project Manager has approved the report ready for issue to the client.
A. Applied to reports after external/client review.
The version number starts at '0' and is raised by '1' at each re-type.

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LIST OF DRAWINGS

LIST OF APPENDICES

All Appendices are included in electronic format with Appendix 8 also included in hard copy.

1.0 INTRODUCTION

1.1 Report Context

Lincwaste Limited (LWL) have requested that Golder Associates (UK) Ltd. (Golder) prepare a PPC Permit application to authorise the proposed future development of Whisby Landfill Site as non-hazardous landfill. As part of the application, quantitative risk assessments have been carried out for hydrogeology, stability and landfill gas, and a qualitative risk assessment has been carried out for nuisance and health. These risk assessments have been completed in accordance with the requirements of the Pollution Prevention and Control (PPC) (England and Wales) Regulations 2000 and the Landfill (England and Wales) Regulations 2002.

Landfilling into the voids left by the ongoing sand and gravel extraction in the Whisby area commenced in 1988. This began in phase 2 located north of Pike Drain, and then continued in 1990 to the south (phases 3, 4 and 5). A leachate treatment system of facultative lagoons with irrigation onto short rotational coppice was installed on the restored phase 3, 4, and 5 in 2002. Overtipping is currently occurring in phase 2 to improve the restoration profile.

Expansion into two areas north and east of the previous phase 2, Area A and the Silt lagoon, is proposed. Area A was previously excavated and used for a sand and gravel process plant. The silt lagoon was used for storing the water from the process plant. Dewatering of the lagoon commenced in late 1999 providing another void for landfill.

This Section A report details the Site specific source-pathway-receptor linkages and defines the conceptual model for use in each of the quantitative and qualitative risk assessments. The necessary engineering and environmental controls identified by the risk assessments are also detailed.

The assistance of LWL in the provision of data for this work is gratefully acknowledged. Golder has not independently verified any of the information supplied. It should be noted that the risk assessments submitted in support of this application have been produced for the sole purpose of meeting the requirements of the PPC permit application process. They are not intended to be used in the place of detailed design for future landfill developments.

1.2 Installation Details

The Site is located near the village of Thorpe, approximately 8 km southwest of Lincoln at National Grid Reference SK 895 665. Access to the Site is via Eagle road. Drawing ESID1 shows the Site location in relation to the surrounding features.

A metal gate blocks the entrance off Eagle road and is locked outside operating hours. A 2 m high chain link fence surrounds part of the landfill Site with stock fencing surrounding the remainder. There is a weighbridge and associated office on the access road to the Site. At the

eastern end of phase 2 is a landfill gas flare, connected to the gas extraction system in phases 2 and 3, 4 and 5.

There are two former areas of landfill at the Site (Drawing ESID4). The Phase 2 landfill commenced June 1988, all of its 5 cells had been completed and capped but are now being overtipped. Landfill phase 3, 4, and 5 started in 1990 and occupies an area south of phase 2 and the Pike Drain, all the cells have been filled and capped.

The area that is the subject of this PPC application is termed the *Installation* and is shown on Drawing ESID2. The installation is located within the existing waste management licence boundary. The installation boundary follows the southern edge of phase 2 beside the Pike Drain, the boundary follows Thorpe road north continuing around the Silt lagoon area and Area A before joining up with the western edge of Phase 2 (Drawing ESID4). The application area also includes the leachate treatment lagoons.

The extent of the proposed tipping is presented on Drawing ESID4. Area A and the Silt lagoon area will be filled and restored, with over-tipping of the existing phase 2 landfill. The cell layouts for Area A are indicative only and may be changed following detailed design and materials balance. The cell layout for Area B (the redundant silt lagoons) are still to be designed (following detailed survey after the lagoon is drained).

Permitted waste categories contained in the Phase 2 and Phase 3, 4, and 5 landfill are classified as inert, semi-inert, putrescible/domestic solid wastes and difficult wastes under the waste licence L245. The proposed landfill is to be classified as non-hazardous.

1.3 Site Setting

The Site is located at an elevation of between 10 to 20 m AOD on the Lincolnshire fens. The local topography surrounding the site consists of shallow gradient hills with elevations no greater than 30 m AOD. Drawing ESID2 shows the location of the site in relation to potential environmental receptors, such as residential areas and water bodies. Table ESID1 summarises the land uses within a 500 m radius of the Site.

Table ESID1: Land uses within 500 m of the Site Boundary

Direction	Land Uses
North	Arable and poultry farm land exists to the north of the Site. A drainage ditch connecting to the storage lagoons west of the Site extends down from the north.
East	A public road (Thorpe Road) runs to the east of the Site. Arable and poultry farmland exists to the east extending into the Whisby nature park approximately 500 m from the Site. The Pike Drain flows through the Site and into the Whisby nature park.
South	The Newark to Lincoln railway line runs to the south of the Site. Flooded mineral workings exist beyond the railway before Eagle Lane is reached followed by Arable farmland. A public house is the closest building to the Site approximately 50 m to the south. Domestic dwellings extend southwards from the public house for 500 m. A school exists approximately 700 m to the southeast in the village of Thorpe on the Hill.

West	Two storage lagoons occur to the west of the Site. The area to the west is dominated by Arable and poultry farmland, with drainage ditches present.

The Pike Drain flows from west to east through the Site. The Site haul road is located to the south of the Pike Drain as are phase 3, 4, and 5, Phase 2 and Area A are located to the north of the drain. There are several road crossings located along the length of the haul road.

Groundwater in the sands and gravels surrounding the site is a potential receptor of contamination. The groundwater feeds into several lakes located 500 m to the southeast of the site. The lakes are situated in the Whisby Nature Park and were formed by groundwater collecting in old extraction quarries. The Pike Drain also flows through the Nature Park forming a potential surface water receptor.

Drawing ESID3 shows sites of cultural and natural heritage within a 5 km radius of the installation boundary. Within the 5 km radius there are two SSSI sites. Swanholme Lakes with an area of 53.96 hectares is located approximately 4.5 km northeast of the site. Doddington Clay Woods with an area of 23.65 hectares is located approximately 4.5 km north of the site. No habitat sites of European status have been identified within 5 km of the installation boundary.

There are four scheduled monuments within a 5 km radius of the installation boundary (Drawing ESID3). These are detailed on Table ESID2.

Table ESID2: Sites of Cultural and Natural Heritage

Location (NGR)		**Site**
486500	365680	Remains of a preceptory, fishponds and post-medieval gardens at Eagle Hall.
490860	361710	Churchyard cross, St Germain's Churchyard, Thulby.
491280	362780	Hall close: a medieval and post-medieval hall complex south of Dovecote Lane, Haddington with Dovecote, gardens, fishponds, churchyard and cultivation remains.
487780	370540	Moated site west of church road, Harby.

2.0 SOURCE TERM CHARACTERISATION

2.1 The Development of the Installation

2.1.1 Historical development

Sands and gravels have been extracted for many years at the Site from shallow workings by Lafarge Limited (formerly Redland Aggregates Limited). Restoration of the ensuing voids has been by landfilling. Drawing ESID4 shows the general layout of the site.

Landfilling commenced in June 1988 within phase 2. All of the 5 cells in this phase were completed and capped, but have settled. Phase 3, 4, and 5 commenced in 1990, the 8 cells in this area have since been filled and completed. A leachate treatment system of facultative lagoons and short rotational coppice was installed on these phases in 2002 (Golder 2001a).

Extraction of sands and gravels continued to the northeast. A sand and gravel process plant is situated in the north of Area A with a process water-settling lagoon occupying the area to the east. Dewatering of the lagoon commenced in late 1999, with the intention to use both the lagoon area and Area A for restoration with non-hazardous waste as detailed in this report. Two silt lagoons have been developed to the west of the installation to replace the dewatered lagoon.

Phase 2 is currently being overtipped following cap removal, as substantial settlement had occurred leaving an uneven landscape.

2.1.2 Proposed development

It is proposed that future landfill cells be constructed in Area A and the drained Silt lagoon (Drawing ESID6) with the restoration contours tying in to the overtipped Phase 2.

The permitted waste types for proposed landfill are to be non-hazardous and the cells will be sized on the expected annual waste input. The current average waste input ranges between 50,000 and 75,000 tonnes per annum.

Under the current planning permission for the site, restoration is to be undertaken as shown on Drawing ESID5 on completion of landfilling activities. The approved afteruse for the site is agriculture.

2.2 Installation Engineering

2.2.1 Groundwater management

To control groundwater pressures against the sidewall liners during cell construction and filling, groundwater drainage systems have been used. These involved a MDPE perforated drainage pipe being positioned behind the sidewall lining system at the base of the sand and gravel (see Drawing ESID6). The pipe is surrounded by gravel backfill contained in a geotextile. The pipe drains under gravity to a discharge point or sump.

For Phase 2 a pipe was installed along the southern edge of the area parallel to the Pike Drain and also along the western edge, discharging into Area A. For Phase 3, 4, and 5 drainage pipe was installed around the whole perimeter of the area discharging into a sump on the western edge. The water is pumped from this sump to the lagoons to the west of area A.

A groundwater drainage system will need to be installed for the proposed landfill until sufficient depth of waste has been placed in the cells to overcome external groundwater pressures on the lining system. This will consist of MDPE perforated drainage pipes positioned at the base of the sand and gravel or within the Lias clay behind the sidewall lining to drain the groundwater away from the landfill cell. This will need to drain to a sump located at the edge of the landfill area.

2.2.2 Basal lining

2.2.2.1 Existing Landfill Basal Lining

Table ESID3 presents a summary of the construction details on a cell by cell basis.

The Lower Lias clay provided a geological barrier for the base of the Phase 2 landfill and cells 1-6 in Phase 3, 4, and 5. There was no requirement for re-working the basal clay but any exposed water bearing strata, consisting of the rare Limestone bands, were required to be identified and removed. The standard for the basal lining was altered prior to the construction of cells 7 and 8 to a minimum thickness of 1 m of reworked clay being placed to an engineered specification (maximum permeability of 1×10^{-9} m/s) across the base of each cell.

There is no basal leachate drainage in Phase 2 and the early cells (1-4) of Phase 3, 4, and 5, with leachate control within the waste mass reliant on the permeability contrast between the waste body and the perimeter clay liner. The later cells of Phase 3, 4, and 5 have had basal leachate drainage systems constructed. Cell 5 has a gravel drainage blanket, while cells 6, 7 and 8 have HDPE piped drainage systems across the base of the waste mass contained in a calcareous-free aggregate surround.

2.2.2.2 Proposed Landfill Basal Lining

The proposed basal lining will consist of a minimum thickness of 1 m of reworked clay being placed to an engineered specification across the base of each cell. The engineered specification should be a maximum permeability of 1 x 10^{-9} m/s.

The proposed leachate drainage system is to be 300 mm of gravel.

Table ESID3: Summary of Installation Cconstruction Details

	Phase 2	Phase 3, 4, and 5			Future Phases
		Cells 1-4	Cell 5	Cells 6, 7 & 8	
Status	Overtipping	Restored	Restored	Restored	-
Basal Lining	No engineered clay	No engineered clay	1 m thick engineered clay	1 m thick engineered clay	1 m thick engineered clay
Basal drainage	No basal drainage	No basal drainage	Gravel drainage blanket	Radial piped gravel drainage system	300 mm thick gravel drainage system with spine drains.
Side slope lining and drainage	1 m engineered clay. No drainage	1 m engineered clay. No drainage	1 m engineered clay. No drainage	1 m engineered clay. No drainage	1 m engineered clay. No drainage
Cap details	Previous cap 1 m engineered clay and soils.	1 m engineered clay. 1m cover soils	1 m engineered clay. 1 m cover soils	HDPE Geomembrane. 1 m cover soils	Geomembrane with possible geotextile. 1m cover soils.

2.2.2.3 Construction Quality Assurance

Construction Quality Assurance (CQA) Programmes have been undertaken to ensure that the engineered liner systems conform to the standard specifications required by the Environment Agency. Table ESID4 summarises the known CQA work undertaken at the site.

Table ESID4: CQA Programmes Undertaken at the Site

Date	Contractor	CQA Programme
October and November 1987	M J Carter Associates	Construction of Phase 2 cells
January and July 1988	M J Carter Associates	Slope stabilisation in Phase 2
January and September 1989	M J Carter Associates	Slope stabilisation in Phase 2
June, July and September 1990	M J Carter Associates	Cell 1 construction in Phase 3,4, and 5
January and February 1991	M J Carter Associates	Construction of bunds. Development of cells 1 and 2.
February and March 1991	M J Carter Associates	Construction of cells 3 and 4
July 1991	M J Carter Associates	Remediation of cell 3
August 1991	M J Carter Associates	Capping of cells 1 and 2
September 1991	M J Carter Associates	Construction of cell 3
October, November and December 1991	M J Carter Associates	Construction of cells 4, 5, and 6

Date	Contractor	CQA Programme
March 1992	M J Carter Associates	Construction of cell 4 and cover to drainage
May 1992	M J Carter Associates	Remediation to cell 5
February 1993	M J Carter Associates	Construction of cell 5
March 1994	C L Associates	Construction of cell 6
April 1994	C L Associates	Capping of cells 2, 3 and 4.
November 1994	C L Associates	Investigation of cell 1 cap integrity. Remediation works to cell 6. Construction of cell 5 cap.
March 1995	C L Associates	Construction of cell 6 and seal rising in cell 6.
June 1995	C L Associates	Specification of Geomembrane cap.
August 1995	C L Associates	Construction of cell 7. Quality testing of sealing material from Area A

2.2.3 Side slope lining

2.2.3.1 Existing Landfill Side Slope Lining

The Phase 2 and phase 3, 4, and 5 cells have low permeability clay side walls and inter-cell bunds built from the excavated clay cell base which had been reworked and compacted. The bunds are at least 2 m wide and the side wall at least 1.0 m thick, with both having a maximum permeability of 1 x 10^{-9} m/s. There is no information on the height of the bunds separating the cells in phase 2, in phase 3, 4, and 5 the bunds are 2.0 m high (ESID6).

There is no side-slope leachate drainage in either of the phases.

2.2.3.2 Proposed Landfill Side Slope Lining

The proposed side slope lining is to be a low permeability engineered clay barrier to a minimum thickness of 1 m and a maximum permeability of 1 x 10^{-9} m/s. There will be no leachate draining system for the side slope lining.

The inter-cell bunds will be built from low permeability engineered clay to 2.0 m high with a width of at least 2 m. It will have a maximum permeability of 1 x 10^{-9} m/s. This will allow isolation of the leachate within each cell.

2.2.4 Capping

2.2.4.1 Existing Landfill Capping

All the Phase 2 landfill cells were originally capped with a minimum of 1.0 m of low permeability clay. The cells settled and underwent re-profiling of the cap with soils, the re-profiled cells subsequently settled further. As part of the re-profiling the cells are progressively being stripped of restoration soils and capping; prior to re-profiling with waste;

and subsequent capping and restoration. Cells 1 to 5 of phase 3, 4, and 5 were also capped with a minimum of 1.0 m of low permeability clay; cells 6 to 8 have been capped using an HDPE geomembrane on top of a 200 mm thick sand blinding layer (ESID6). At least 1.0 m of cover soils have been placed upon the cap.

2.2.4.2 Proposed Landfill Capping

It is intended to cap future cells with an HDPE geomembrane placed on top of 200 mm layer of blinding sand and possibly including a geotextile for protection. The geomembrane cap will be joined by overlapping adjacent panels, with a minimum overlap of 1.0 m. At least 1.0 m of cover soils will be placed upon the cap.

2.2.5 Restoration and aftercare

It is anticipated that the degradation of wastes deposited within the landfill will result in the settlement of the final landfill surface by approximately 25%. To achieve the post-settlement levels surcharging of the wastes will be required. The final restoration contours are shown on drawing ESID5. These are designed to tie in with the surrounding topography.

Restoration soils will be placed over the liner to a thickness of 1.0 m. Where hedges and trees are to be planted the soils will need to be locally thickened.

2.3 Leachate Management and Monitoring Infrastructure

2.3.1 Leachate generation

It is proposed that the extension of Whisby Landfill be permitted to accept biodegradable non-hazardous waste. Leachate is formed by the percolation of water through the waste mass together with the decomposition of the waste material. The decomposition of refuse is highly complex, with microbiological, physical and chemical processes acting simultaneously within the cell.

As part of the requirements for a PPC application, a site water balance should be provided that highlights the likely leachate production rates per year. Table ESID5 provides rainfall infiltration rates to various elements of the existing and future Site. These data are based on phase footprint areas and infiltration rates. During the active period of the site we have used effective rainfall data for infiltration rates (Section 3.1) to the waste mass, and during the post closure phase we have used a 20 mm/year infiltration rate as being representative of that through a CQA'd geomembrane cap.

Table ESID5: Predicted Site Infiltration Volumes (Annual)

Area	Estimated cap area (m^2)	Leachate production rates per year (m^3)	
		Site active	Capped Site
Area A	69,000	15,870	1,380
Silt Lagoon area	117,000	26,910	2,340

Leachate Levels are to be maintained below the agreed level of 4.5 m AOD (see Section 2.3.2.1). By assuming a waste porosity of 0.15, the volume of leachate that can be stored on-site has been calculated using Equation (1) below. Table ESID6 summarises the volumes of leachate that may be stored on-site.

(1) $V = L.Ab.n$

Where,

V : Volume of leachate that can be stored on Site (m^3);

Ab : Cell basal area (m^2);

L : Maximum leachate head (m) - assumed for these purposes to be 2 m, enabling leachate Levels to be below the inter-cell bunds;

N : Porosity of the waste - assumed to be 0.15.

Table ESID6: Calculated Volumes of Leachate that may be Stored On-Site within Cells

	Basal Area (m^2)	Volume of leachate that can be stored on-site (m^3)
Area A	41,000	12,300
Silt Lagoon area	62,000	18,600

2.3.2 Leachate management and monitoring

2.3.2.1 Leachate Management

Design

The Whisby Landfill has been designed and is operated on the principles of engineered and hydraulic containment, such that the leachate levels are maintained at lower elevations than the surrounding groundwater levels in the sand and gravel aquifer. In the previous phases at the site the Licence Condition 2.17 states that the levels should be maintained at 4.5 m AOD, reportedly the interface between the top of the Lias clay and the drift. In this situation the leachate will be lower than the perceived lowest groundwater level in the sands and gravels aquifer providing hydraulic containment.

When leachate levels have risen over the regulation 4.5 m AOD level, leachate has been removed by pumping. Leachate abstraction is currently ongoing from cells in Phase 2 and cells 6 to 8 in Phase 3, 4, and 5.

The recent overtipping of Phase 2 has allowed the true state of leachate levels in its cells to be observed. It was seen that the landfill waste was actually very dry despite having shown leachate levels above 4.5 m AOD for several years. It is suggested that the vertical abstraction wells provided pathways for increased infiltration due to poor surface water runoff. The water could not escape into the waste mass and therefore rose up the well giving elevated leachate levels within the boreholes.

R*ecirculation*
During the early stages of waste infilling, leachate has been recirculated after collection in the sump and removal via the vertical abstraction wells. The leachate was returned to the waste mass to fully utilise its absorptive capacity, minimising the leachate head on the basal liner. Leachate recirculation may be used in the future development at the site.

Leachate Treatment
Facultative lagoon based treatment and irrigation to Short rotational coppice (SRC) is currently being utilised by Lincwaste Limited as a method to treat leachate at the Whisby Site. The lagoons were built in 2002 and commissioned in 2003, the SRC was planted in 2003. Two lined leachate lagoons have been built on top of the Phase 3, 4, and 5 cell 5 area (see Drawing ESID7) to pre-treat and store leachate. The primary lagoon is maintained at a consistent level where the leachate is mixed using a specific source aerator to allow facultative treatment. The treated leachate is pumped to the secondary lagoon for storage. The treated leachate from the secondary lagoon is then irrigated on to the willow SRC plot established on cells 1 to 4 of Phase 3, 4, and 5. The coppice is managed as a commercial operation with the willow harvested as a biofuel product.

There are currently two feeds into the Primary leachate lagoon. Leachate feed 1 currently receives leachate from the wells in Phase 2 and the cell 6 sump, Leachate feed 2 currently receives leachate from cell 8.

2.3.2.2 Leachate Level Monitoring

Leachate levels have been monitored on a regular basis since February 1998 from twelve leachate monitoring boreholes located on Phase 2 and three leachate sumps located on Phase 3, 4, and 5 (Drawing ESID7). The leachate elevation monitoring is required to be carried out quarterly but has regularly been implemented at additional times.

A summary of the data obtained from the monitoring is detailed in Table ESID7 with the full data set in Appendix ESID1. The cell 5 sump is no longer monitored as the leachate treatment lagoons have replaced it.

Table ESID7: Summary of Leachate Levels (February 1998 to January 2004)

Borehole or Sump	Minimum Level (mOD)	Maximum Level (mOD)	Mean Level (mOD)	Standard Deviation
CELL 5 SUMP	0.6	12.09	3.76	1.70
CELL 6 SUMP	-0.03	10.91	3.59	1.76
CELL 7 SUMP	0.35	9.731	2.36	2.16
CELL 8 SUMP	-1.06	12.01	1.756	1.09
EBH06	0	14.56	6.69	2.37
EBH07	-0.85	13.78	6.05	3.21
EBH08	0	12.92	8.46	2.50
EBH09	0.76	14.52	6.27	3.49
EBH10	2.81	12.9	6.28	2.59
EBH11	2.74	11.51	8.19	2.05
WBYCell8a	0	11.39	5.94	4.45
WBYCell8c	2.35	14.40	8.23	4.01
WBYPH2-A	0	9.84	5.89	2.27
WBYPH2-b	0	10.50	6.07	2.55
WBYPH2-c	0	11.74	5.68	2.49
WBYPH2-d	0	10.48	5.46	2.40
WBYPH2-e	1.77	10.73	4.98	2.05
WBYPH2-f	6.89	11.53	9.00	1.25

The proposed monitoring infrastructure will consist of an extraction borehole (concrete ring sump) and two remote monitoring boreholes contained in each cell. This will allow leachate levels to be maintained below the licence level of 4.5 m AOD and to ensure hydraulic containment.

2.3.2.3 Leachate Quality Monitoring

Leachate quality in the Phase 2 landfill is currently monitored by six gas extraction and leachate monitoring boreholes (Drawing ESID7). For Phase 3, 4, and 5 leachate is sampled at the sumps of cells 6, 7 and 8. The leachate quality monitoring is required to be carried out quarterly or monthly, for the suite detailed in Table ESID8

Table ESID8: Leachate Quality Monitoring Suite

Determinand	Unit	Analysis
Ammoniacal Nitrogen	(N:mg/l) (mg/l)	Monthly
Biological Oxygen Demand (BOD)	(mg/l)	Quarterly
Calcium as Ca (Dissolved)	(mg/l)	Quarterly
Chloride	(mg/l)	Monthly
Chromium as Cr (Dissolved)	(mg/l)	Quarterly
Chemical Oxygen Demand (COD)	(mg/l)	Quarterly
Conductivity (Us/cm @ 25C: LABORATORY DETERMINATION)	(uS / cm)	Monthly
Copper as Cu (Dissolved)	(mg/l)	Quarterly
Dissolved Oxygen (Lab)	(mg/l) (mg/l)	Monthly
Iron as Fe (Dissolved)	(mg/l)	Quarterly
Lead as Pb (Dissolved)	(mg/l)	Quarterly
Magnesium (Dissolved)	(mg/l)	Quarterly
Manganese as Mn (Dissolved)	(mg/l)	Quarterly

Determinand	Unit	Analysis
Nickel as Ni (Dissolved)	(mg/l)	Quarterly
Nitrate	(N:mg/l) (mg/l)	Monthly
pH (Lab)		Monthly
Potassium as K (dissolved)	(mg/l)	Monthly
Sodium as Na (dissolved)	(mg/l)	Quarterly
Total Alkalinity as CaCO3	(mg/l)	Quarterly
Total Organic Carbon	(mg/l)	Monthly
Total Oxidised Nitrogen	(mg/l)	Quarterly
Total Sulphur as SO4 (Dissolved)	(mg/l)	Quarterly
Zinc as Zn (Dissolved)	(mg/l)	Quarterly

The results of the leachate chemical analysis for the period June 1998 to December 2003 are summarised in Table ESID9, and presented in full in Appendix ESID2.

Table ESID9: Summary of Leachate Quality (June 1998 to December 2003)

Determinand	Number of Points	Minimum	Maximum	Mean	Standard Deviation
Alkalinity (mg/l)	82	284.00	18,078.00	6,551.62	3,129.11
BOD (mg/l)	76	5.00	12,100.00	696.05	1,822.38
Calcium (mg/l)	82	47.00	1,720.00	184.25	211.94
Cadmium (mg/l)	58	0.0005	0.0078	0.0039	0.00
Chloride (mg/l)	107	21.00	4,300.00	1,762.31	934.81
COD (mg/l)	76	102.00	16,600.00	2,691.09	2,627.25
Chromium (mg/l)	75	0.006	0.31	0.08	0.08
Copper (mg/l)	81	0.007	1.61	0.09	0.21
Dissolved Oxygen (Lab) (mg/l)	106	0.00	9.10	0.80	1.37
Electrical Conductivity (Lab) (uS / cm)	107	616.00	26,800.00	14,125.29	6,101.23
Iron (mg/l)	82	0.24	508.00	19.82	65.83
Potassium (mg/l)	107	2.18	2,030.00	898.87	393.46
Magnesium (d) (mg/l)	82	13.80	320.00	129.18	53.47
Manganese (mg/l)	81	0.10	11.60	1.38	1.83
Sodium (mg/l)	82	16.80	2,360.00	1,163.78	556.02
Ammoniacal Nitrogen as N (mg/l)	107	0.70	2,760.00	1,155.54	670.60
Nickel (mg/l)	81	0.02	0.54	0.19	0.12
Nitrite (mg/l)	24	0.10	0.50	0.15	0.11
Nitrate (mg/l)	90	0.30	57.00	3.23	7.49
Lead (mg/l)	81	0.005	0.14	0.03	0.02
pH (Lab)	107	5.90	8.40	7.64	0.47
Sulphate (mg/l)	82	0.12	1,500.00	111.08	206.61
Total Organic Carbon (mg/l)	103	6.70	5,940.00	793.04	892.31
Total Oxidised Nitrogen (mg/l)	81	0.30	57.00	4.09	8.27
Zinc (d) (mg/l)	81	0.02	1.69	0.22	0.25

In February 2004 leachate samples from the primary and secondary leachate treatment lagoons were analysed for List I and List II substances. Those substances found above the detection limits and their respective concentrations are detailed in Table ESID10, with the full results given in Appendix ESID3.

Table ESID10: Leachate Analysis (February 2004)

Determinand	Primary Lagoon	Secondary Lagoon	UK DWS	Freshwater EQS (for hardness band >250mg/l CaCO3)
Arsenic (µg /l)	12	10	10	50
Barium (mg/l)	0.19	0.25	1	
Boron (mg/l)	3.27	2.87	1	2
Cadmium (µg/l)	<0.5	1	5	5
Chromium (µg/l)	63	66	50	50-250
Cobalt (mg/l)	0.027	0.021		
Copper (µg/l)	7	8	2000	112
Lead (µg/l)	7	8	10	20-250
Nickel (µg/l)	130	120	50	200
Selenium (µg/l)	1	<1	10	
Vanadium (µg/l)	22	17		60
Zinc (µg/l)	38	42	5000	200-500
Fluoride (µg/l)	600	500	1500	
Ammoniacal Nitrogen as N (mg/l)	433	293	0.39	
Nitrate as N (mg/l)	27.7	10.7	50	
Total Inorganic Phosphorus (ug/l)	3320	3640	2200	
Dichloroprop (ug/l)	1.51	0.69	0.1	
MCPA (ug/l)	2.7	1.84	0.1	2
Mecoprop (ug/l)	1.79	0.97	0.1	2
Tellurium (ug/l)	0.1	0.2		
Uranium (ug/l)	0.7	0.5		
Titanium (ug/l)	43	44		

Of the substances detected nine showed levels over their respective UK drinking water standards (UK DWS), arsenic, boron, chromium, nickel, ammoniacal nitrogen, inorganic phosphorous, dichloroprop, MCPA and mecoprop. Of these boron and MCPA also exceed their respective freshwater Environmental Quality Standard (EQS). The List I substance cadmium is detected below the DWS but above the minimum reporting value (MRV) of 0.1 µg/l.

2.4 Landfill Gas Management and Monitoring

2.4.1 Landfill gas generation

Landfill gas is currently generated at the Whisby Landfill. The landfill gas composition is based on information provided by WRG, and is listed in Table ESID11.

Table ESID11: Gas Composition of the Site

Species	Composition[1] (%)
Methane (CH_4)	Uniform 35 – 40 %
Carbon Dioxide (CO_2)	Uniform 45 – 50 %
Note: Data provided by WRG	

2.4.2 Landfill gas management

There is a requirement to collect landfill gas at the Whisby Landfill Site, and the gas control scheme in place currently covers all of Phases 2, 3, 4, and 5. The current landfill gas control is based upon an active gas extraction system incorporating a network of gas extraction wells and a Hoffstetter elevated flare stack (Drawing ESID8). The gas extraction wells have been spaced with a radius of influence to ensure that the landfill gas is drawn back towards the centre of the site and away from the side slope liner, so that oxygen is not drawn into the system from outside the landfill.

The extraction wells are drilled at a diameter of 300 mm and completed with a 90 mm diameter well liner installed in the borehole, the annulus filled with no fines granular material. The gas wells are drilled to no more than 80% of the depth of the waste to ensure there is no interference with the basal lining system. Gas extraction pipework comprises various sizes of MDPE materials.

The gas flare at the site had a rate of 1000 m^3/h from 1993 to 2001 but has since been lowered to 250 m^3/h.

2.4.3 Landfill gas monitoring infrastructure

Landfill gas was first monitored at the site in 1991. Currently monitoring is undertaken in 43 monitoring boreholes (Drawing ESID7). The required monitoring is for 2 weekly determinations of $\%CH_4$, $\%CO_2$ and $\%O_2$ content and differential pressure. Some measurements of H_2S (ppm) have also been taken. A summary of the average gas concentrations sampled from January 1998 to January 2004 is detailed in Table ESID12 with the full data set in Appendix ESID4.

Table ESID12: Landfill Gas Monitoring Data (January 1998 to January 2004)

	Average Landfill Gas Monitoring Concentrations			
Borehole	**Methane (%v/v)**	**Carbon Dioxide (%v/v)**	**Hydrogen Sulphide (ppm)**	**Oxygen (%v/v)**
BH01	0.52	3.84	0.04	16.37
BH02	0.00	1.20	0.03	19.11
BH02Aclay	0.01	0.44	0.03	20.16
BH02Asand	0.01	1.00	0.03	19.77
BH02Bclay	0.00	0.29	0.02	20.24
BH02Bsand	0.01	0.99	0.01	19.81
BH02Cclay	0.01	0.37	0.02	20.33
BH02Csand	0.01	3.41	0.04	18.08
BH02Dclay	0.01	0.56	0.00	20.30
BH02Dsand	0.12	3.87	0.04	18.03
BH03A	14.05	12.46	0.06	9.18
BH03Bclay	19.60	9.74	0.09	14.19
BH03Bsand	44.85	21.94	2.67	6.11
BH03Cclay	1.90	3.06	0.01	18.02

Borehole	Average Landfill Gas Monitoring Concentrations			
	Methane (%v/v)	Carbon Dioxide (%v/v)	Hydrogen Sulphide (ppm)	Oxygen (%v/v)
BH03Csand	5.21	7.17	0.23	14.06
BH03Dclay	0.04	0.78	0.01	19.66
BH03Dsand	0.00	3.05	0.01	17.10
BH08	0.00	1.77	0.03	18.25
BH08A	0.71	4.69	0.15	14.58
BH13Aorange	11.23	7.85	0.13	14.09
BH13Ared	14.43	9.91	0.41	12.71
BH13Cclay	2.03	1.34	0.07	19.55
BH13Csand	11.78	6.60	0.06	16.01
BH16Aclay	0.06	0.42	0.02	20.11
BH16Asand	0.32	2.70	0.04	16.85
BH16orange	1.34	3.02	0.00	15.69
BH16red	0.66	2.97	0.01	17.04
BH16yellow	1.09	3.02	0.01	16.11
BH17Aclay	11.48	6.39	0.23	15.24
BH17Asand	10.70	6.32	0.26	15.14
WBY1100	0.71	2.88	0.03	17.16
WBY2100	53.09	28.62	0.32	3.63
WBY3100	33.18	18.78	0.26	8.13
WBY4100	1.54	1.50	0.05	18.87
WBY5100	0.02	2.18	0.05	17.44
WBY6100	8.53	11.00	0.13	12.08

2.5 Surface Water Management System

Surface water from the Phase 2 area currently discharges directly into the Pike Drain. Surface water from Phase 3, 4, and 5 currently discharges to the Pike Drain via drainage ditches on the western and northern edges.

A surface water management system will be developed for the future landfill extension. This will consist of drainage ditches leading to a collection sump or to the existing lagoons west of area A. Temporary ditches will be constructed for each of the stages of landfill development to prevent run-off water entering the operational areas. These ditches will feed to a surface water drainage ditch.

2.6 Post Closure Controls

The long-term management of groundwater, surface water and leachate systems will be dependant on the outcome of the Hydrogeological Risk Assessment and will be developed as the proposed restoration proceeds. The leachate management scheme will be flexible and reactive to varying site conditions.

The future landfill gas management at the site will be dependent on the outcome of the Landfill Gas Risk Assessment (Section D). The risks associated with subsidence, differential settlement and/or structural failure is visited within the Stability Risk Assessment (Section C). Permit completion criteria are also noted within the following section reports as appropriate.

There is no identified potential for future degradation or failure of the site design or management systems post closure that will increase the risk posed by the landfill. The surface water drains should be inspected regularly to ensure that they are operating as necessary.

3.0 PATHWAY AND RECEPTOR TERM CHARACTERISATION

3.1 Climate

The average annual rainfall for Area 17W (Lincoln area) in the Ministry of Agriculture Fisheries and Food, Technical Bulletin 35, is 605 mm for the period 1941-70. In comparison to this the average annual rainfall calculated by the Met Office at Skellingthorpe Hall (NGR SK 930 715) located approximately 6 km northeast of the site is 611 mm. The effective precipitation, i.e. the yearly sum of monthly rainfall in excess of evapotranspiration, for the same time period is 230 mm.

Wind rose data has been obtained from the Waddington weather station located approximately 8 km east-southeast from the site, for the period 2000 to 2002. The wind rose data indicates that that the prevalent wind direction is towards the northeast (16% of the time).

3.2 Geology

3.2.1 Regional geology

Published geological maps for the region (BGS Sheet 114 – Lincoln) show the site is underlain by superficial deposits comprising Pleistocene and recent river sands and gravels (Drawing ESID9). Mineral survey reports for the area indicate that sands and gravels were between 7.5 and 12.5 m thick prior to extraction. These deposits have been removed in the areas that have been landfilled.

The sands and gravels are underlain by the Jurassic Lower Lias clay which contains shale and rare limestone deposits, dipping gently to the southeast. The Lias clay is approximately 120 m thick beneath the site, according to extrapolated data from an oil exploration borehole 1.5 km away (Golder 2002a).

3.2.2 Local geological setting

Previous site investigations have included the installation of 28 boreholes to depths of between 7.8 and 25 m. All the boreholes penetrate into the Lower Lias clay with sand and gravel thickness confirmed to vary between 7.0 and 11.2 m.

Limestone bands were logged in 4 of the boreholes, BHPZ01, BHPZ02, BHPZ03 and BH01. BHPZ01 had 3 limestone bands logged with a total thickness of 0.38 m, BHPZ02 had 3 limestone bands logged with a total thickness of 0.9 m and BHPZ03 had 5 limestone bands logged with a total thickness of 1.07 m. Borehole BH01 drilled to the west of the site proved a limestone band at approximately - 1.5 m AOD (Golder 2000).

3.3 Man-Made Subsurface Pathways

Connection of the rare limestone bands in the Lias to the superficial deposits could occur through the boreholes that intersect the bands. However the water levels monitored for the two horizons in these boreholes show generally similar elevations indicating a hydraulic continuity between the two horizons.

3.4 Hydrology

3.4.1 Surface water courses

The Pike Drain is a surface water feature that flows from west to east along the southern boundary of the application area. The drain discharges into the River Witham approximately 8 km east of the site on the outskirts of Lincoln. During the summer period flow in the drain has been observed to be low (approximated less than 3 l/s) (Golder 2000).

Surface water from phase 3, 4, and 5 currently runs into the drainage ditches constructed along the western perimeter of phase 3, 4, and 5, continuing along the northern perimeter. The ditches drain into the Pike Drain. The site has a discharge consent to an unnamed tributary of the Pike Drain at SK 8949 6732, dated 17 September 1984 subject to a variation in 1991. The original consent was issued to Steetley Construction Materials Ltd by Anglian Water Authority for a discharge of trade effluent.

Two lagoons are located to the west of the installation area, which form the current process water settling/storage lagoons. Groundwater also discharges to these lagoons.

3.4.2 Surface water monitoring

Surface water monitoring of the Pike Drain is currently undertaken at two locations, upstream and downstream (Drawing ESID11). The quality of the surface water is monitored on a monthly or quarterly basis for the suites detailed in Table ESID13.

Table ESID13: Surface Water Quality Suites

Determinand	Unit	Analysis
Ammoniacal Nitrogen	(N:mg/l) (mg/l)	Monthly
Cadmium as Cd (Dissolved)	(mg/l)	Quarterly
Calcium as Ca (Dissolved)	(mg/l)	Quarterly
Chloride	(mg/l)	Monthly
Conductivity (Us/cm @ 25C: LABORATORY DETERMINATION)	(uS / cm)	Monthly
Copper as Cu (Dissolved)	(mg/l)	Quarterly
Dissolved Oxygen (Lab)	(mg/l) (mg/l)	Monthly
Iron as Fe (Dissolved)	(mg/l)	Quarterly
Lead as Pb (Dissolved)	(mg/l)	Quarterly
Magnesium (Dissolved)	(mg/l)	Quarterly
Manganese as Mn (Dissolved)	(mg/l)	Quarterly

Determinand	Unit	Analysis
Nickel as Ni (Dissolved)	(mg/l)	Quarterly
Nitrate	(N:mg/l) (mg/l)	Monthly
pH (Lab)		Monthly
Potassium as K (dissolved)	(mg/l)	Monthly
Sodium as Na (dissolved)	(mg/l)	Quarterly
Total Alkalinity as CaCO3	(mg/l)	Quarterly
Total Organic Carbon	(mg/l)	Monthly
Total Oxidised Nitrogen	(mg/l)	Quarterly
Total Sulphur as SO4 (Dissolved)	(mg/l)	Quarterly
Zinc as Zn (Dissolved)	(mg/l)	Quarterly

The client supplied surface water quality data collected from January 1998 to December 2003 is contained in Appendix ESID5 and is summarised in Table ESID14.

Table ESID14: Surface Water Quality Summary

Monitoring Point	Chloride (mg/l)				Ammonia as Ammoniacal Nitrogen (mg/l)				Iron as Fe (Dissolved) (mg/l)			
	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.
Pike Drain Upstream	49.00	84.00	66.10	9.58	0.04	5.00	0.34	0.60	0.01	2.07	0.31	0.47
Pike Drain Downstream	48.00	83.00	66.94	9.58	0.04	3.20	0.37	0.49	0.01	3.88	0.40	0.84

There is very little difference between the water chemistries analysed at the upstream Pike Drain and the downstream Pike Drain and in the cases where average determinand concentration changes it is higher at the upstream monitoring point. This indicates that the quality of the surface water is not being adversely affected by the landfill development.

The concentration of chloride was always below the UK drinking water standard (DWS) of 250 mg/l as was nitrite (DWS of 0.1 mg/l) and nitrate (DWS of 50 mg/l). Lead was greater than its DWS of 0.05 mg/l on only one occasion and Cadmium is over its DWS on two occasions (DWS of 0.005 mg/l). Iron is over the DWS of 0.2 mg/l fifteen times, but is only over the freshwater Environmental quality standard (EQS) of 1 mg/l three times. Ammoniacal nitrogen concentration is over the DWS fourteen times (DWS of 0.5 mg/l).

3.4.3 Surface water abstractions, flood risk and protection zones

Information supplied by the Environment Agency has revealed that there are 6 licensed surface water abstractions within a 5 km radius of the site (Appendix ESID6). The closest abstraction is 3.5 km from the site boundary and is taken from the Pike Drain down gradient of the site.

The site is not located on any floodplains as identified by the Environment Agency, therefore there is no flood risk (Drawing ESID10).

The site is not located in any nature protection zones or natural heritage areas.

3.5 Hydrogeology

3.5.1 Aquifer characteristics

3.5.1.1 Aquifer Properties and Status

According to data maps located on the Environment Agency website the site is not located within any source protection zones (SPZ). The closest SPZ is approximately located 7 km from the eastern boundary of the site (ESID10). The SPZ refers to a total catchment.

The Environment Agency (which includes the former National River Authority) has produced a series of maps, covering England and Wales, which identify the vulnerability of groundwater to contamination. It uses geological information to define major, minor and non-aquifers, and information on soils to determine the protection afforded to the underlying geology and therefore its overall vulnerability.

The groundwater vulnerability map for this area (Sheet 18, Groundwater vulnerability of Nottinghamshire) classifies the drift sands and gravels as a minor aquifer that can be used locally as a source of water and is important in supplying base flow to rivers (Drawing ESID10). The map also shows that the area has soils which readily transmit liquid discharges because they are either shallow or susceptible to rapid-by-pass flow directly to rock, gravel or groundwater. Natural water levels within the sands and gravels range between 8 and 10 m AOD according to the Regulation 15 Risk Assessment. Current water levels at the site range between -5 and 11 m AOD (Drawing ESID11).

The Lower Lias clay is classified on the map as a non-aquifer, indicating that it is regarded to contain insignificant quantities of groundwater.

The sand and gravels have relatively high permeability, considered to be several magnitudes greater than the Lower Lias clay (both horizontally and vertically). The sands and gravels have moderate storage attributes.

The Lower Lias clay functions as an aquitard due to its very low permeability. Redland Aggregates Limited (now Lafarge Limited) laboratory tested the clay using constant head permeability tests on remoulded samples in a triaxial cell. These tests produced a permeability value range of 6.9×10^{-11} m/s to 8.4×10^{-12} m/s.

The rare limestone bands within the Lower Lias clay have low primary permeability, but enhanced secondary permeability due to fracturing which may effect the hydrogeological interpretation. Falling head permeability tests were carried out in 3 borehole piezometers by

Redland Aggregates Limited resulting in calculations of limestone permeability values between approximately 2.67 x 10^{-6} m/s and 5.5 x 10^{-7} m/s.

3.5.1.2 Groundwater Abstractions

Groundwater is currently abstracted from the Toe Drain sump located at the western edge of landfill Phase 3, 4, and 5 and also from Area A. The abstracted water is discharged to the lagoons to the west of Area A (Drawing ESID10).

Information supplied by the Environment has revealed that there are 20 licensed groundwater abstractions within a 5 km radius of the Site. These are presented in Appendix ESID5, with those within a 2 km radius being listed in Table ESID15. Groundwater is abstracted from the sand and gravels aquifer.

Table ESID15: Groundwater Abstractions within 2 km of the Site

NGR	Distance from Site (km)	Annual Licensed quantity (m^3)	Purpose
9100 6560	1.7	332	General agriculture
8920 6570	0.9	455	General agriculture
8845 6570	1.3	26140	General agriculture and spray irrigation
8949 6678	0.3	1210000	Industrial, commercial and public services
8955 6610	0.4	58000	General agriculture and spray irrigation

3.5.2 Local Hydrogeology

3.5.2.1 Monitoring Infrastructure

Groundwater level monitoring is undertaken on a regular basis at the site from 39 boreholes. Table ESID16 summarises the details of the boreholes where groundwater monitoring is currently taking place.

Table ESID16: Details of Groundwater Level Monitoring Boreholes

Borehole	Easting	Northing	Known Borehole Depths (m)	Specific Geological Units Monitored	Depth Range of Screened Interval (m bgl)
BH01	4478.179	6608.248	13.73		
BH02	5182.738	6545.705	12.73		
BH2Aclay	5164.063	6536.044	16.88	Lias Clay	
BH2Asand	5164.063	6536.044	8.38	Sand and Gravel	
BH2Bclay	5189.884	6502.416	17.64	Lias Clay	
BH2Bsand	5189.884	6502.416	8.54	Sand and Gravel	

Borehole	Easting	Northing	Known Borehole Depths (m)	Specific Geological Units Monitored	Depth Range of Screened Interval (m bgl)
BH2Cclay	5145.463	6495.349	18.00	Lias Clay	
BH2Csand	5145.463	6495.349	7.98	Sand and Gravel	
BH2Dclay	5113.524	6486.544	18.35	Lias Clay	
BH2Dsand	5113.524	6486.544	8.85	Sand and Gravel	
BH3A	4658.486	6564.068	11.20		
BH3Bclay	4658.153	6661.395		Lias Clay	
BH3Bsand	4658.153	6661.395		Sand and Gravel	
BH3Cclay	4889.568	6585.376	18.00	Lias Clay	
BH3Csand	4889.568	6585.376	11.00	Sand and Gravel	
BH3Dclay	5091.250	6612.500	18.00	Lias Clay	
BH3Dsand	5091.250	6612.500	10.00	Sand and Gravel	
BH08	4334.911	6307.371			
BH08A	4354.946	6308.67			
BH13Aorange	4936.457	6455.711			
BH13Ared	4936.457	6455.711			
BH13Ayellow	4936.457	6455.711			
BH13Cclay	4863.186	6438.94	18.00	Lias Clay	
BH13Csand	4863.186	6438.94	9.00	Sand and Gravel	
BH16	5056.021	6535.765			
BH16A	5051.543	6520.444	18.00		
BH17Aclay	4839.403	6558.03	18.37	Lias Clay	
BH17Asand	4839.403	6558.03		Sand and Gravel	4.0-7.0
WBY1100	4751.904	6573.672	8.00	Sand and Gravel	4.0-7.0
WBY2100	4603.058	6574.963	7.80		4.0-7.0
WBY3100	4551.671	6594.981	8.20	Sand and Gravel	4.0-7.0
WBY4100	4766.245	6408.278	8.40	Sand and Gravel	4.0-7.0
WBY5100	4677.106	6387.045	8.50	Sand and Gravel	4.0-7.0
WBY6100	4507.216	6345.985	8.30	Sand and Gravel	4.0-7.0
PZ01	4805.384	6719.443	20.30	Lias Clay	19.0-20.0
PZ02	4688.474	6884.442	25.0	Lias Clay	21.0-22.5
PZ03	4492.26	6723.597		Lias Clay	16.4-17.4

Ten boreholes (2A, 2B, 2C, 2D, 3B, 3C, 3D, 13C, 16A, 17A) have multi-level monitoring with one monitoring the groundwater level in the sands and gravels and a second monitoring the piezometric level in the underlying Lias clay.

Boreholes 16 and PZ01-PZ03 have had little to no monitoring carried out. Boreholes 16A and 17A have been blocked or damaged at certain times preventing water levels from being monitored. Boreholes 01, 08, 08A, 13A, 13B and WBY1100 to WBY6100 have all been monitored dry at various times between January 1999 and July 2002 suggesting that the water levels have dropped below their response zones.

New monitoring boreholes will be needed around the northern and eastern edges of the proposed installation to provide adequate monitoring.

3.5.2.2 Groundwater Levels and Flow

Groundwater levels have been monitored on an approximately monthly basis since December 1998 with fortnightly monitoring occurring between January 2002 and July 2003. Drawing ESID11 presents the location of all groundwater monitoring points with the water level data obtained from these points detailed in Appendix ESID7.

The sand and gravel groundwater levels in the area of the landfill have varied between 4.3 and 11.2 m AOD since 1998 (Appendix ESID7). The groundwater contours shown on Drawing ESID11 for 20 November 2003 indicate that local groundwater flow in the landfill site area is towards the north and northwest. This is probably as a result of the dewatering around Area A.

Groundwater levels are highest to the east and southwest of the site. Borehole 02 to the east has a level of about 8.5 m AOD and Borehole 08 to the southwest has a level of about 10 m AOD. The water levels decrease towards the centre of the Site with Borehole 03A having a level of about 4.5 m AOD. Groundwater adjacent to the excavated Area A drops dramatically as a result of the dewatering. Borehole 03B shows low water levels of about -5.5 m AOD (Drawing ESID11).

While none of the boreholes appear to indicate a long-term trend in water level, when Area A has been landfilled and completed, dewatering of the quarry will no longer be needed and water levels local to area A will rise. The installation will be sub-water table with the landfill operated on the principles of engineered and hydraulic containment. Therefore the height that the groundwater rises to after dewatering ceases will need to be established, to make sure that the leachate levels within the landfill cells are below the surrounding sand and gravel water level. Continued extraction of sand and gravel in the local area may cause changes in the hydraulic balance of the area.

Graphs showing the groundwater fluctuations measured during the period June 1998 to December 2004 are presented in Appendix ESID8. Seasonal fluctuations can be seen in Boreholes BH02, BH02A-2D, BH03C and BH13C. These boreholes are more remote from the landfill tipping areas and hence are less effected by dewatering. The seasonal fluctuations are generally in the order of ± 1 to 2.5 m with highs occurring in November to February and lows from May to July.

Where the water levels in both the Lias clay and the sand and gravel horizons is measured, the levels are generally very similar (see Boreholes 2A, 2B, 2C, 2D, 3B, 3C, 3D, 13C, 16A and 17A) . This indicates that there is hydraulic continuity between the two horizons.

The dewatering of Area A has lowered the groundwater level local to the site. The height of the Pike Drain surface water feature at around 13 m AOD suggests that there is currently little interaction between this and the sand and gravels groundwater. This suggests that the flows

within the Pike Drain are currently caused by surface runoff. Following the cessation of dewatering groundwater levels will rise and the Pike Drain will be in connection.

Table ESID17: Summary of Groundwater Levels (June 1998 to December 2003)

	Groundwater Elevation (m AOD)				
Borehole	**No. of Points**	**Minimum**	**Maximum**	**Average**	**Standard Deviation**
BH01	45	7.06	9.12	7.46	0.29
BH02	74	6.65	11.21	9.17	0.82
BH02Aclay	72	7.78	10.88	9.31	0.72
BH02Asand	74	6.56	10.77	9.15	0.91
BH02Bclay	70	8.08	10.64	9.16	0.49
BH02Bsand	74	5.72	10.50	9.03	0.74
BH02Cclay	74	7.23	10.63	8.59	0.58
BH02Csand	74	6.95	10.81	8.57	0.66
BH02Dclay	73	-2.27	10.34	8.17	1.36
BH02Dsand	68	7.28	10.33	8.33	0.58
BH03A	69	4.31	7.20	4.81	0.38
BH03Bclay	77	-8.27	-3.78	-5.38	0.54
BH03Bsand	86	-8.14	-3.48	-5.35	0.52
BH03Cclay	75	4.57	10.06	7.13	0.94
BH03Csand	76	5.33	9.05	7.03	0.91
BH03Dclay	65	5.16	10.73	9.70	0.80
BH03Dsand	65	6.14	10.97	8.52	0.90
BH08	21	9.39	10.51	10.19	0.20
BH08A	30	8.28	13.85	8.77	1.40
BH13Aoran	43	7.21	8.14	7.72	0.24
BH13Ared	40	5.88	8.08	7.34	0.44
BH13Ayell	51	6.54	8.20	7.63	0.31
BH13Boran	3	7.49	7.49	7.49	0.00
BH13Bred	3	7.47	7.47	7.47	0.00
BH13Cclay	76	-2.00	8.18	6.95	1.23
BH13Csand	89	3.87	9.70	6.88	1.23
BH16Aclay	26	7.01	11.88	7.85	1.04
BH16Asand	23	6.89	10.14	7.68	0.70
BH16oran	3	8.06	8.06	8.06	0.00
BH16red	3	8.06	8.06	8.06	0.00
BH16yell	2	8.06	8.06	8.06	0.00
BH17Aclay	35	4.28	8.34	5.92	0.98
BH17Asand	40	4.95	9.46	6.42	1.35
BH17oran	2	7.75	7.75	7.75	0.00
BH17red	2	7.58	7.58	7.58	0.00
BH17yell	2	8.05	8.05	8.05	0.00
WBY1100	48	5.52	7.60	7.39	0.41
WBY2100	49	7.38	7.71	7.59	0.08
WBY3100	49	7.39	7.78	7.69	0.12
WBY4100	42	8.69	9.21	9.06	0.11
WBY5100	47	8.99	9.36	9.25	0.08
WBY6100	49	8.93	14.13	9.87	0.71

3.5.3 Groundwater quality

3.5.3.1 Monitoring Schedule

Groundwater quality is currently monitored on a monthly or quarterly basis in BH2, BH3A, BH3Bsand and BH13Csand for the suites detailed in Table ESID18. Quality data has also been collected from boreholes BH03C (November 2000 to July 2002) and BH17A (January 1998 to March 2001) in the past.

Table ESID18: Groundwater Monitoring Suite.

Determinand	Units	Analysis
Temperature (field)	°C	Monthly
Electrical conductivity (field)	uS	Monthly
pH (field)		Monthly
Ammoniacal Nitrogen	(N:mg/l) (mg/l)	Monthly
Cadmium as Cd (Dissolved)	(mg/l)	Quarterly
Calcium as Ca (Dissolved)	(mg/l)	Quarterly
Chloride	(mg/l)	Monthly
Conductivity (Us/cm @ 25C: LABORATORY DETERMINATION)	(uS / cm)	Monthly
Copper as Cu (Dissolved)	(mg/l)	Quarterly
Dissolved Oxygen (Lab)	(mg/l) (mg/l)	Monthly
Iron as Fe (Dissolved)	(mg/l)	Quarterly
Lead as Pb (Dissolved)	(mg/l)	Quarterly
Magnesium (Dissolved)	(mg/l)	Quarterly
Manganese as Mn (Dissolved)	(mg/l)	Quarterly
Nickel as Ni (Dissolved)	(mg/l)	Quarterly
Nitrate	(N:mg/l) (mg/l)	Monthly
pH (Lab)		Monthly
Potassium as K (dissolved)	(mg/l)	Monthly
Sodium as Na (dissolved)	(mg/l)	Quarterly
Total Alkalinity as CaCO3	(mg/l)	Quarterly
Total Organic Carbon	(mg/l)	Monthly
Total Oxidised Nitrogen	(mg/l)	Quarterly
Total Sulphur as SO4 (Dissolved)	(mg/l)	Quarterly
Zinc as Zn (Dissolved)	(mg/l)	Quarterly

3.5.3.2 Summary of Groundwater Quality

Client supplied groundwater monitoring data is presented in Appendix ESID9 and is summarised in Table ESID19.

Table ESID19: Summary of Groundwater Quality

	BH02	BH03A	BH03B sand	BH03C sand	BH13A red	BH13C sand	BH17A sand	Combined
Cadmium (mg/l)								
No. of Points	19	19	21		1	21	12	93
Minimum	0.00	0.00	0.00		0.00	0.00	0.01	0.00
Maximum	0.01	0.67	0.73		0.00	0.01	0.01	0.73
Average	0.01	0.04	0.04		0.00	0.01	0.01	0.02

	BH02	BH03A	BH03B sand	BH03C sand	BH13A red	BH13C sand	BH17A sand	Combined
Standard Deviation	0.00	0.15	0.16		0.00	0.00	0.00	0.10
Chloride (mg/l)								
No. of Points	61	63	67	6	1	66	40	304
Minimum	16.00	26.00	33.00	20.00	60.00	9.00	56.00	9.00
Maximum	136.00	81.00	81.00	73.00	60.00	72.00	139.00	139.00
Average	71.15	67.63	65.28	59.00	60.00	44.42	83.08	64.62
Standard Deviation	23.95	10.20	10.35	19.58	0.00	16.62	17.99	20.26
Electrical Conductivity (Lab) (µS / cm)								
No. of Points	61	63	67	6	1	66	40	304
Minimum	506.00	716.00	713.00	1,140.00	1,220.00	349.00	550.00	349.00
Maximum	2,270.00	1,880.00	1,990.00	1,440.00	1,220.00	1,930.00	1,700.00	2,270.00
Average	1,051.18	1,415.43	1,455.27	1,223.33	1,220.00	1,204.24	1,252.60	1,279.41
Standard Deviation	232.51	241.92	277.13	108.20	0.00	242.60	195.46	282.34
Iron (mg/l)								
No. of Points	21	21	23		1	23	14	103
Minimum	0.01	0.02	0.01		9.42	0.01	0.04	0.01
Maximum	1.52	32.40	58.80		9.42	32.30	5.05	58.80
Average	0.29	10.17	20.46		9.42	3.33	0.70	7.63
Standard Deviation	0.45	9.34	18.32		0.00	7.32	1.43	12.72
Ammoniacal Nitrogen as N (mg/l)								
No. of Points	61	63	67	6	1	66	40	304
Minimum	0.04	0.10	0.10	0.10	1.92	0.04	0.10	0.04
Maximum	1.20	2.40	6.90	1.40	1.92	19.40	2.00	19.40
Average	0.30	0.69	0.84	0.53	1.92	0.84	0.43	0.65
Standard Deviation	0.24	0.42	1.14	0.48	0.00	2.42	0.42	1.29
Nickel (mg/l)								
No. of Points	19	19	21		1	21	12	93
Minimum	0.005	0.005	0.005		0.005	0.018	0.020	0.01
Maximum	0.020	0.100	0.050		0.005	0.170	0.020	0.17
Average	0.015	0.022	0.018		0.005	0.045	0.020	0.02
Standard Deviation	0.007	0.020	0.009		0.000	0.037	0.000	0.02

The concentration of the list I metal Cadmium has been detected above the UK drinking water standard (UK DWS) of 0.005 mg/l on five occasions. In Borehole BH02, BH03A and BH03B in January 1998, and in BH3A and BH03B in October 1998. Since then the concentration has been below the UK DWS or below the detection limit.

Chloride concentrations are always below the UK DWS of 250 mg/l. The concentration of ammoniacal nitrogen has exceeded the UK DWS of 0.5 mg/l on occasions. The concentration is exceeded seven times in borehole BH02, thirty-six times in BH3A, twenty-nine times in BH3B and eighteen times in BH13C. As the electrical conductivity is within the range normally measured in groundwater and chloride and cadmium concentrations are consistently

below the UK DWS it is likely that much of the ammoniacal nitrogen is due to agricultural activity surrounding the site, rather than the landfill site itself.

Iron concentrations have exceeded the UK DWS of 0.2 mg/l on six occasions in BH02, fifteen occasions in BH03A, eighteen occasions in BH03B and fourteen occasions in BH13C.

3.6 Receptors and Compliance Points

Hydrogeological Risk Assessment
A quantitative hydrogeological risk assessment for the site is presented as Section B of this application.

In the definition that has become accepted by the environmental and waste industry, there are three components to the risk assessment – the source, pathway and receptor. The source is the components of the leachate derived by percolation of recharge through the waste. The pathway includes any routes connected to a receptor. In consideration of the hydrogeological risk assessment, the receptors at Whisby Landfill are the groundwater in the sands and gravels adjacent to the landfill and the surface water receptors of Pike Drain, Whisby Nature Park and River Witham.

Whisby Landfill Site operates on the principle of hydraulic containment. As such the inward hydraulic gradient will not support advective flow of leachate from the site unless the leachate levels rise above the groundwater levels. Diffusion of contaminants through the clay liner will be the only mechanism for contaminants to be transported through the clay lining system and so will need to be assessed.

For list I substances the compliance point will be the outside of the landfill liner. For list II substances the receptor will be considered to be the groundwater in the sand and gravel aquifer surrounding the landfill. A secondary receptor to be considered is the Pike Drain surface feature.

Landfill Gas Risk Assessment
A detailed gas risk assessment is presented as the Section D report.

Stability Risk Assessment
A detailed stability risk assessment is presented as the Section C report.

Risk Assessment for Nuisance and Health Issues
A detailed qualitative human health and nuisance risk assessment is presented in the Section E report.

4.0 SITE REPORT

4.1 Introduction and Background Information

The site is located near the village of Thorpe, approximately 8 km southwest of Lincoln at National Grid Reference SK 895 665. Drawing ESID1 shows the site location in relation to the surrounding features. Further details regarding the site setting are presented in Sections 1.2 and 1.3.

Landfilling into sand and gravel extraction voids in the Whisby area commenced in 1988. Two phases have been filled and restored with overtipping now occurring in one phase after the substantial settlement of the landfill. Further details regarding the landfill history are presented in Sections 1.1 and 2.1.1.

Expansion into two areas, Area A and the Silt Lagoon Area, is proposed along with overtipping the current phase 2. The area that is the subject of the PPC application is shown on Drawing ESID2. The extension will accept non-hazardous waste and the area will be restored for after use as agricultural land. Further details of the installation development and engineering are found in Sections 2.1 and 2.2.

The geology of the region shows the site is underlain by superficial deposits comprising river sands and gravels, these deposits have been removed in the landfilled areas. Lower Lias clay containing shale and rare limestone deposits lies beneath the sands and gravels with an approximate 120 m thickness. Further details of the sites geological setting are detailed in Section 3.2.

The sands and gravels are classified by the Environment Agency as a minor aquifer with the Lower Lias clay classified as a non-aquifer. The sand and gravels have moderate storage attributes with relatively high permeability, considered to be several magnitudes greater than the Lower Lias clay.

Groundwater is currently abstracted from the Toe Drain sump located at the western edge of landfill Phase 3, 4, and 5. The closest licensed groundwater abstractions are from a catchpit (NGR SK8955 6610), approximately 300 m south of the installation, and secondly from a well at Scotland Farm (NGR SK892 657), approximately 500 m south of the installation. Groundwater is abstracted from the sand and gravels aquifer. Further details regarding the hydrogeological setting are found in Section 3.5.

4.2 Objectives of this Assessment

The PPC Regulations require that a permit application is accompanied by a Baseline Site Report, which describes the condition of the whole site, not just the landfill. In particular operators are required to "*identify any substances in, on, or under land which may constitute a*

pollution risk". This section therefore attempts to provide a factual baseline account of the land that may later be compared against the findings of a site Closure report, or the results of other investigations. It allows pollutants that were present on site prior to the issue of the permit to be distinguished from those that occurred as a result of its operation under the permit.

The baseline report has been compiled following review of documents 'IPPC Part A (1) Installations: Guide for Applicants, Version 2, December 2000', produced by the Environment Agency, and 'IPPC, A Practical Guide, Edition 2, June 2002', produced by the Department for Environment, Food and Rural Affairs. The more recent advice 'Technical Guidance Note IPPC H7' on Application Site Reporting has been followed and the requirements suggested in the H7 template are satisfied by this report.

4.3 Site Investigation (data collection) Details

Details of the site investigation activities carried out at the site are presented in Sections 3.2 to 3.6.

In addition, LWL undertake routine analysis of groundwater quality, surface water quality and gas quality within the immediate vicinity of the site.

4.4 Summary of Site Investigation and Analysis Findings

A summary of the results of the site investigations and subsequent groundwater, surface water, landfill gas, and leachate monitoring undertaken at the site are presented in Sections 3.5, 3.4, 3.6, and 2.3 respectively. The results of both in-situ and laboratory tests of the Lias clay permeability are presented in Section 3.5.1.

4.5 Data Interpretation

Sections 3.4.2 and 3.5.3.2 outline the proposed baseline conditions for the site for surface water and groundwater quality respectively. The proposed baseline conditions are constrained by the fact that there is no site specific record of groundwater or surface water quality at the Site before landfilling operations began.

4.6 Conclusions

In consideration of the findings of this Site Report, it is concluded that the current groundwater and surface water quality presented in Sections 3.4.4 and 3.5.3 provide a good estimate of the baseline conditions present at the site. It should be remembered that these proposed baseline conditions are limited by the assumptions stated in Section 4.5.

5.0 REFERENCES

British Geological Survey (1973) Geological Map 114, Lincoln (solid and drift). Scale 1:50,000.

Golder Associates (2000) Regulation 15 Assessment Whisby Landfill.

Golder Associates (2001a) Leachate Treatment Facility Working Plan: Version A.0.

Golder Associates (2001b) Working Plan for the Composting Facility at Whisby Landfill Site Lincolnshire: Version A.0.

Golder Associates (2002a) Working Plan for Whisby Landfill Site, Lincoln.

Golder Associates (2002b) Whisby Landfill Site Environmental Monitoring Audit.

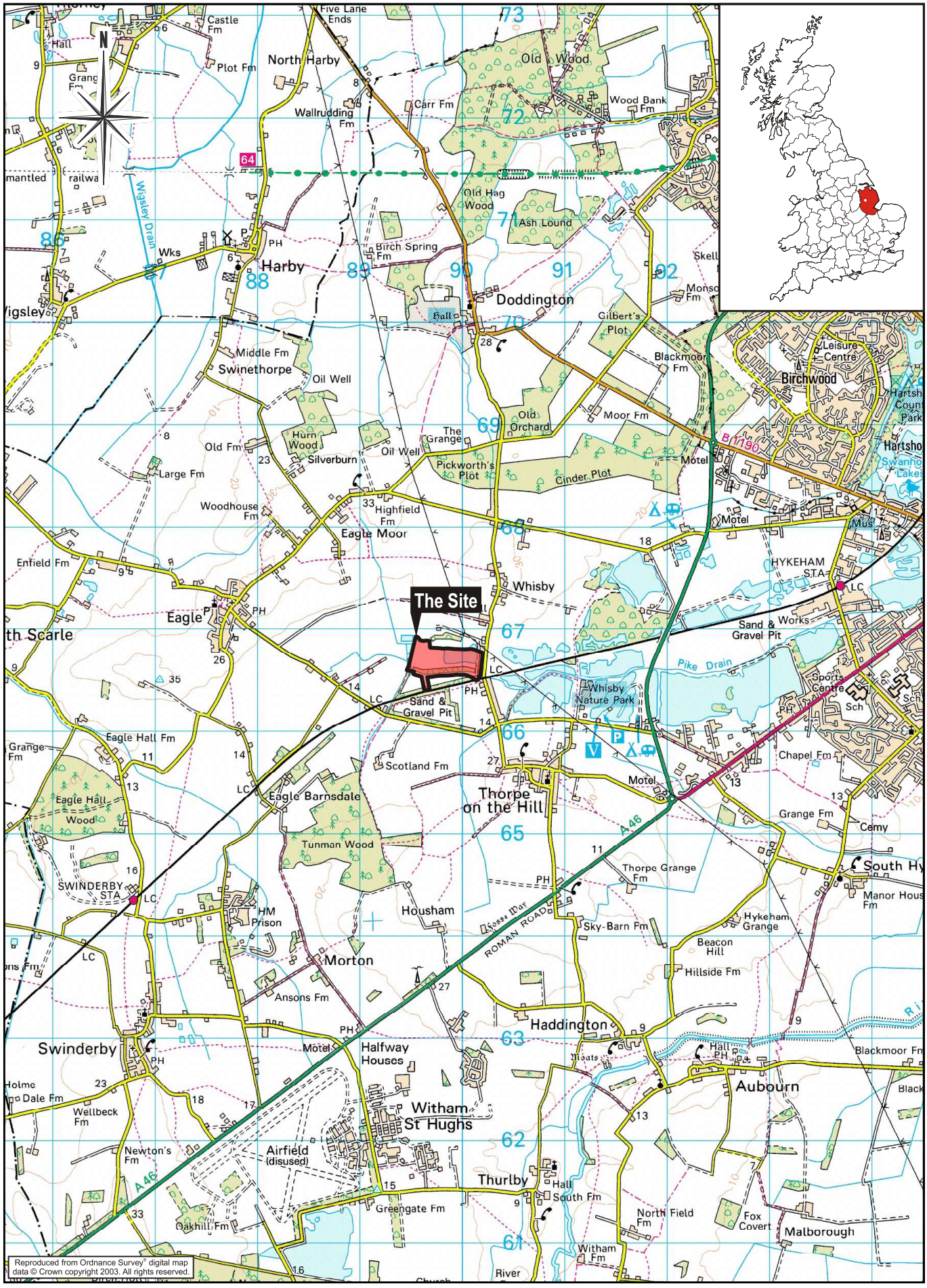
Ministry of Agriculture Fisheries and Food (1976) Technical Bulletin 35, The Agricultural Climate of England and Wales.

National Rivers Authority (1994) Policy and Practice for the Protection of Groundwater, Groundwater Vulnerability Sheet 18 for Nottingham. Scale 1:100,000.

Ordnance Survey (1999) Landranger Map 121, Lincoln and Newark-on-Trent. Scale 1:50,000.

TABLES

DRAWINGS



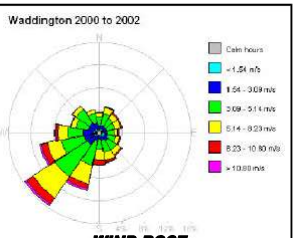
Date	29th April 2004
Project No.	03523334
Created by	D.M.
File No.	5221896

Title

Site Location (1:50,000)
Whisby Landfill Site
Lincolnshire

Drawing
ESID1

Waddington 2000 to 2002



WIND ROSE

NOTE

1. All levels relative to Newlyn Ordnance Datum.

REFERENCE

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2. Site survey provided by May Gurney Limited, Drawing Ref: WE/3722/012, dated 10.11.03.

LEGEND

- Installation boundary
- Cell boundary
- 500m offset from installation boundary
- Building

Sources

- Restored landfill
- Operational landfill
- Piggyback area
- Future landfill
- (LG) Gas utilisation plant
- (LT) Leachate treatment
- (SW) Consented discharge point

Receptors

- Domestic property
- Commercial property
- Industrial property
- Arable or livestock field
- Nature Park
- Railway
- Minor road
- Footpath, track or bridleway
- Watercourses and drains

Pathways

- Watercourses and drains
- Groundwater flow

waste recycling group

3 Sidings Court
White Rose Way
Doncaster
DN4 5NU

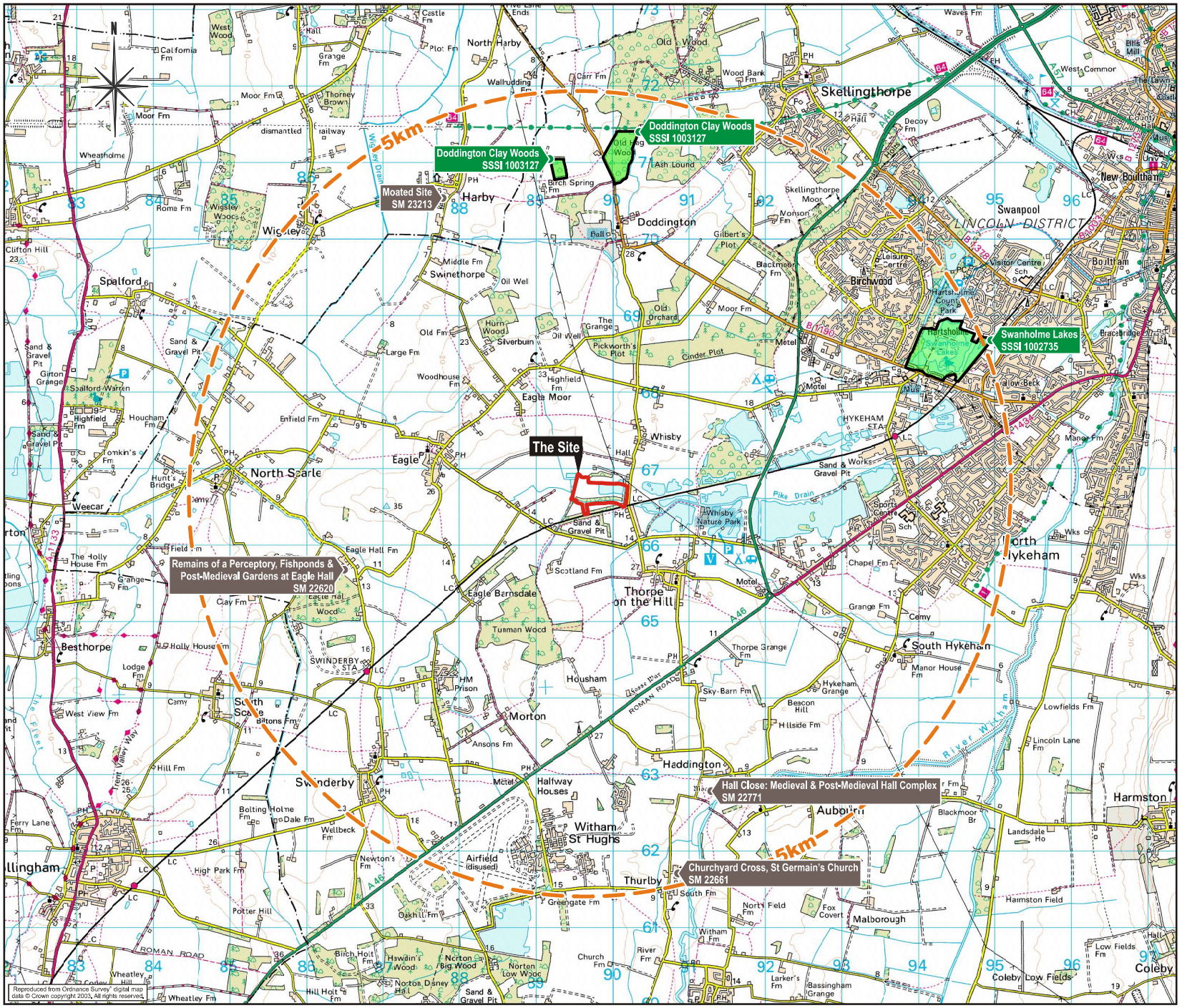
Project: Section A: Environmental Setting and Installation Design

Location: Whisby Landfill Site, Lincolnshire

Title: Environmental Site Setting (Source, Pathways and Receptors)

Project No. 03523334		Engineer	Drawing No. ESID2
File No. 5221000		Reviewed by	
Created by D.M.			
Scale 1:5,000		Date 29th April 2004	

Golder Associates



LEGEND

- Installation boundary
- 5km offset from installation boundary
- Natural Heritage: SSSI, SPA & RAMSAR
- Natural Heritage: Local Nature Reserve (Woodland Park)
- Cultural Heritage: Listed buildings and scheduled ancient monuments

waste recycling GROUP
3 Sidings Court
White Rose Way
Doncaster
DN4 5NU

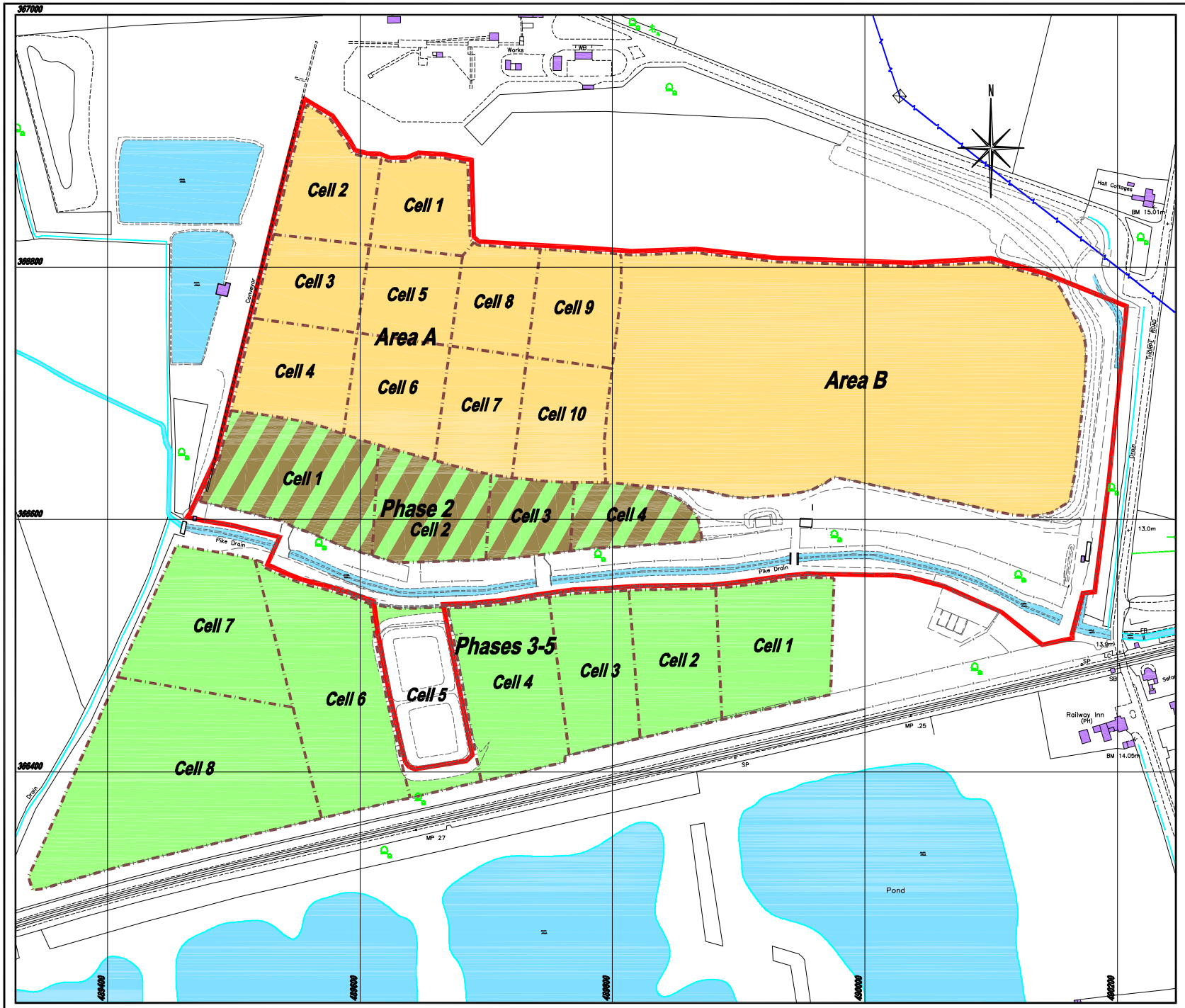
Project
Section A: Environmental Setting and Installation Design

Location
Whisby Landfill Site, Lincolnshire

Title
Cultural and Natural Heritage

Project No. 03523334	Engineer	Drawing No.	ESID3
File No. 5221897	Reviewed by		
Created by D.M.			
Scale 1:50,000	Date 29th April 2004		

Golder Associates



NOTES

1. All levels relative to Newlyn Ordnance Datum.
2. Area B cell layout to be determined prior to the completion of Area A.

REFERENCE

1. Surrounding topography reproduced from Ordnance Survey® digital map data © Crown copyright 2003. All rights reserved.

LEGEND

- Installation boundary
- Cell boundary
- Restored landfill
- Operational landfill
- Piggyback area
- Future landfill

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3 Sidings Court
White Rose Way
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DN4 5NU

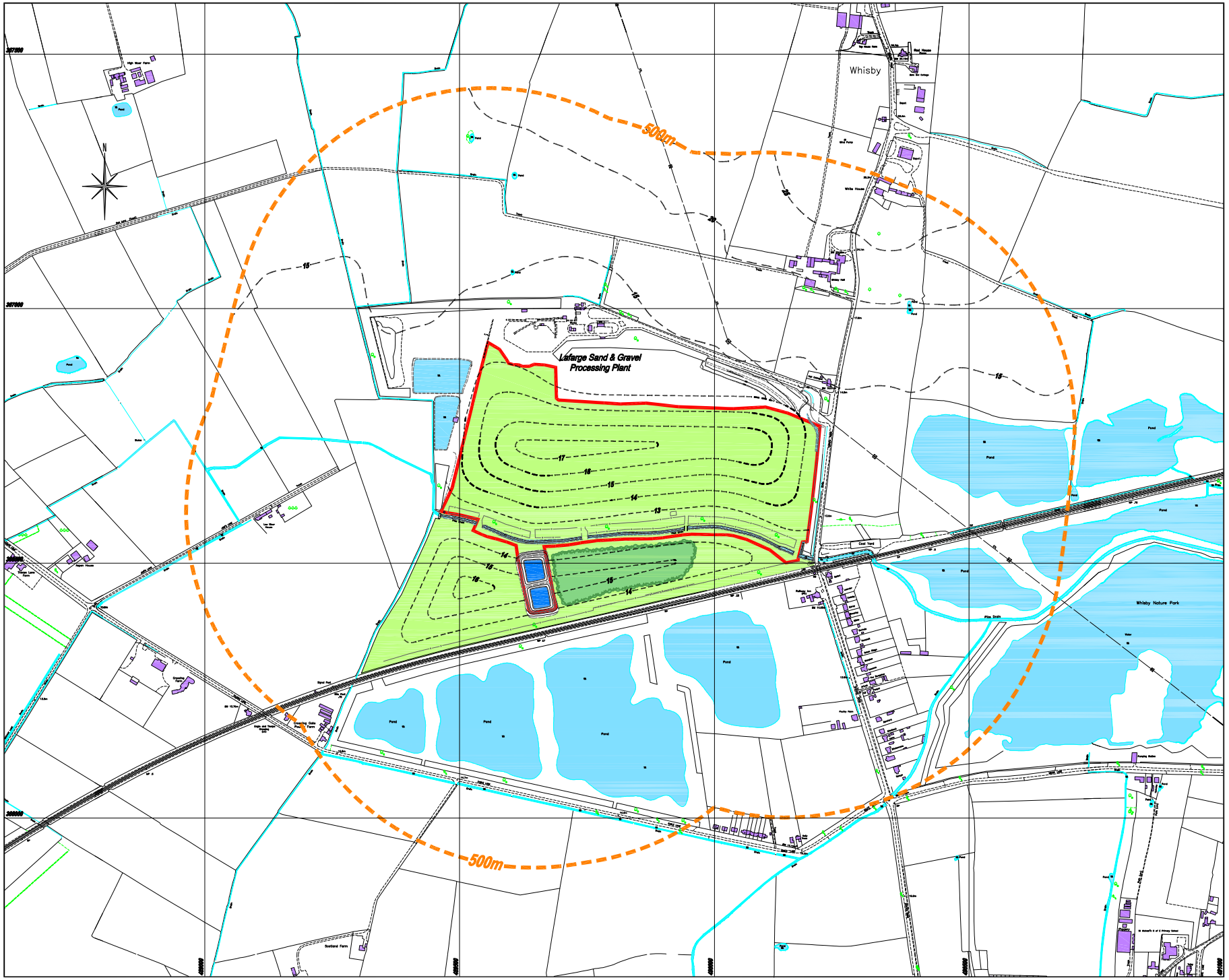
Project
Section A: Environmental Setting and Installation Design

Location
Whisby Landfill Site, Lincolnshire

Title
Site Layout and Waste Deposition

Project No. 03523334	Engineer	Drawing No.	ESID4
File No. 5221901	Reviewed by		
Created by D.M.			
Scale 1:3,000	Date 29th April 2004		

Golder Associates



NOTE

1. All levels relative to Newlyn Ordnance Datum.

REFERENCE

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LEGEND

- Installation boundary
- Post-settlement, post-restoration contour : mAOD
- Regional contour : mAOD
- 500m offset from installation boundary
- Building
- Agricultural field
- SRC planting area

3 Sidings Court
White Rose Way
Doncaster
DN4 5NU

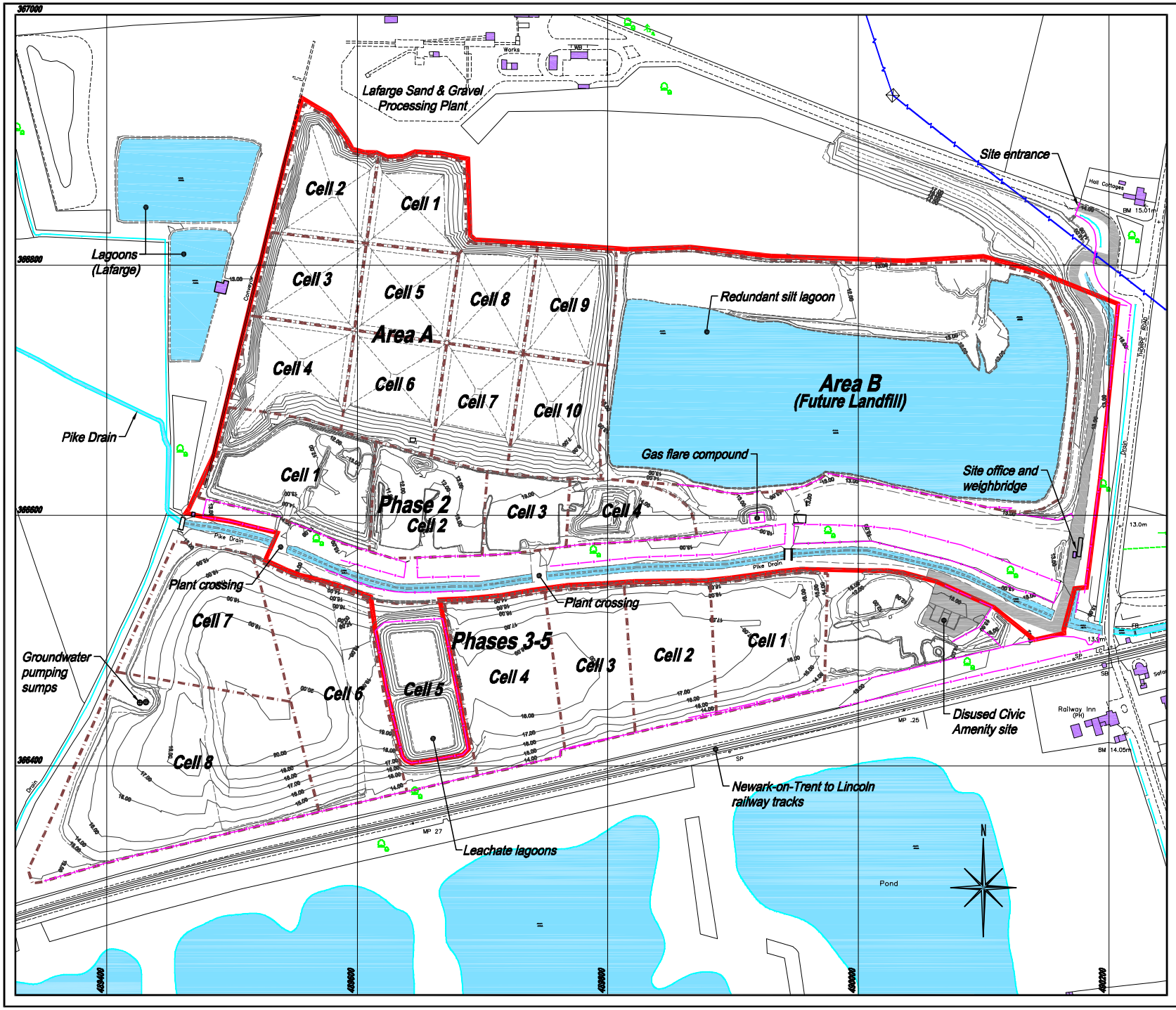
Project: Section A: Environmental Setting and Installation Design

Location: Whisby Landfill Site, Lincolnshire

Title: Restoration

Project No. 03323334	Engineer	Drawing No.	ESID5
File No. 5221902	Reviewed by		
Created by D.M.			
Scale 1:5,000	Date 29th April 2004		

Golder Associates



NOTES

1. All levels relative to Newlyn Ordnance Datum.
2. Area B cell layout to be determined prior to the completion of Area A.

REFERENCE

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2. Site survey provided by May Gurney Limited, Drawing Ref: WE/3722/012, dated 10.11.03.

LEGEND

- Installation boundary
- Ground contour : mAOD
- Break of slope
- Cell boundary
- Site fencing
- Building
- Area of hardstanding
- Surface water feature

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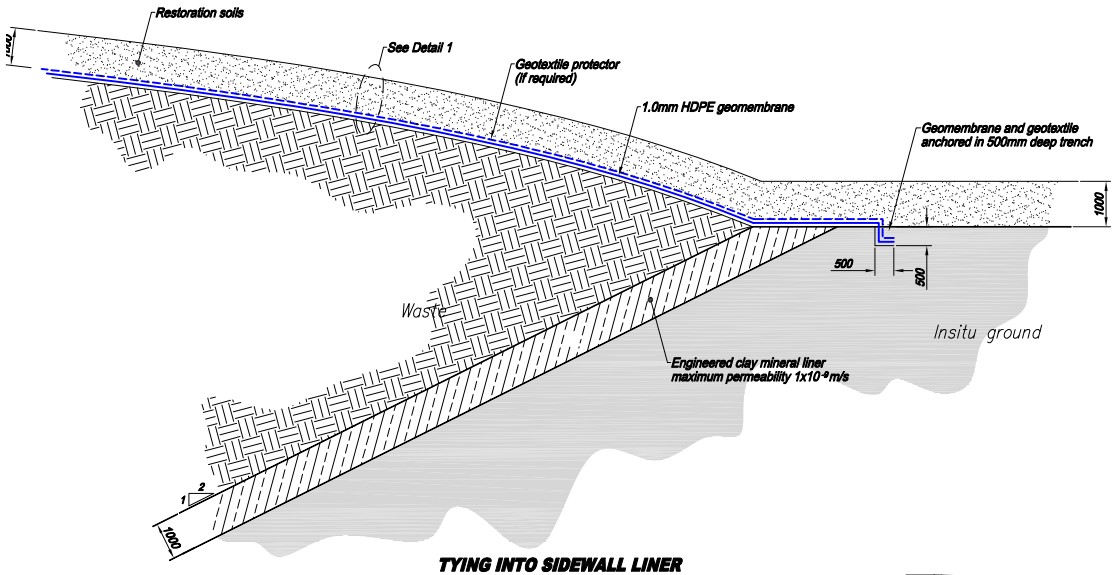
Project: **Section A: Environmental Setting and Installation Design**

Location: **Whisby Landfill Site, Lincolnshire**

Title: **Installation**

Project No. 03523334	Engineer	Drawing No.	ESID6A
File No. 5221903	Reviewed by		
Created by D.M.			
Scale 1:3,000	Date 29th April 2004		

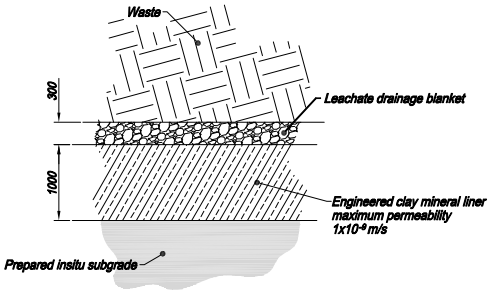
Golder Associates



TYING INTO SIDEWALL LINER

CAPPING DETAIL

1:100



CLAY LINER DETAIL

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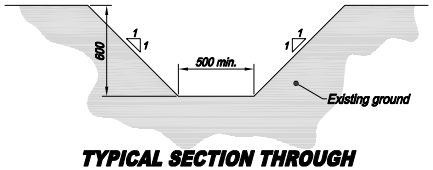
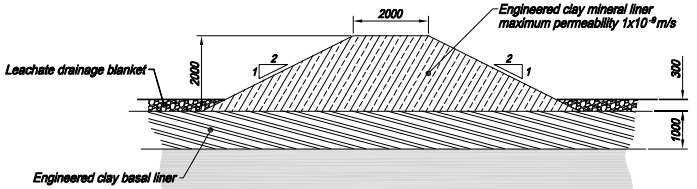


TYPICAL SECTION THROUGH UNLINED DRAINAGE DITCH



INTERCELL BUND DETAIL

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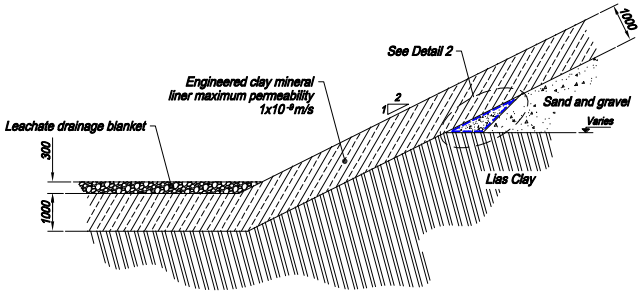

TYPICAL SIDE SLOPE SECTION

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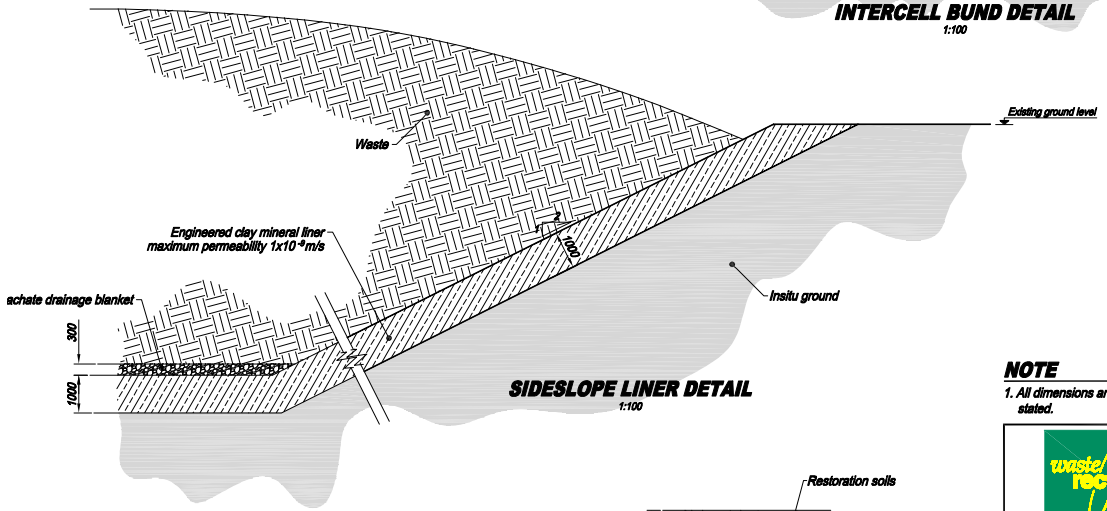

SIDESLOPE LINER DETAIL

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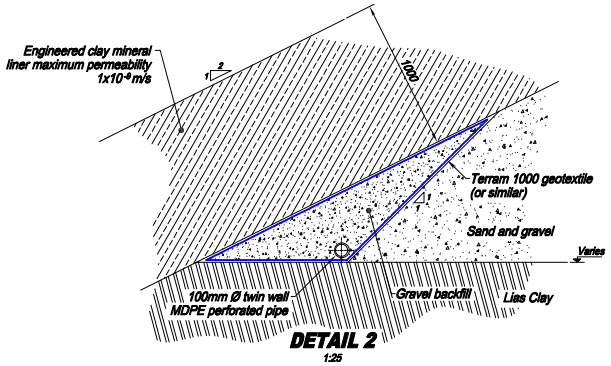
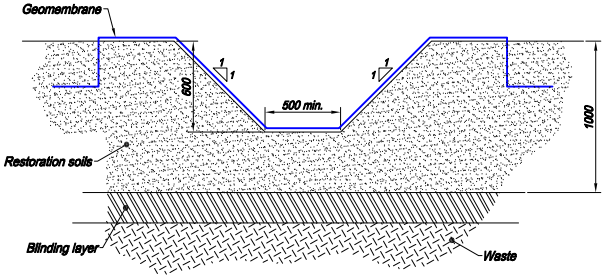


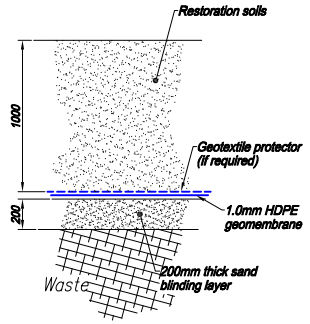
DETAIL 2

1:25



TYPICAL SECTION THROUGH LINED DRAINAGE DITCH

1:25



GENERAL CAPPING DETAIL

DETAIL 1

1:25

NOTE

1. All dimensions are in millimetres unless otherwise stated.

waste recycling group

3 Sidings Court
White Rose Way
Doncaster
DN4 5NU

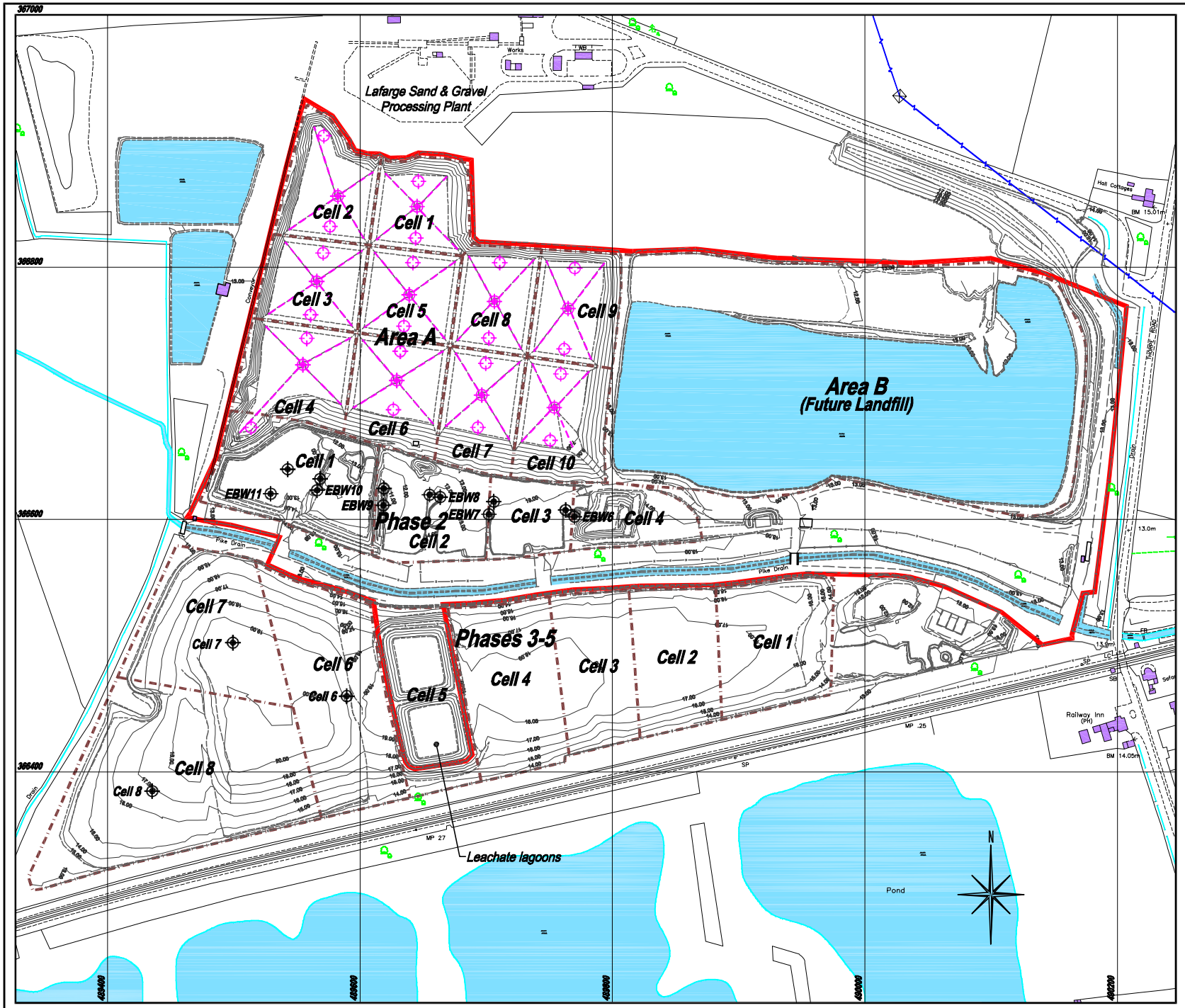
Project: **Section A: Environmental Setting and Installation Design**

Location: **Whisby Landfill Site, Lincolnshire**

Title: **Installation Details**

Project No. 03623334		Engineer	Drawing No. **ESID6B**
File No. 5221907		Reviewed by	
Created by D.M.			
Scale As Shown	Date 29th April 2004		

Golder Associates



NOTES

1. All levels relative to Newlyn Ordnance Datum.
2. Area B cell layout to be determined prior to the completion of Area A.

REFERENCE

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2. Site survey provided by May Gurney Limited, Drawing Ref: WE/3722/012, dated 10.11.03.

LEGEND

- Installation boundary
- Ground contour : mAOD
- Break of slope
- Cell boundary
- Existing leachate extraction / monitoring well
- Future leachate extraction well
- Future leachate monitoring well
- Future leachate drainage pipe

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3 Sidings Court
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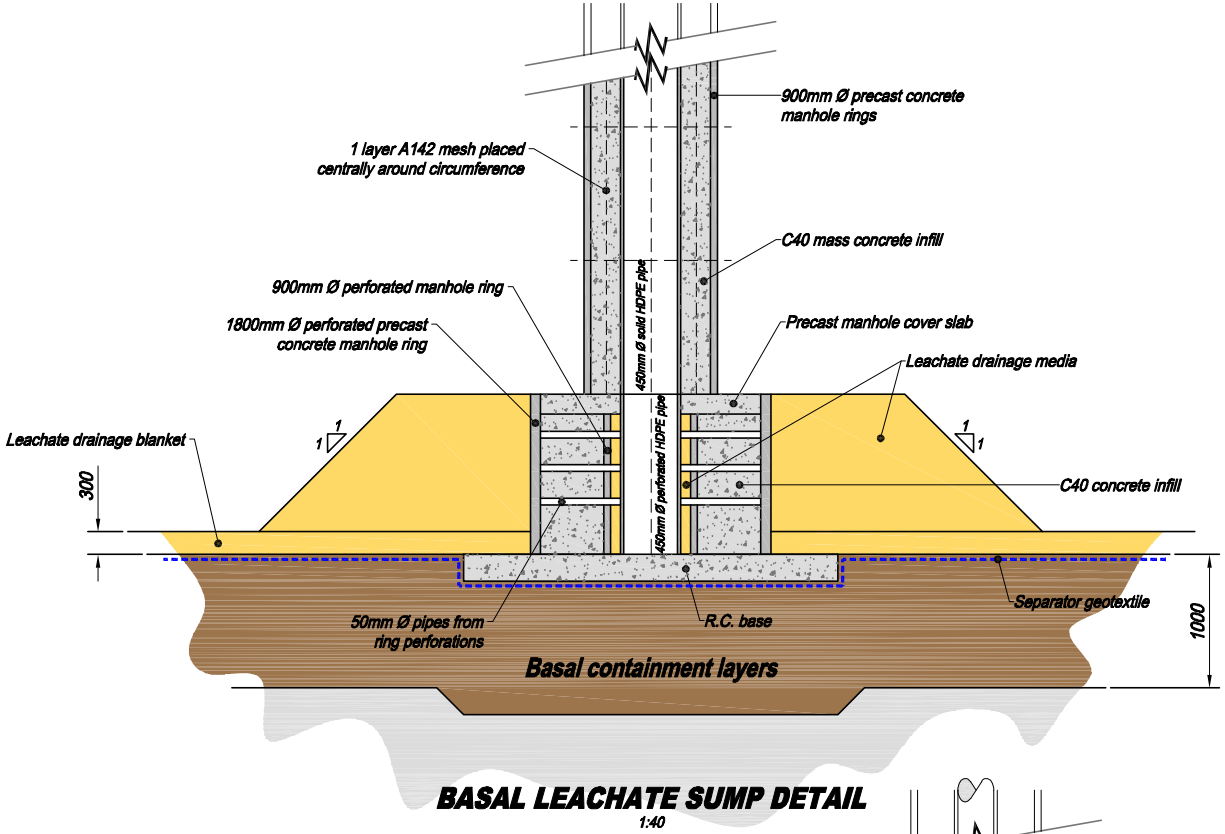
Project Section A: Environmental Setting and Installation Design

Location Whisby Landfill Site, Lincolnshire

Title Leachate Management

Project No. 03523334	Engineer	Drawing No.	ESID7A
File No. 5221904	Reviewed by		
Created by D.M.			
Scale 1:3,000	Date 29th April 2004		

Golder Associates



BASAL LEACHATE SUMP DETAIL

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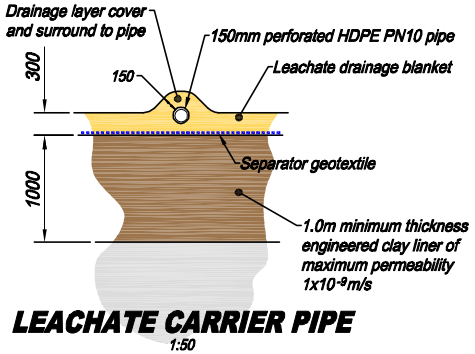
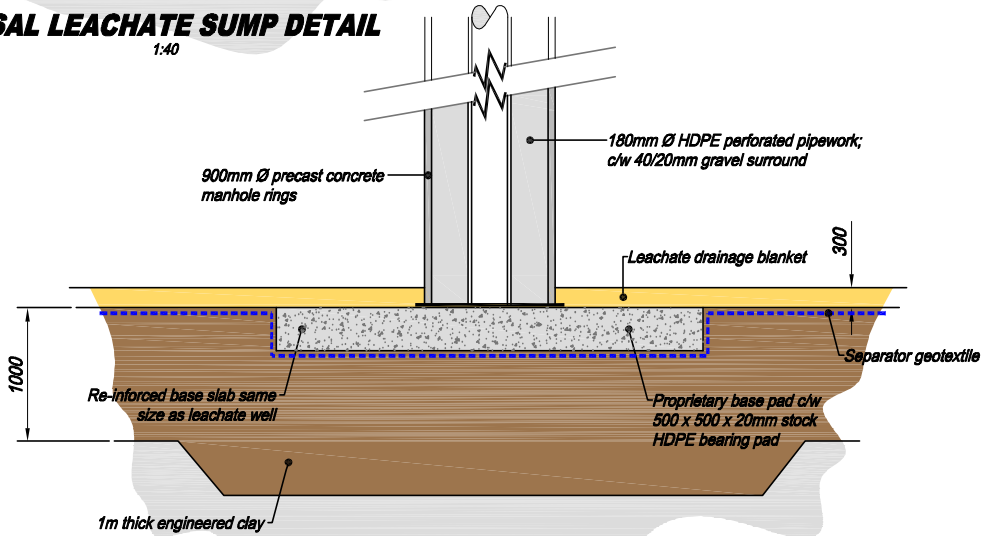


LEACHATE CARRIER PIPE

1:50



REMOTE LEACHATE MONITORING WELL DETAIL

1:40

Chamber Height 20m

Safe working bearing capacity of soil (qs) factored in kN/m	Foundation Dimensions
200	2500 x 2500 x 300 DP
300	2000 x 2000 x 300 DP
450	1650 x 1650 x 300 DP
600	1450 x 1450 x 300 DP

NOTE

1. All dimensions shown are in millimetres unless otherwise stated.

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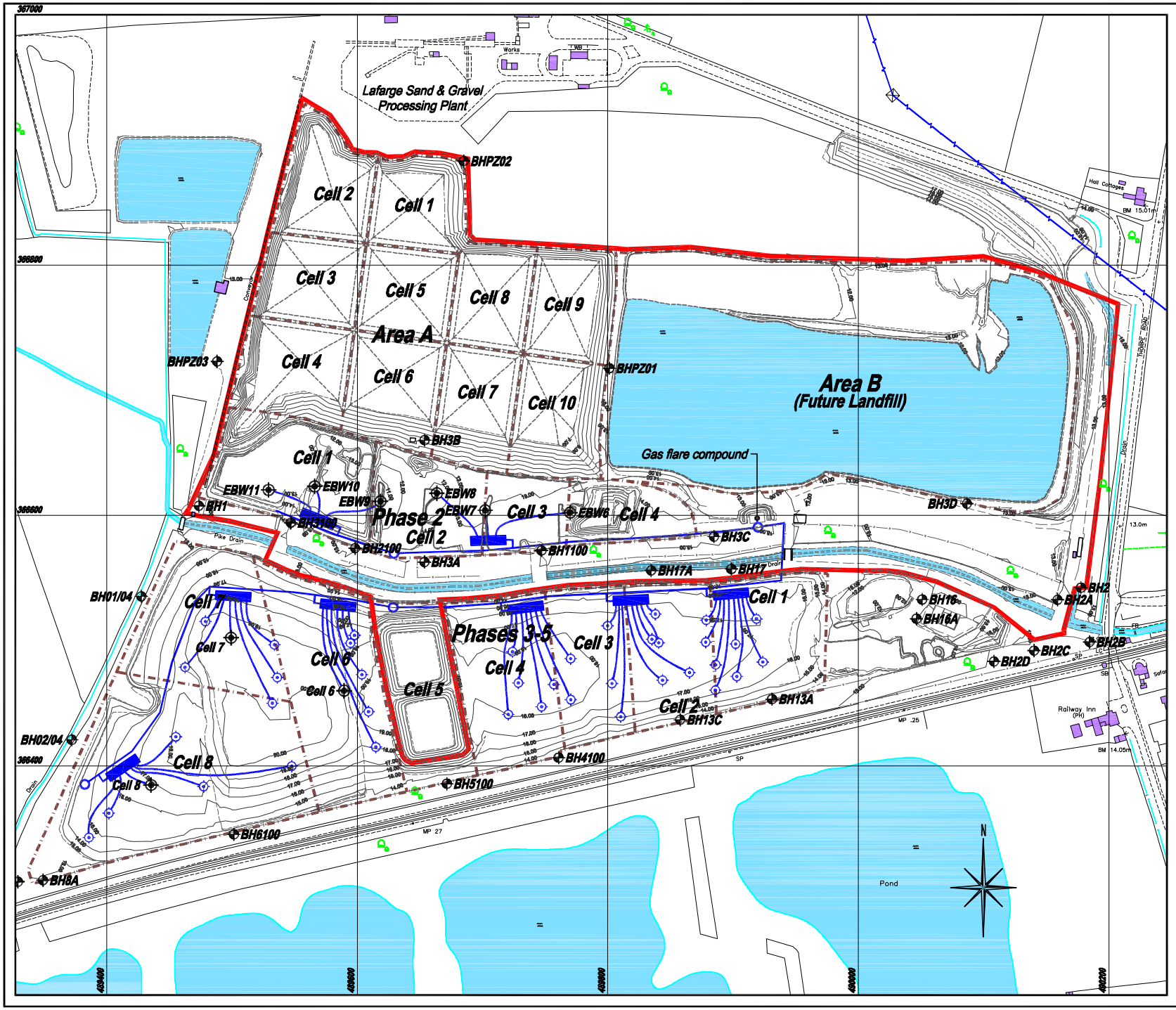
Project: **Section A: Environmental Setting and Installation Design**

Location: **Whisby Landfill Site, Lincolnshire**

Title: **Leachate Management Details (Future)**

Project No. 03523334		Engineer	Drawing No. ESID7B
File No. 5221905		Reviewed by	
Created by D.M.			
Scale As Shown	Date 29th April 2004		

Golder Associates



NOTES

1. All levels relative to Newlyn Ordnance Datum.
2. Area B cell layout to be determined prior to the completion of Area A.

REFERENCE

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2. Site survey provided by May Gurney Limited, Drawing Ref: WE/3722/012, dated 10.11.03.

LEGEND

- Installation boundary
- Ground contour : mAOD
- Break of slope
- Cell boundary
- Existing combined gas / groundwater monitoring borehole
- Existing leachate extraction / monitoring well (selected only)
- Gas extraction well
- Knockout pot (indicative location)
- Manifold (indicative location)
- Gas pipeline (indicative location)

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3 Sidings Court
White Rose Way
Doncaster
DN4 5NU

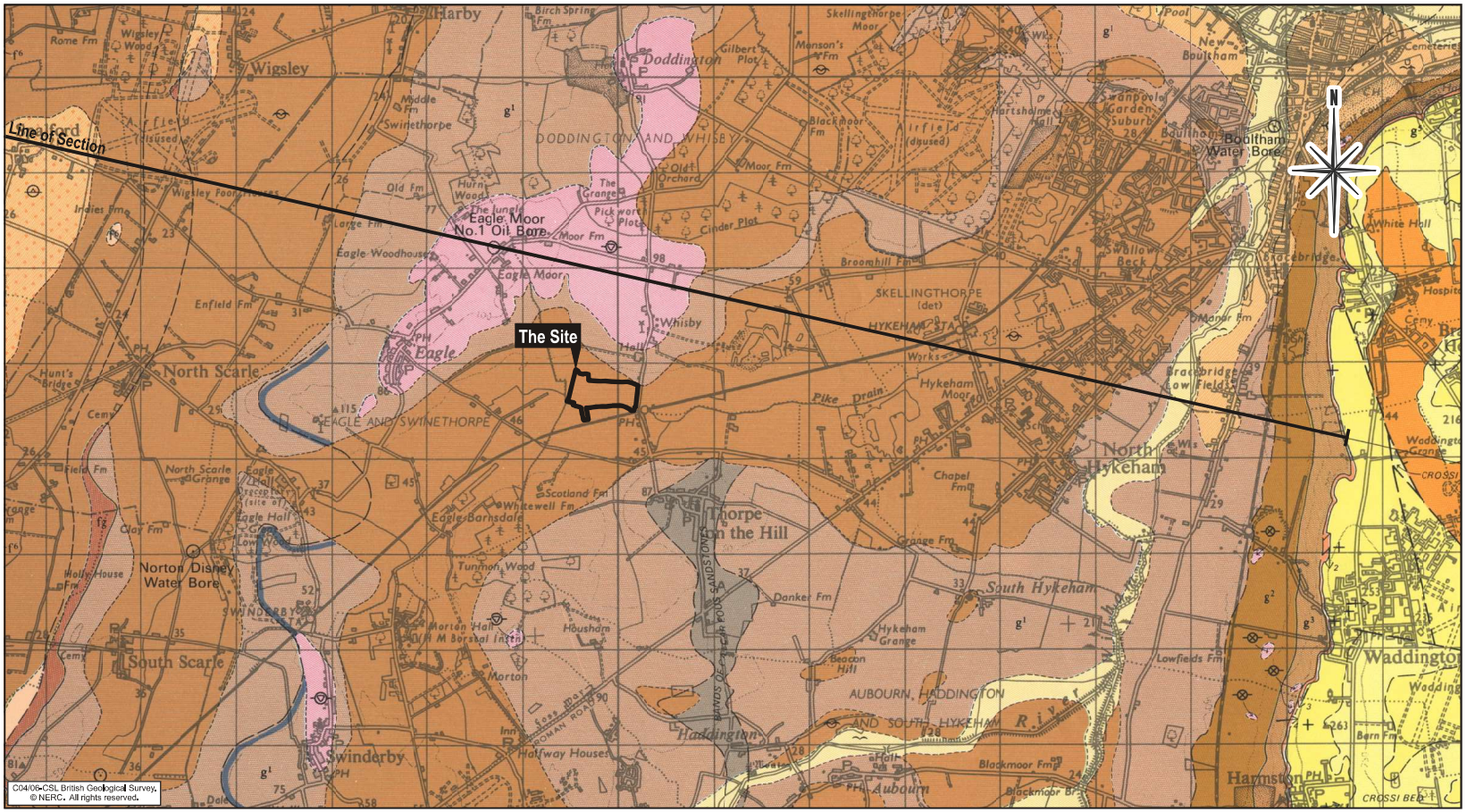
Project: **Section A: Environmental Setting and Installation Design**

Location: **Whisby Landfill Site, Lincolnshire**

Title: **Landfill Gas Management**

Project No. 03523334	Engineer	Drawing No.	**ESID8**
File No. 5221908	Reviewed by		
Created by D.M.			
Scale 1:3,000	Date 29th April 2004		

Golder Associates



REGIONAL GEOLOGY
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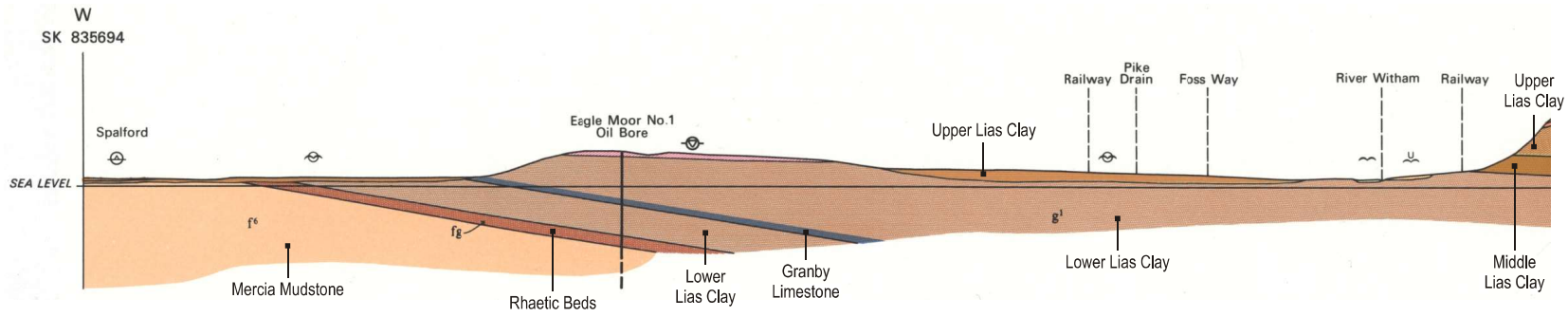


GEOLOGY CROSS SECTION
Horizontal = 1:50,000

LEGEND : Regional Geology

PLEISTOCENE AND RECENT

- Older blown sand
- Peat
- Alluvium
- Undifferentiated river terrace sand and gravel
- Fen gravel
- Marine or estuarine silt and clay with some peat
- Head
- Older river sand and gravel
- Glacial sand and gravel
- Boulder Clay
- Sand of unknown age

LEGEND

Installation boundary

waste recycling GROUP
3 Sidings Court
White Rose Way
Doncaster
DN4 5NU

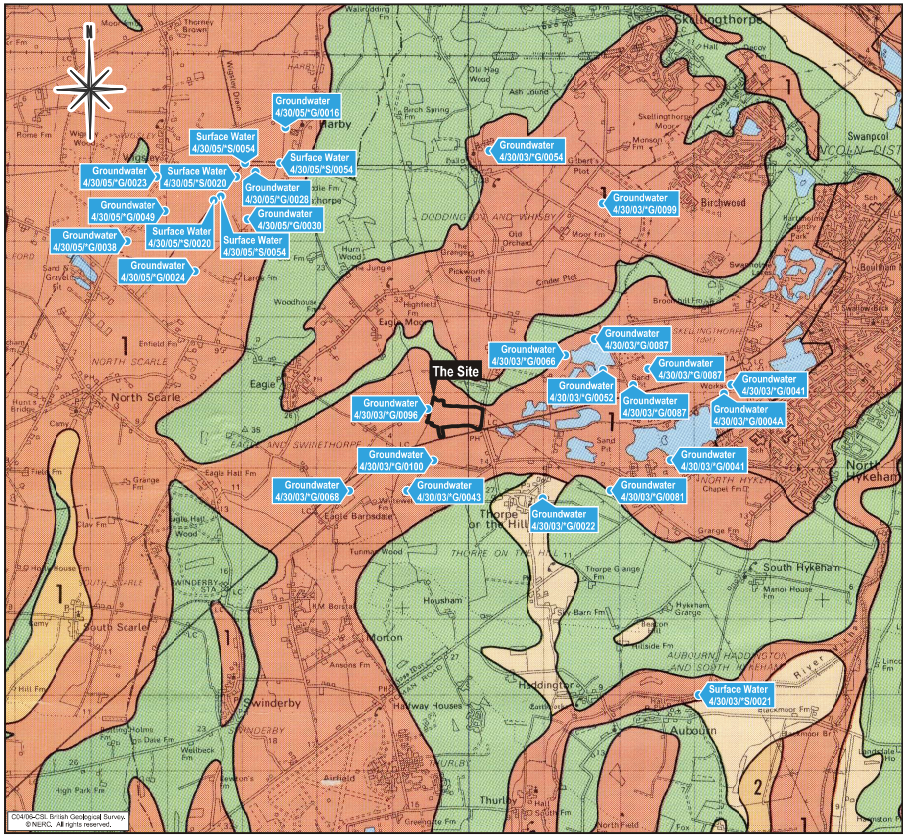
Project
Section A: Environmental Setting and Installation Design

Location
Whisby Landfill Site, Lincolnshire

Title
Regional Geology

Project No. 03523334	Engineer	Drawing No.	**ESID9**
File No. 5221898	Reviewed by		
Created by D.M.			
Scale 1:50,000	Date 29th April 2004		

Golder Associates



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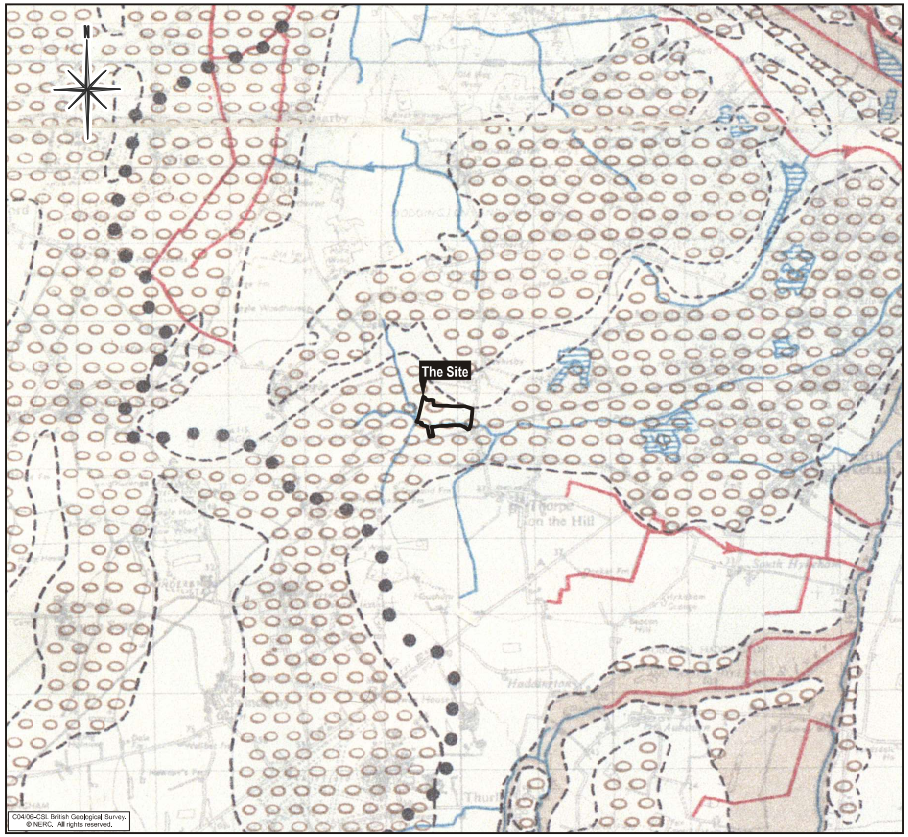

REGIONAL HYDROGEOLOGY
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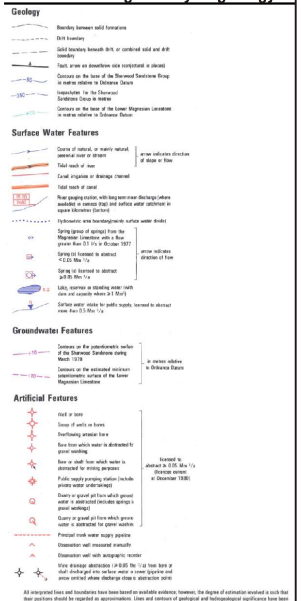
LEGEND: Regional Hydrogeology



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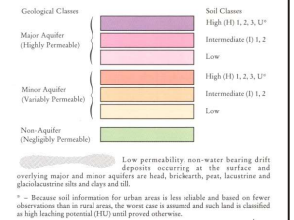
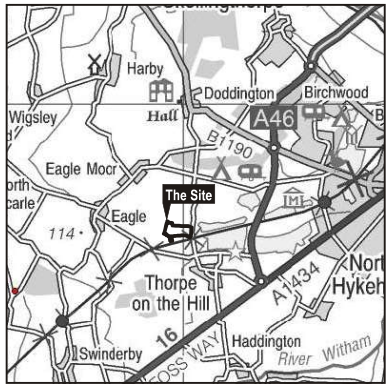




Source Protection
- Inner Zone
- Outer Zone
- Total Catchment
- Special Interest

GROUNDWATER SOURCE PROTECTION

Indicative Floodplain
- River
- Sea

LOCAL FLOODPLAIN

LEGEND

- Installation boundary
- Licensed abstraction

waste recycling group
3 Sidings Court
White Rose Way
Doncaster
DN4 5NU

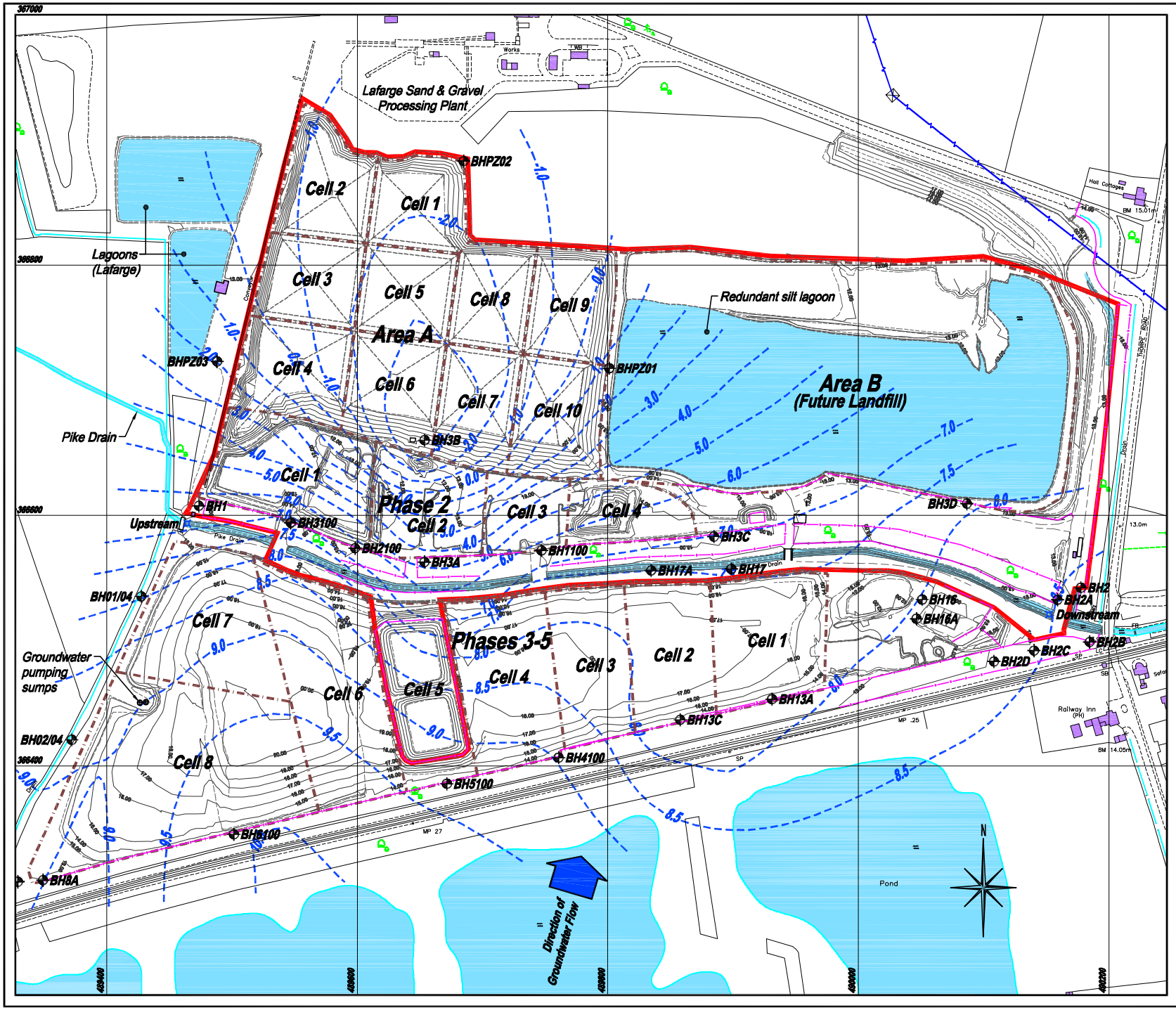
Project: **Section A: Environmental Setting and Installation Design**

Location: **Whisby Landfill Site, Lincolnshire**

Title: **Regional Hydrogeology**

Project No. 03523334		Engineer	Drawing No. ESID10
File No. 5221899		Reviewed by	
Created by D.M.			
Scale As Shown	Date 29th April 2004		

Golder Associates



NOTES

1. All levels relative to Newlyn Ordnance Datum.
2. Area B cell layout to be determined prior to the completion of Area A.

REFERENCE

1. Surrounding topography reproduced from Ordnance Survey® digital map data © Crown copyright 2003. All rights reserved.
2. Site survey provided by May Gurney Limited, Drawing Ref: WE/3722/012, dated 10.11.03.

LEGEND

- Installation boundary
- Ground contour : mAOD
- Break of slope
- Cell boundary
- Existing combined gas / groundwater monitoring borehole
- Surface water monitoring point
- 6.0 November 2003 groundwater contour : mAOD

waste recycling group
3 Sidings Court
White Rose Way
Doncaster
DN4 5NU

Project: **Section A: Environmental Setting and Installation Design**

Location: **Whisby Landfill Site, Lincolnshire**

Title: **Local Hydrogeology and Hydrology**

Project No. 03523334	Engineer	Drawing No.	**ESID11**
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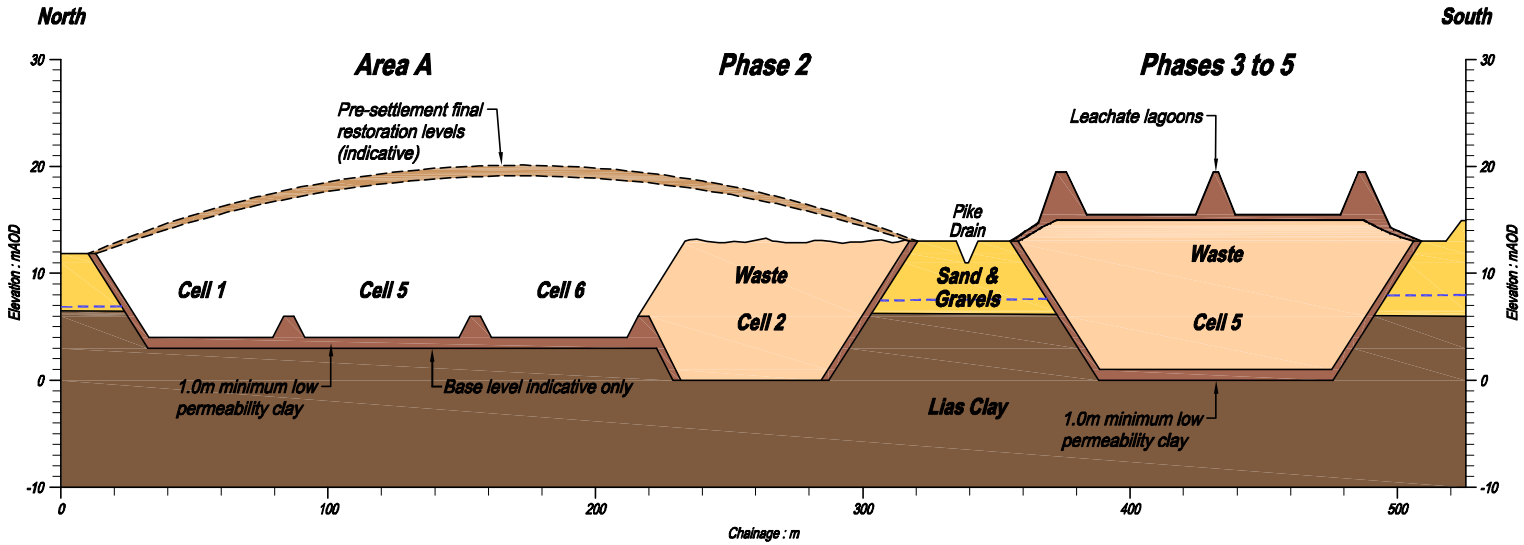
Created by D.M.			
Scale 1:3,000	Date 29th April 2004		

Golder Associates



SECTION A-A

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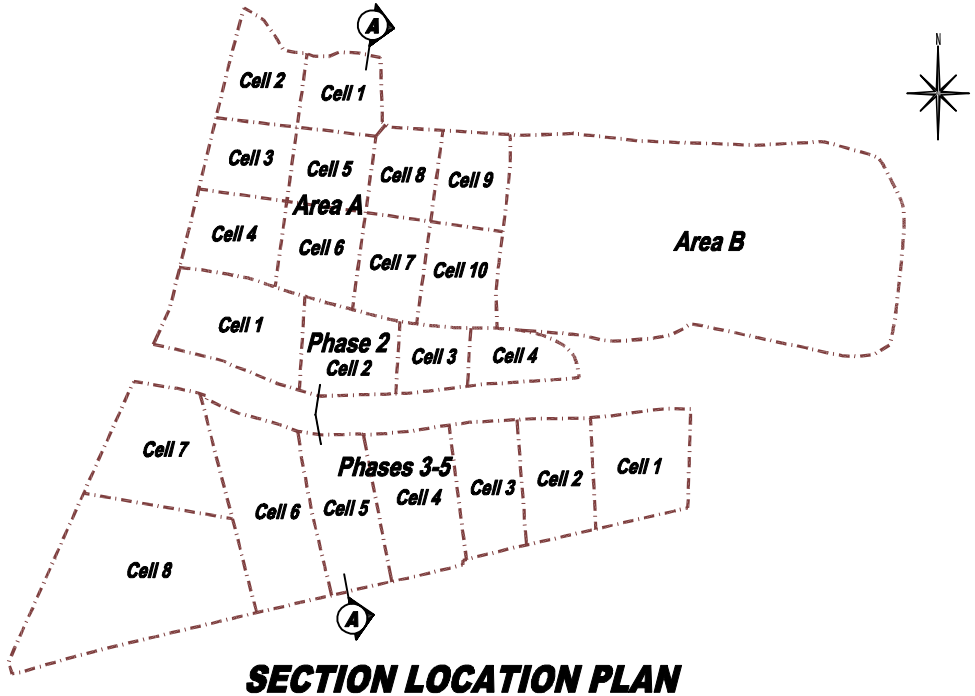
Vertical : 1:500



SECTION LOCATION PLAN

NOTE

1. Geology interpretated from log data collated from site investigation and monitoring boreholes.

LEGEND

- Sands and Gravels
- Lias Clay
- Waste
- Water table

waste recycling group

3 Sidings Court
White Rose Way
Doncaster
DN4 5NU

Project
Section A: Environmental Setting and Installation Design

Location
Whisby Landfill Site, Lincolnshire

Title
Hydrogeological Cross Section

Project No. 03523334	Engineer	Drawing No.	ESID12
File No. 5221910	Reviewed by		
Created by D.M.			
Scale As Shown	Date 29th April 2004		

Golder Associates

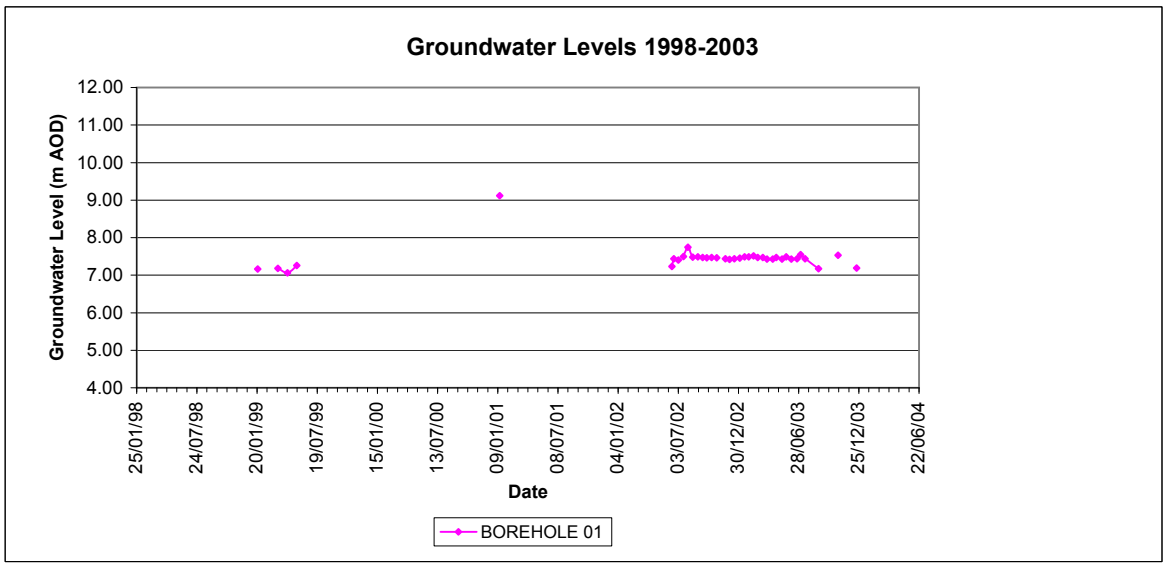
APPENDICES

APPENDICES

ELECTRONIC COPY OF ALL APPENDICES

APPENDIX 8

GROUNDWATER HYDROGRAPHS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25/12/03
22/06/04
Date
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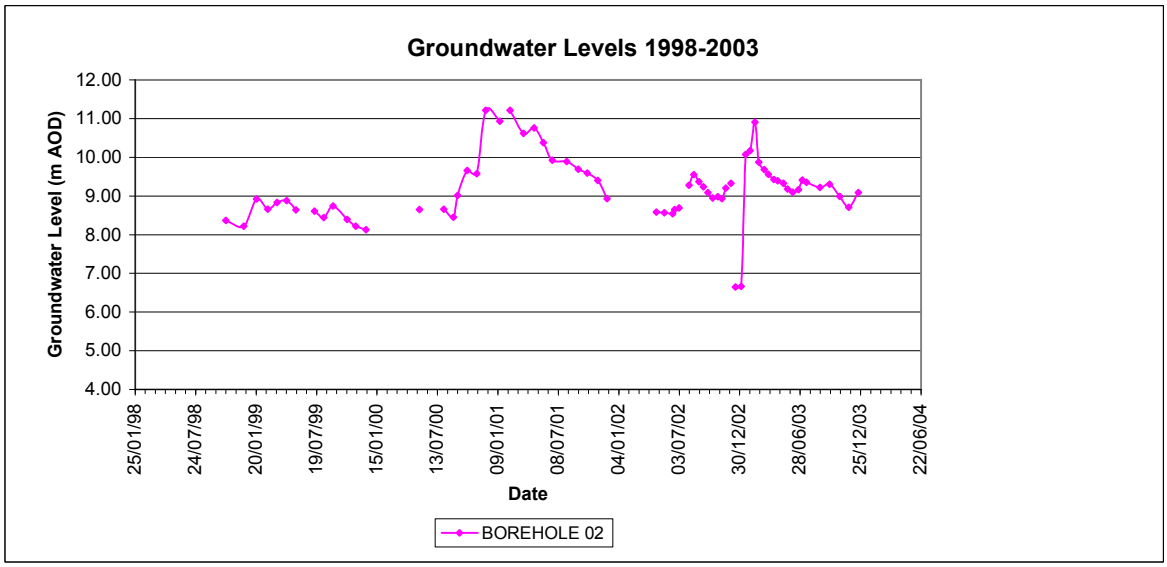
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25/12/03
22/06/04
Date
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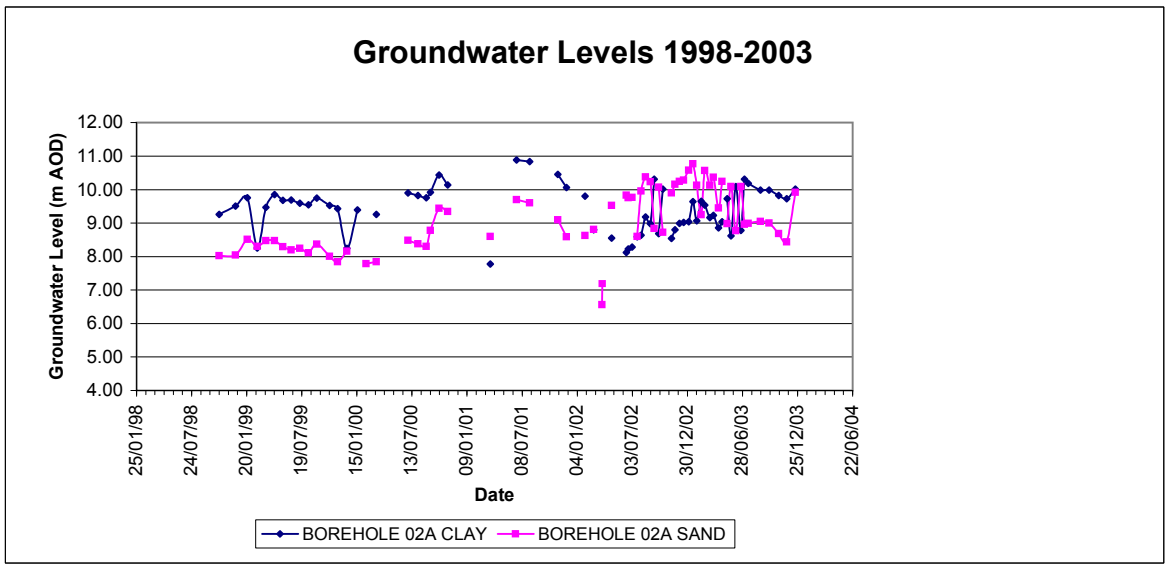
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22/06/04
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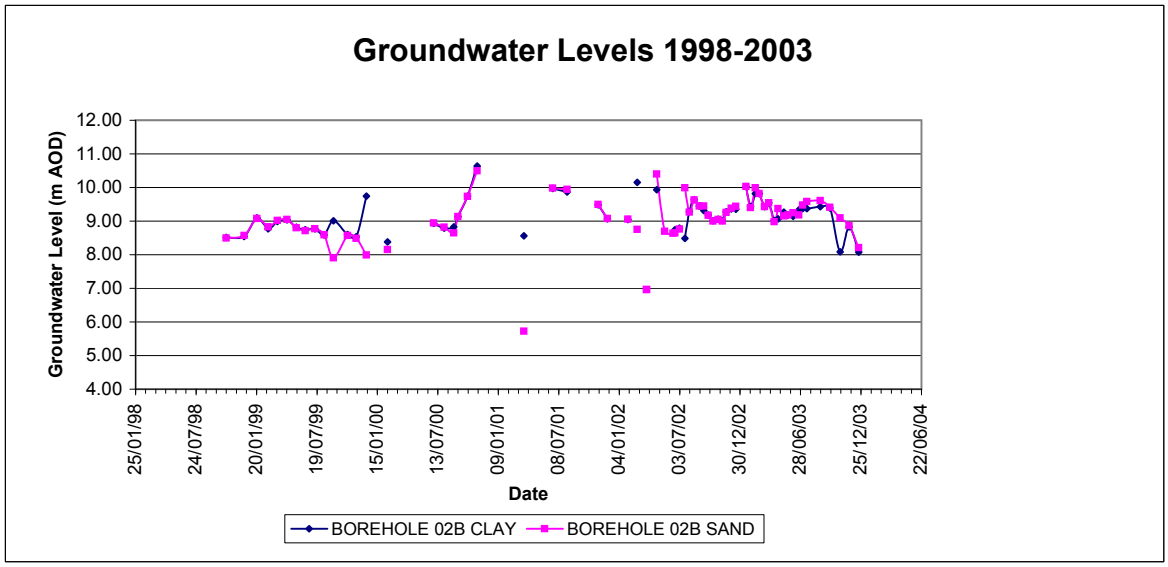
BOREHOLE 02A SAND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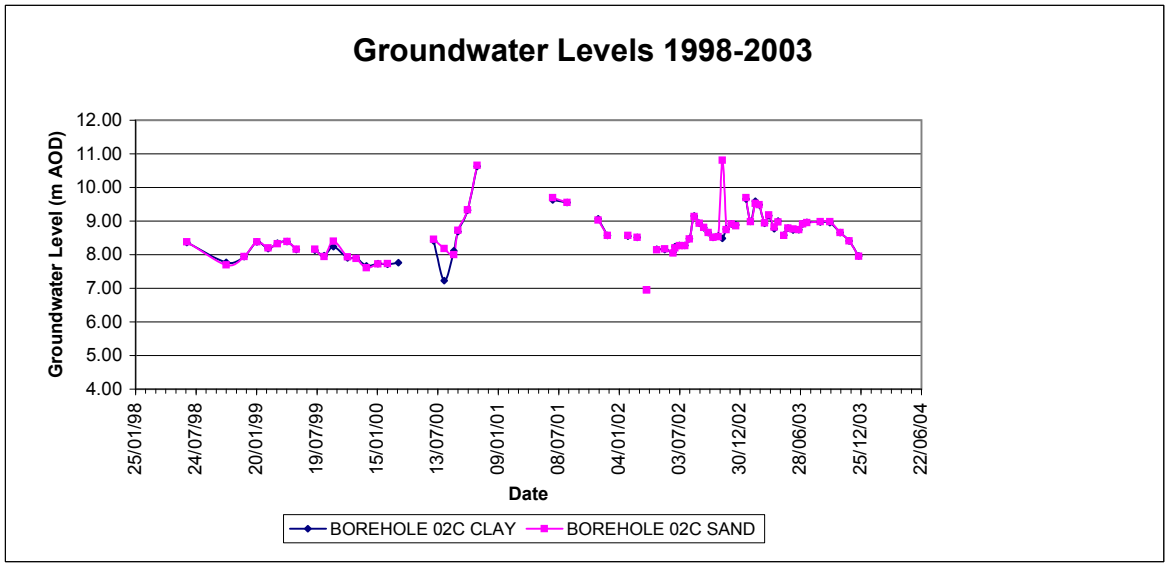
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22/06/04
Date
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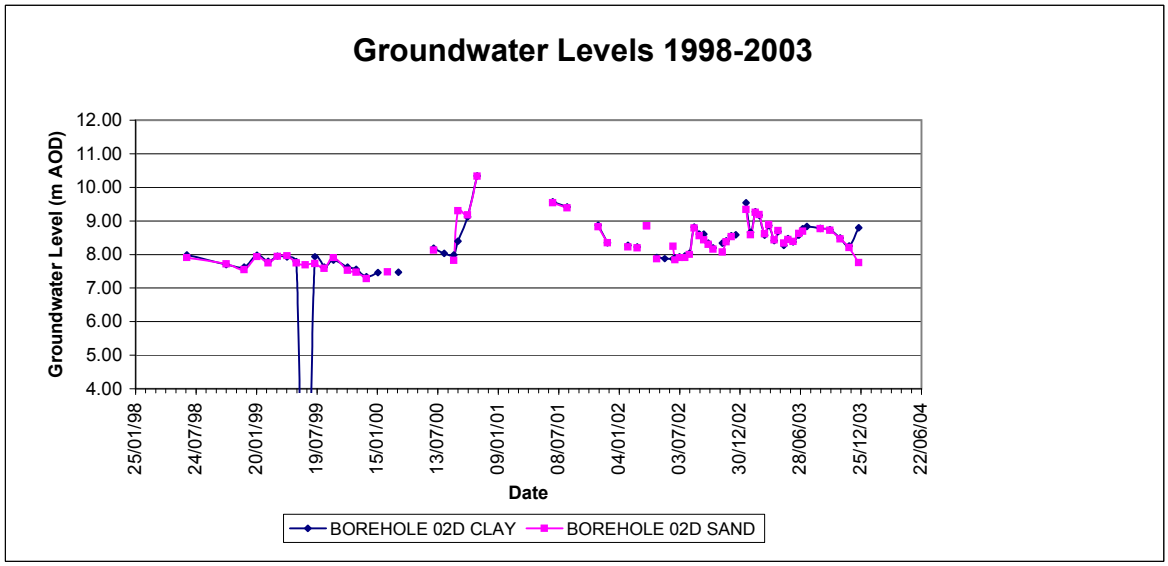
BOREHOLE 02C SAND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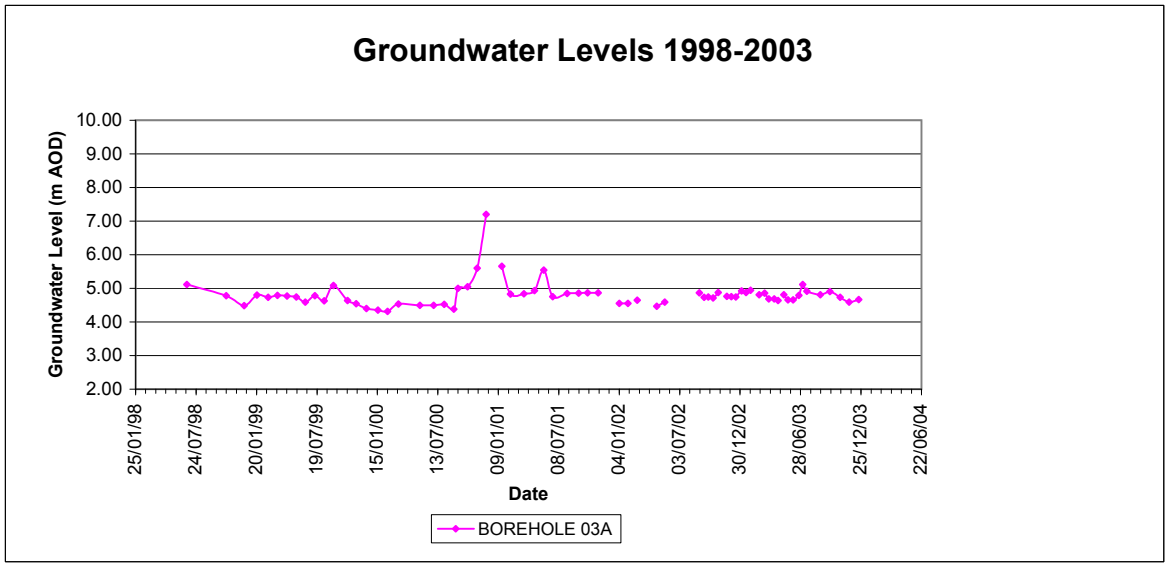
BOREHOLE 02D SAND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22/06/04
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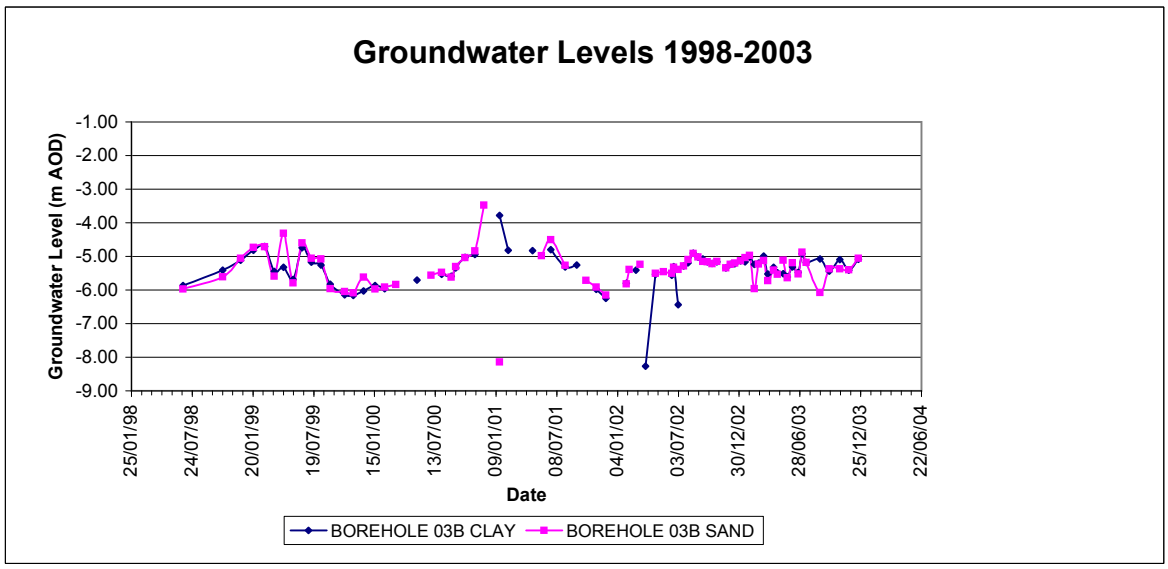
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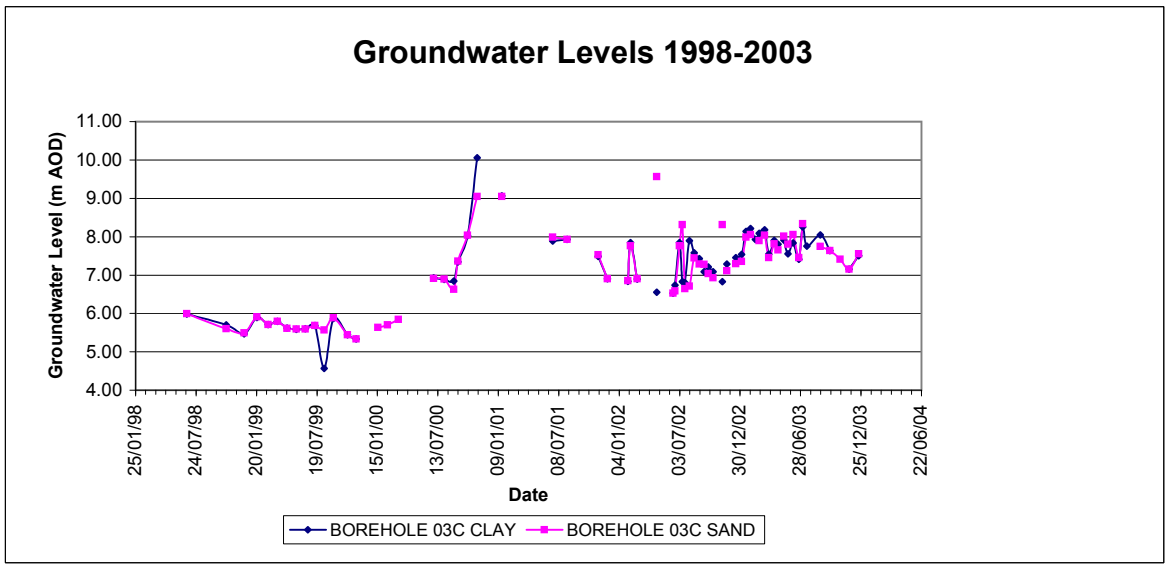
BOREHOLE 03B SAND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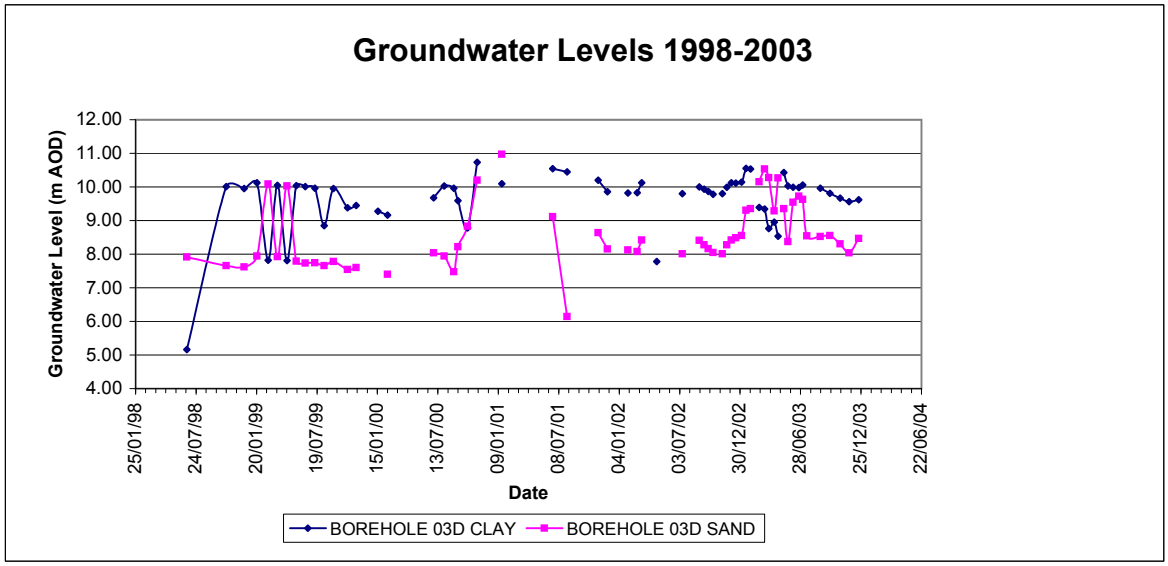
BOREHOLE 03C SAND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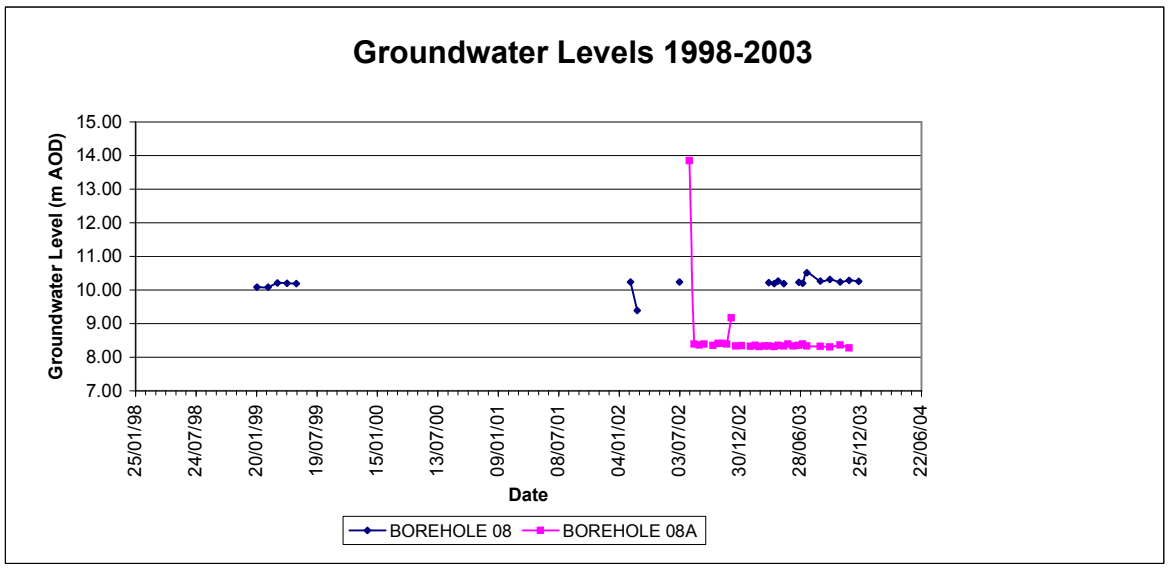
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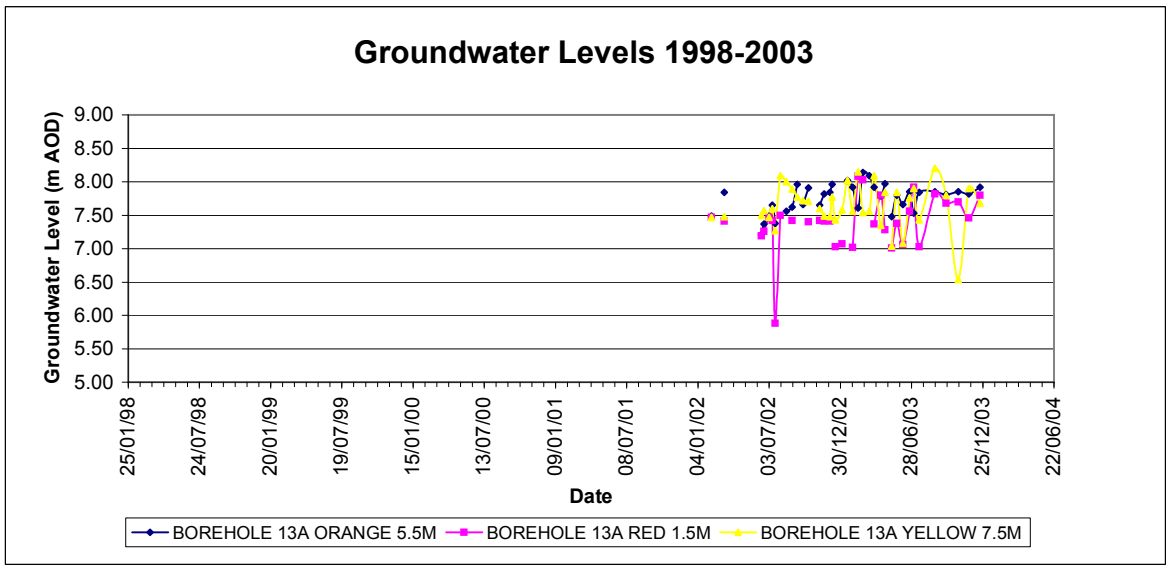
BOREHOLE 08A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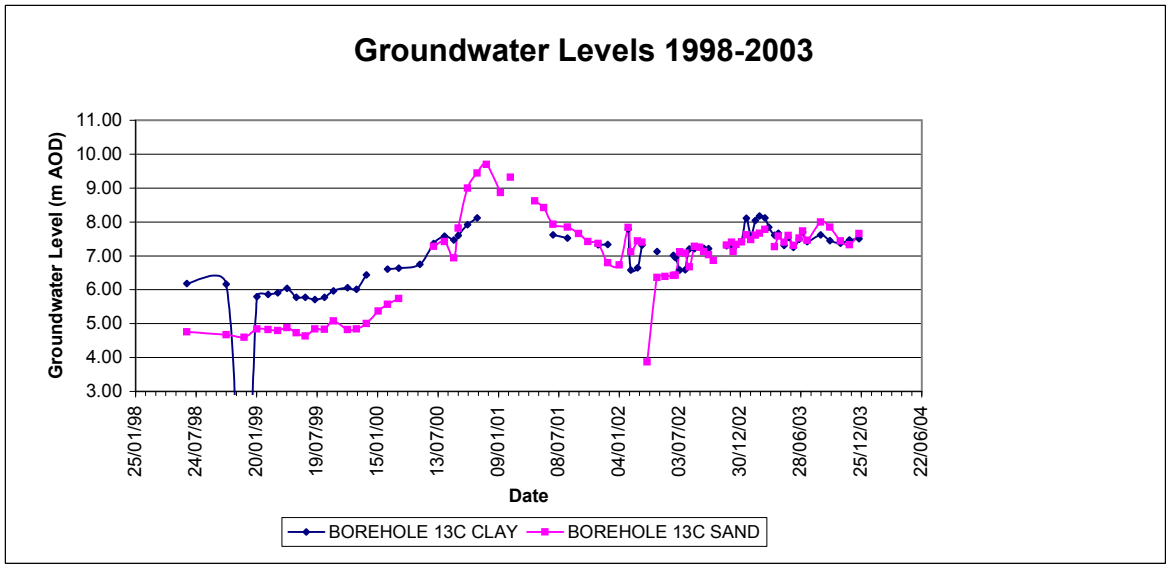
BOREHOLE 13A RED 1.5M
BOREHOLE 13A YELLOW 7.5M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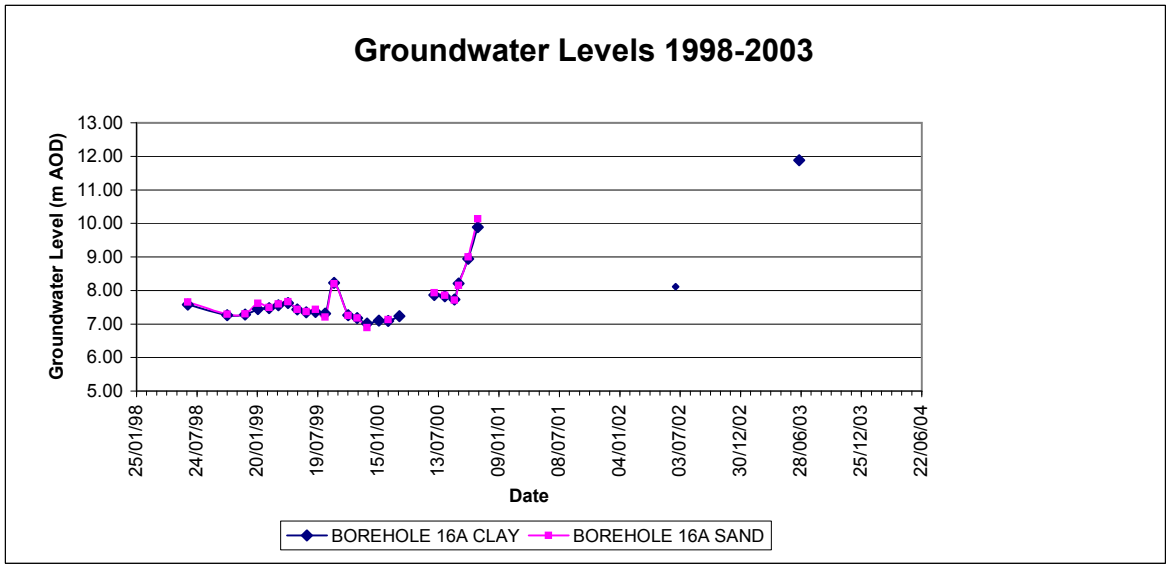
BOREHOLE 13C SAND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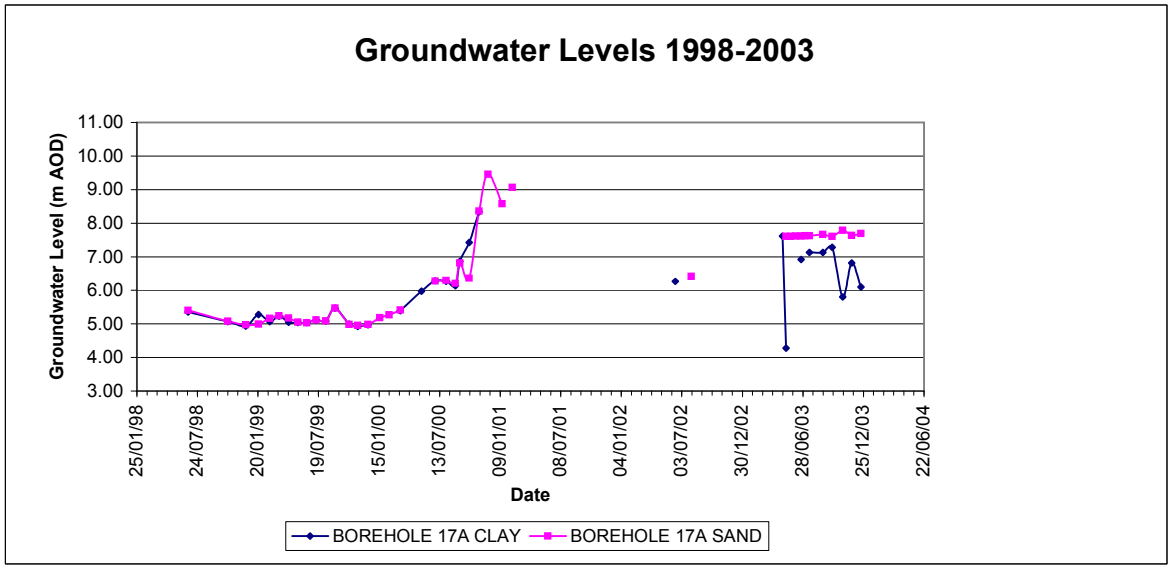
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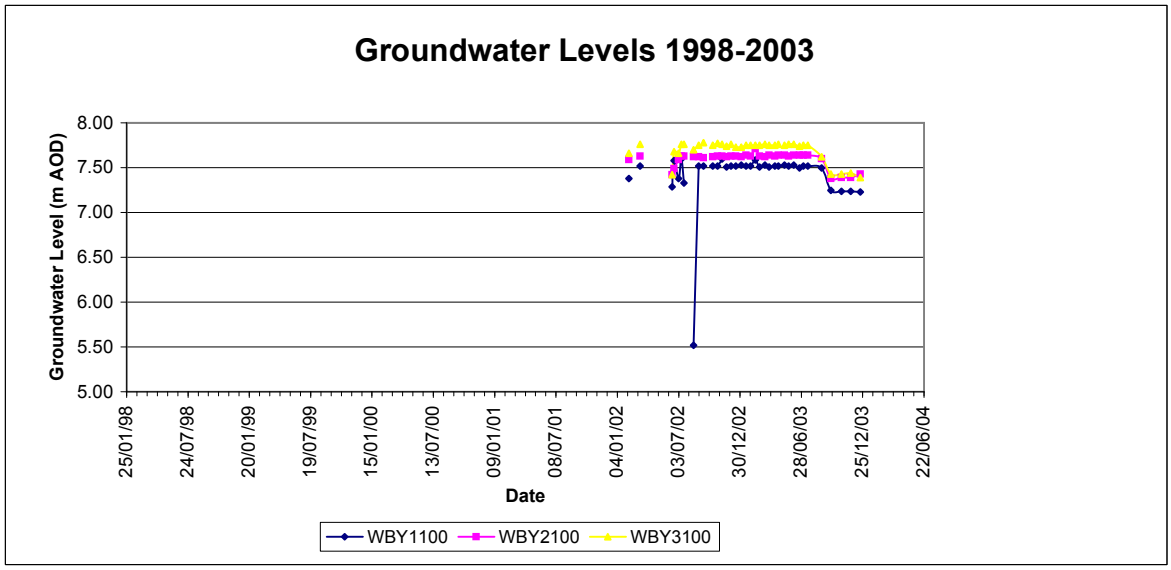
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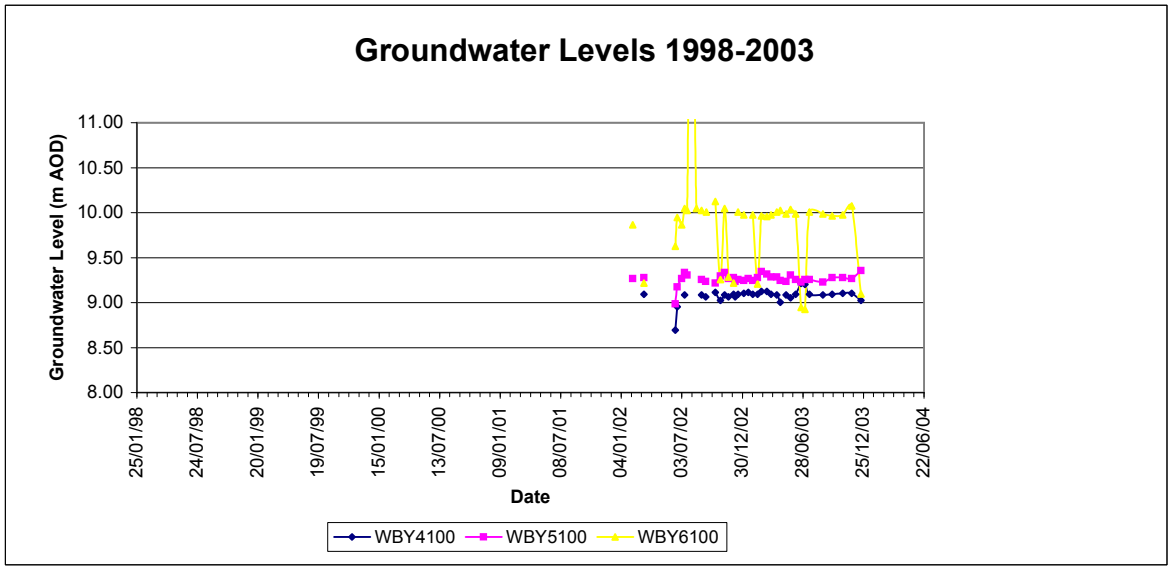
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22/06/04
Date
WBY4100
WBY5100
WBY6100

APPENDIX 2

Specification for Construction of Incinerator Bottom Ash Cell 1
report ref. WR7885_Rev1

LINCWASTE LIMITED
(FCC ENVIRONMENT LIMITED)

CQA PLAN FOR CONSTRUCTION OF INCINERATOR BOTTOM ASH CELL 1 AT WHISBY LANDFILL SITE

Document Reference: WR7885_2 Rev1
April 2023

Project Quality Assurance

Report Reference : WR7885_2 Rev1

Report Date : April 2023

Prepared for : FCC Environment Limited
6 Sidings Court
White Rose Way
Doncaster
Yorkshire
DN4 5NU

Issued by : Sirius Environmental Limited
4245 Park Approach
Thorpe Park
Leeds
LS15 8GB

Rev	Date Issued	Amendment Details	Author	Reviewer
1	17/04/2023	Text amendments following updates to drawings	JC	AK

Purpose

This document was prepared as a CQA Plan for the Construction of the Incinerator Bottom Ash (IBA) Cell 1 at Whisby Landfill Site, for Lincwaste Limited, who are the permit holders for the site, but are a subsidiary company of FCC Environment (UK) Limited and will be referred to as FCC Environment Limited (FCC) from here on in.

Sirius Environmental Limited (Sirius) accepts no responsibility or liability for any use that is made of this document other than by the Client, FCC Environment (UK) Limited, for the purposes for which it was originally commissioned and prepared.

TABLE OF CONTENTS

SECTION **PAGE**

LIST OF APPENDICES

1 SCOPE OF THE CONSTRUCTION WORKS

1.1 General Description

The design concepts for the Cell 1 Construction were developed to accord with the Permit for the site.

The position of the proposed development in relation to previous cells, is shown on Drawing WR7885_01_01.

Construction of the lining system for Cell 1 shall generally involve:

- Excavation and filling to achieve the formation levels,
- Installation of Drainage Geocomposite below any fill or directly below the lining system, on the as-excavated formation level;
- Installation of toe drains to discharge the backwall drainage geocomposite into the ponded area to the west of the cell;
- Installation of a 1000mm thick Engineered Clay liner on the sidewall areas, to a maximum permeability of $1x10^{-9}$ m/s;
- Construction of an intercell bund on the western edge of the cell;
- In-situ testing of the basal clay liner (in-situ clay) to ensure compliance with the Specification;
- Installation of a separation geotextile above the Engineered Clay Liner; and
- Installation of leachate collection spin drains and a leachate collection/monitoring sump; and
- Installation of a target pad.

2 CQA SUPERVISION

2.1 General

The CQA Project Team will comprise the following:

The CQA Engineer - Will be office based and responsible for the following:

- Administration of the CQA program;
- Attendance at selected progress or liaison meetings and is the key contact with regulatory officers;
- Production of the CQA Validation Report.

The CQA Inspector – The representative of the CQA Engineer located full time at the site during works requiring CQA supervision and responsible for the following:

- The on-site representative of the CQA Engineer;
- To be fully familiar with all CQA requirements for the project;
- Attendance at all CQA-related meetings (e.g. Pre-construction and Progress);
- Preparation, or overseeing the ongoing preparation of the as-built drawings;
- Assigning locations for testing and sampling;
- Keeping daily reports and records;
- Reporting to the CQA Engineer any relevant observations;
- Overseeing the collection and shipping of all samples for laboratory testing;
- Reviewing the results of laboratory testing and making appropriate recommendations;
- Reporting any unresolved deviations from this CQA Plan to the CQA Engineer;
- Provision of all records and relevant data to the CQA Engineer for the preparation of the final validation report, which will be submitted to the Environment Agency (EA) for approval upon completion of the works;
- Noting and bringing to the attention of the Contractor any on-site activities that could result in damage to the liner system; and
- Verification that the works carried out are constructed in accordance with the requirements of the Specification and CQA Plan.

Staff undertaking the roles of the CQA Engineer and the CQA Inspector should have relevant experience in landfill construction and earthworks control or be supervised by experienced staff until relevant experience is obtained. The CVs of the CQA Project Team shall be supplied to the Environment Agency prior to commencement of the works. Should changes to CQA personnel be required, the Environment Agency shall be immediately notified and the respective CV shall be issued.

2.2 Definitions

For the sake of clarification the following definitions are given:

Construction Quality Assurance (CQA):

- Means a planned and systematic pattern of all means and actions designed to provide confidence that items or services meet contractual and regulatory requirements and shall perform satisfactory in service.

Construction Quality Assurance refers to means and actions employed by the Supervisor, to assure conformity of the preparation, production and installation of this CQA Method Statement, the Contract Drawings, and Specification. CQA is provided by Stratus.

Construction Quality Control (CQC):

- Means "those actions that provide a means to measure and regulate the characteristics of an item or service to contractual requirements".

Construction Quality Control refers to those actions taken by Manufacturers, Installers, Contractors, or the Employer to ensure that the materials and the workmanship meet the requirements of the Contract Drawings and Specification.

Employer:

Means 'the person or persons, firm or company or other body whom own and have responsibility for the facility. For the works undertaken at Hazel Lane Landfill Site, the Employer is FCC Environment (UK) Limited. The Employer has entered into a contract with a Contractor for the execution of the works detailed in the Specification and Contract Drawings. Personal representatives or other parties, e.g. the Supervisor, may represent the Employer on site.'

Contractor:

Means 'the person or persons, firm, company or other body to whom the contract has been awarded by the Employer, and includes the Contractor's personal representatives or other parties, e.g. Sub-contractors, Manufacturer's'.

The Contractor shall undertake the execution of the works under the terms of the contract.

Specification:

Means, 'that part of the Contract entered into between the Employer and the Contractor, which sets out the Employer's detailed requirements as to how the works should be constructed, tested, measured and quality assured'.

This CQA Plan is to be read in conjunction with the Specification Ref: WR7885_1 which forms part of this CQA Method Statement and is included within the Design Pack.

2.3 Daily Meetings

Meetings will be held daily between the CQA Inspector and the Contractor's representative. The purpose of which is to:

- Review the work activities and locations for that day;
- Note the Contractor's installation personnel and plant for the day/shift;
- Review the previous days progress;
- Review the work schedule;
- Discuss any interfacing with other contractors and/or site operations; and
- Discuss/highlight any problems and identify solutions.

2.4 Site Visits

It is anticipated that from time to time the EA will visit the site to review the works. During these visits the CQA Inspector shall make available all test results and daily records up to that date for inspection by the EA.

Any problem encountered during construction should be discussed with the EA upon their arrival to site prior to any subsequent site walkover. The CQA Inspector shall discuss the problems encountered any discuss any proposed remediation methods.

2.5 CQA Requirements

The CQA requirements associated with each component of the works are detailed in the individual sections below.

2.6 CQA Proformas

The CQA Inspector is to ensure that all the information required by each section is recorded in the daily records and in associated proformas, which are included in Appendix 1. This is to include keeping records of sampling locations and the details/locations of failures. All of the records are to be submitted as part of the CQA Validation Report.

3 EXCAVATION AND ENGINEERED FILL

3.1 CQA Requirements

The works will be carried out using Construction Quality Assurance (CQA) procedures developed for the works and which form part of this CQA Plan. The CQA Inspector will observe, record and oversee the works as required to complete the CQA programme.

The CQA procedures include for checking of various parts of the works in a systematic way and include, but are not limited to consideration of the following elements.

The CQA Inspector shall:

- Assess the method statement submitted by the Contractor for the installation of the preparatory earthworks;
- Ensure an assessment of the sub-grade is carried out and record the results of the sub-grade assessment;
- Ensure that all material within the working area deemed unsuitable in accordance with the Specification is removed to an area agreed with FCC's Site Manager;
- Ensure the classification of the fill material is in accordance with the Specification;
- Ensure that only suitable soils are used where required as engineered fill;
- Monitor the placement and compaction of the engineered fill, ensuring that the works are carried out in accordance with the Specification;
- Ensure testing on the completed formation and layers of engineered fill is carried out in accordance with frequencies detailed in the Specification, including hand shear vane testing in order to demonstrate that the specified minimum *in situ* shear strength has been achieved;
- Ensure that all areas of non-compliance are remediated in accordance with the Specification;
- Take photographs during the construction; and
- Ensure that surveys are undertaken in accordance with the Specification to confirm that the requisite levels and layer thicknesses have been achieved.

All laboratory testing will be undertaken by UKAS Accredited Laboratories, with accreditation for all the required tests. The CQA Inspector shall fully document each item above and the documentation shall be presented in the CQA Validation Report.

4 UNDER CELL DRAINAGE

4.1 CQA Requirements

The CQA Inspector shall:

- Assess the method statement submitted by the Contractor detailing their proposed deployment and seaming techniques for the drainage geocomposite;
- Ensure that the geocomposite materials are delivered, handled and stored in accordance with the Specification and the manufacturer's recommendations;
- Make a visual inspection of each roll of geocomposite as it is unloaded to identify any damage and record the relevant information for each roll;
- Assess all geocomposite manufacturers' quality control certificates to confirm that the geocomposite meets the requirements of the Specification prior to installation;
- Assess and approve, with respect to the requirements set out in the Specification, the proposed panel layout for the geocomposite to be submitted by the Contractor. The methodology shall show the Contractor's proposed start point and direction of working. The panels shall be arranged so that seams are aligned parallel to the line of maximum slope (i.e. normal to contours), wherever practicable, in accordance with accepted good practice. The panel layout shall seek to minimise the number of required heat bonded seams;
- Identify rolls from which conformance samples of the geocomposite are to be taken for laboratory conformance testing in accordance with the Specification;
- Assess the results of conformance tests to ensure compliance with the Specification. Should any materials fail to meet the requirements of the Specification, the CQA Inspector shall reject the failed roll and schedule further testing in accordance with the Specification;
- Provide written certification to the Contractor that the surface on which the geocomposite is to be installed is acceptable prior to installation. *Note the CQA Inspector may withdraw the certificate should the surface deteriorate for any cause prior to installation and only reissue upon remediation works being compliant with the Specification*;
- Witness all panel deployment ensuring compliance with the Specification;
- Witness all seam constructions to ensure compliance with the Specification:

- Ensure that all defects are identified on the geocomposite and witness that they are repaired in accordance with the Specification;
- Ensure that geocomposite and seam construction continues to the back of the anchor trenches;
- Ensure that geocomposite and seam construction continues to the base of the toe-drain trench at the base of the cell side-slopes;
- Ensure that on completion of the geocomposite installation the Contractor produces a fully referenced as-built panel layout plan including all the detail listed within the Specification;
- Ensure that the pipe materials are delivered, handled and stored in accordance with the Specification; and
- Ensure that the pipework is installed at the agreed locations (following the cell excavation works) and in accordance with the Specification; and
- Ensure that pipework is installed in accordance with the construction details on the drawings, that the pipes are jointed to give a water tight seal, and that there is adequate bedding, surround and cover for the pipes.

All laboratory testing will be undertaken by UKAS Accredited Laboratories, with accreditation for all the required tests. The CQA Inspector shall fully document each item above and the documentation shall be presented in the CQA Validation Report.

5 ENGINEERED CLAY LINER

5.1 CQA Requirements

The CQA Inspector shall:

- Assess the method statement submitted by the Contractor for the installation of the engineered clay liner;
- If the material used for the engineered clay liner is imported from another source than the source previously used on site, ensure that a source evaluation report has been approved by the Environment Agency for the material to be used in the construction of the engineered clay liner;
- Ensure that all material within the working footprint deemed unsuitable in accordance with the Specification is removed to an area agreed with FCC's Site Manager;
- Ensure that only suitable soils are used where required as the clay liner;
- Oversee and document the compaction trial prior to engineered clay liner field construction, ensuring that the trial pad is constructed in accordance with the methodology stated in the Specification;
- Witness and ensure testing is completed on the Trial Pad;
- Record the type and condition of the material used in the Trial Pad;
- Record details of the method of transportation, treatment and the placement of the material used for the Trial Pad;
- Record the type, dimensions, weight and operating speed of compaction plant, together with the specification sheet for the roller/s, used for the Trial Pad;
- Document the number of passes of the roller for the Trial Pad, or of each type of roller if more than one is used. The number of passes is defined as the number of times that each point on the surface of the layer being compacted is traversed by the compaction roller in its operating mode;
- Record the method of measuring the moisture content and density of each sample point in the Trial Pad;
- Take photographs of the Trial Pad (particularly the destructive testing);
- If the field Trial Pad is to be incorporated into the works, survey and test the subgrade in accordance with the Specification;

- Keep records of all field tests and samples, including failures with a diagram showing sample positions;
- Provide written certification to the Contractor that the surface on which the clay liner is to be placed is acceptable prior to installation. *Note the CQA Inspector may withdraw the certificate should the surface deteriorate for any cause prior to installation and only reissue upon remediation works being compliant with the Specification*;
- Record the subgrade acceptance on the Ground Assessment Sheet – Subgrade proforma;
- Ensure that the previous lift is suitable to accept the next lift of clay liner ensuring there is no deterioration prior to subsequent lift placement;
- Monitor the placement and compaction of the clay liner, ensuring that the works are carried out in accordance with the Specification, and that the characteristics of the material do not change and unsuitable material as defined in the Specification is precluded from the liner;
- Ensure that the engineered clay liner construction methodology is consistent with that of the successful field trial, including layer thickness and number of passes of compaction plant;
- Record observations of lift thickness and number of passes of the compaction plant as determined by the compaction trial;
- Record the type, condition and suitability of the material used;
- Record details of any pre-treatment of the ECL material;
- Ensure that joints between sections of placed engineered clay liner are constructed with a “stepped” connection between adjacent layers in order to maintain a competent bond;
- Ensure that *in situ* conformance testing and scheduling of laboratory soils testing is carried out in accordance with the Specification, and assess the results from testing to confirm that the requirements of the Specification have been met;
- Ensure that in-situ measurements and samples taken for laboratory testing are evenly distributed over the entire thickness and area of engineered clay liner;
- Produce a grid reference plan to locate testing and sampling;
- Record any failed test results and remedial action taken;

- Ensure that all areas of non-conformance are remediated in accordance with the Specification;
- Preclude placement of subsequent layers of compacted engineered clay liner until it has been verified that the tested layer has achieved all in-situ strength requirements;
- Take photographs during the construction; and
- Ensure that surveys are undertaken in accordance with the Specification to confirm that the requisite levels and layer thicknesses have been achieved.

All laboratory testing will be undertaken by UKAS Accredited Laboratories, with accreditation for all the required tests. The CQA Inspector shall fully document each item above and the documentation shall be presented in the CQA Validation Report.

6 SEPARATION GEOTEXTILE

6.1 CQA Requirements

The CQA Inspector shall:

- Assess the method statement submitted by the Contractor detailing their proposed deployment and seaming techniques:
- Ensure that the separation geotextile delivered to site conforms with the Specification;
- Ensure that the testing requirements for the separation geotextile product to be used within the works are in accordance with the testing requirements of the Specification;
- Ensure that the materials are delivered, handled and stored in accordance with the Specification and the manufacturer's recommendations;
- Make a visual inspection of each roll as it is unloaded to identify any damage and record the relevant information for each roll;
- Assess all separation geotextile manufacturers' quality control certificates to confirm that the geotextile meets the requirements of the Specification prior to installation;
- Assess and approve, with respect to the requirements set out in the Specification, the proposed panel layout for the separation geotextile to be submitted by the Contractor. The methodology shall show the Contractor's proposed start point and direction of working. The panels shall be arranged so that seams are aligned parallel to the line of maximum slope (i.e. normal to contours), wherever relevant and practicable, in accordance with accepted good practice. The panel layout shall seek to minimise the number of required heat bonded seams;
- Identify rolls from which conformance samples of the separation geotextile are to be taken for laboratory conformance testing in accordance with the Specification;
- Assess the results of conformance tests to ensure compliance with the Specification. Should any materials fail to meet the requirements of the Specification, the CQA Inspector shall reject the failed roll and schedule further testing in accordance with the Specification;
- Provide written certification to the Contractor that the surface on which the separation geotextile is to be installed is acceptable prior to installation. *Note the CQA Inspector may withdraw the certificate should the surface deteriorate for any cause prior to*

installation and only reissue upon remediation works being compliant with the Specification;

- Witness all panel deployment ensuring compliance with the Specification;
- Witness all seam constructions to ensure compliance with the Specification:
- Ensure that all defects are identified on the separation geotextile and witness that they are repaired in accordance with the Specification;
- Ensure that separation geotextile and seam construction continues to the back of the anchor trenches;
- Ensure that the separation geotextile is installed in accordance with the relevant construction details on the drawings at the locations leachate collection drains, the leachate collection point and the target pad; and
- Ensure that on completion of the separation geotextile installation the Contractor produces a fully referenced as-built panel layout plan including all the detail listed within the Specification.

All laboratory testing will be undertaken by UKAS Accredited Laboratories, with accreditation for all the required tests. The CQA Inspector shall fully document each item above and the documentation shall be presented in the CQA Validation Report.

7 LEACHATE COLLECTION AND REMOVAL SYSTEM

7.1 CQA Requirements

As part of the CQA procedures required for the installation of leachate collection and removal system, the CQA Inspector shall:

- Assess the method statement submitted by the Contractor for the installation of the leachate collection system;
- Ensure that the stone delivered to site is complaint with the Specification;
- Provide written certification to the Contractor that the surface of the separation geotextile is to is acceptable prior to installation of the leachate collection system. *Note the CQA Inspector may withdraw the certificate should the surface deteriorate for any cause prior to installation and only reissue upon remediation works being compliant with the Specification*;
- Ensure a sufficient thickness of drainage stone is maintained between the separation geotextile and the construction plant as referred to in the Specification;
- Provide continuous monitoring of the drainage stone placement to ensure that the lining system is not compromised by the construction plant and investigating any changes in the appearance of the drainage stone to identify any non-compliant material;
- Ensure that sampling and testing of the drainage stone is undertaken in accordance with the Specification;
- Assess the results of laboratory testing confirming that the leachate drainage stone meets the specified requirements;
- Ensure that the drainage stone is placed over the areas and to the minimum depths detailed in the drawings;
- Identify areas of the leachate drainage layer which do not meet the Specification to the Contractor, who will remediate them in accordance with the Specification;
- Assess pipework manufacturers' quality control data and calculations confirming that the proposed pipes and connections meet the Specification prior to installation;
- Ensure that the pipe materials are delivered, handled and stored in accordance with the manufacturers recommendations;

- Ensure that the pipework is installed at the locations indicated on the relevant drawings;
- Ensure that the pipework connections are constructed in accordance with the Specification and that end caps are fitted to all up gradient pipe runs;
- Physically verify that the leachate drainage stone placed over the pipework as haunching is placed to provide the minimum depth of cover, as detailed in the Specification, at 10m intervals along each pipe run;
- Witness the location and construction of the leachate collection / monitoring point, ensuring compliance with the Specification using the appropriate checklist. Particular attention should be paid to the placement of reinforcement and the appropriate use of a vibrating poker in removing air bubbles from all cast in-situ concrete;
- Ensure that the Contractor surveys the location and level of the leachate collection / monitoring point; and
- Assess the method statements submitted by the Contractor detailing their proposed deployment and seaming techniques (for the geotextile surrounding the pipework haunching):
- Witness all geotextile panel deployment ensuring compliance with the Specification;
- Witness all geotextile seam constructions to ensure compliance with the Specification; and
- Ensure that all defects are identified on the geotextile and witness that they are repaired in accordance with the Specification.

All laboratory testing will be undertaken by UKAS Accredited Laboratories, with accreditation for all the required tests. The CQA Inspector shall fully document each item above and the documentation shall be presented in the CQA Validation Report.

8 CQA VALIDATION REPORT

Upon completion of the lining works and/or capping works the CQA Inspector will prepare a Validation Report summarising the works undertaken and including all CQA documentation prepared. As a minimum this shall include:

- Description of the works;
- Completed Summary Sheets detailing the installation of each element of the works;
- Contractor's and Manufacturers' Documentation;
- Test (Laboratory & Field) Reports, failing results / tests will also be presented (e.g. failing trail welds or air pressure tests) and correlated to the subsequent remedial works and / or re-testing;
- Details of all materials and equipment used;
- As Built Drawings: Topographic and Panel Layout and all engineering layers as per the Specification, to include:
    - Title of Project, contract, element of works;
    - Drawing version number, with details of revision history;
    - Scale (Scale at size to be printed, eg 1:500 at A1);
    - Details of the Survey Grid (eg. OSGB36, or local grid);
    - North arrow;
    - All references to final levels in metres above ordnance datum;
    - Grid intersections; and
    - Distinguish between surveys done at different times and dates.
- Sample Locations / Penetrations;
- Photographic Record of the Construction;
- Daily Diaries; and
- Description of Non-conformances and the Subsequent Remediation.

Pro-Forma sheets for on-site completion by the CQA Inspector are included in Appendix 1.

The above report will confirm that the works have been carried out in accordance with the Specification as incorporated in this Construction Quality Assurance Plan. The report will be certified by the CQA Engineer.

APPENDIX 1

CQA PROFORMAS

Daily Site Record Sheet

Date:		Site:	
Weather:		CQA Plan Ref:	

Visitors to Site:	

List of Plant	Hours of Operation	Comments

Prepared by:		Signed:	

Sirius Environmental

Ground Assessment & HSV Record Sheet

Site:		CQA Engineer:	Sheet:
CQA Plan Ref:		Jordan Peters	1 of

Date	Location /Grid Ref:	Layer Under Consideration Formation, Drainage Layer, Protection Soils, Regulating Layer, Restoration Soils	Thickness (mm) (if applicable)	Shear Strength (kPa) (if applicable)	Pass/Fail

Surface Acceptance Certificate

Site:		**Sheet No:**	
CQA Engineer:		**CQA Plan Ref:**	

Area of Subgrade under consideration:	

I the undersigned, a duly appointed representative of Sirius Environmental Limited, have visually observed the subgrade described above and confirm the subgrade is an acceptable surface upon which to install

This certification is based on observation of the surface of the subgrade only. No subterranean inspections or tests have been performed by Sirius Environmental Limited, and Sirius Environmental Limited makes no representations or warranties regarding the conditions which may exist below the surface of the subgrade.

Sirius Environmental Representative:	
Name:	Signature:
Date:	Position:

Site and Project:	Buckden L/F - 2021 Capping Works	
Sample No.:	Trial Pad - L1 - 6 Passes	
Date:		**FTC-1012**
		Site Determination of Compaction

(1) Determination of Water Content				
Mass of damp soil + tray (m_1)Mass of damp soil + tray (m_1)	=		611	g
Mass of dried soil + tray (m_2)Mass of dried soil + tray (m_2)	=		501	g
Mass of empty tray (m_3)Mass of empty tray (m_3)	=		15	g
Mass of damp soil (m_4)Mass of damp soil (m_4)	=	$m_1 - m_{3m1} - m_3$		g
Mass of dried soil (m_5)Mass of dried soil (m_5)	=	$m_2 - m_{3m2} - m_3$		g
Mass of moisture (m_6)Mass of moisture (m_6)	=	$m_4 - m_{5m4} - m_5$		g
Water Content (w)	=	$\frac{m_{6m6}}{m_{5m5}}$		
(2) Determination of Dry Density				
Mass of core plus soil (M_1)Mass of core plus soil (M_1)	=		2781	g
Mass of empty core (M_2)Mass of empty core (M_2)	=		933	g
Mass of soil (M)	=	$M_1 - M_{2M1} - M_2$		g
Height of core (h)	=		115	mm
Internal diameter of core (d)	=		102	mm
Internal volume of core (V)	=	$\frac{\prod x\ d^2 x\ h \prod x\ d^2 x\ h}{4}$		mm^{3mm3}
Bulk density (ρ) (see Note 4)	=	$\frac{M\ x\ 1000}{V}$		$Mg\ m^3$
Water Content (w)	=			
Dry density (ρ_d) (see Note 4)	=	$\frac{\rho}{(1+w)}$		$Mg\ m^3$
Average Particle Density (laboratory determination, G_s) =			2.73	$Mg\ m^3$
Void Ratio (e)	=	$\frac{G_s * 1}{\rho_d} - 1$		
Air Voids (Av)	=	$\frac{e - (wG_s)}{1 + e}$		

Notes:

(1) Before weighing, ensure balance is zeroed and plate is free from debris;

(2) Ensure steel core is trimmed flush, and any small depressions in soil surface are filled, prior to weighing and knocking out into tray;

(3) BS 1377 Test method requires 24 hours at 105^0C to ensure complete drying of samples; site determinations will yield conservative results after 12-16 hrs, although the longer the time, the more accurate the determination. Cohesive samples must be diced and spread out across tray before drying; granular samples similarly should be spread.

(4) Bulk and dry density should be expressed to three places of decimals. All formulae are adjusted for different measurement units, no further conversion factors are required.

Revision Index

i	Text amended	19/01/2023	I York

Materials Received

Site:		**Sheet No:**	
CQA Engineer:		**CQA Plan Ref:**	

Delivery Date	Material Description & Number of Units	Dimensions (mm/m) L x W x D Weight (Kg)	MQC Data, (If Required) & Date:	Visual Inspection

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Conformance Sampling & Laboratory Schedule of Testing

Site:		**CQA Plan Ref:**		**Anticipated Area m²**		**Actual Area m²**	
CQA Engineer:		**Enter Material to be Tested**		**Anticipated No of Tests:**		**Actual No of Tests:**	

Date Sample Taken:	Date Sent to Laboratory:	Sample Reference:	Material Sampled	Panel No. / Location	Resin Batch Number & Full Roll Number	Thickness (min. ave) D5994	Asperity GM 12																								

Geocomposite Drainage Layer Deployment Records

Site:		**Project:**	
CQA Engineer:		**CQA Plan Ref:**	

Date	Batch No.	Roll No.	Panel No.	Heat Bonded *	Actual Overlap (mm)	Length (m)	Width (m)	Accumulated Area (m^2)	Visual Inspection

Geocomposite Drainage Layer Patch Repair Records

Site:		**Sheet No:**	
CQA Engineer:		**CQA Plan Ref:**	

Date	Patch/ Repair No.	Panel No(s).	Location	Length (m)	Width (m)	Actual Overlap (mm)	Heat Bonded (if applicable)	Reason for Patch/Repair *(e.g. defect, accidental damage, etc)*
			See Panel Layout/Sample					

Geotextile Deployment Records

Site:		**Project:**	
CQA Engineer:		**CQA Plan Ref:**	

Date	Batch No.	Roll No.	Panel No.	Heat Bonded Yes/No	Actual Overlap (mm)	Length (m)	Width (m)	Accumulated Area (m^2)	Visual Inspection

Geotextile Patch Repair Records

Site:		**Sheet No:**	
CQA Engineer:		**CQA Plan Ref:**	

Date	Patch/ Repair No.	Panel No(s).	Location	Length (m)	Width (m)	Actual Overlap (mm)	Heat Bonded (if applicable)	Reason for Patch/Repair *(e.g. defect, accidental damage, etc)*
			See Panel Layout/Sample & Repair Loacation Sheet					

Sketch Drawing - Panel Layout/Patch Repair/Sample Location

Date:		Site:	
Sheet No:	of	CQA Engineer:	

Sirius Environmental

LEACHATE COLLECTION, MONITORING POINT & TARGET PAD CHECKLIST

Leachate Collection/ Monitoring Point Referred to:

	ACTION	CHECKED
1	Mineral liner locally thickened?	
2	Designated area marked out by surveyor?	
3	2500 x 2500 x 300mm excavated and mineral liner suitably finished?	
4	Concrete on site C40 Sulphate Resisting?	
5	A393 fabric reinforcement placed near base of pour?	
6	A393 fabric reinforcement placed near top of pour?	
7	Vibrating poker used?	
8	Double layer of geotextile deployed beneath slab?	
9	2mm HDPE geomembrane placed beneath slab?	
10	Exact location of concrete slab sprayed on overlying geotextile?	
11	900mm plain pre-cast sulphate resisting concrete man-hole placed and drilled?	
12	Annulus between 900mm ring and 450mm HDPE pipe filled C40 concrete?	
12	Outer 1800mm plain pre-cast sulphate resisting concrete man-hole drilled?	
14	Correctly drilled: 6 top, 6 bottom, evenly spread around man-hole and pipes placed?	
15	Annulus filled with leachate drainage stone?	
16	Shutters in place for 2030 x 250mm thick concrete slab?	
17	Concrete for slab sulphate resisting?	
18	A393 fabric reinforcement placed near base of upper pour?	
19	A393 fabric reinforcement placed near top of upper pour?	
20	Push fit collar in place?	
21	450mm diameter plain HDPE twinwall pipe in place?	
22	End cap fitted?	
23	2 No. 900mm diameter pre-cast sulphate resisting concrete man-holes in place?	
24	A142 fabric reinforcement in place centrally within infill?	
25	Leachate drainage blanket built up to 2000mm above cell base around collection/ monitoring point?	

Target Pad Referred to:

A	Designated area marked out by surveyor ?	
B	Double layer of geotextile deployed beneath slab?	
C	Shutters in place and dimensions checked 5mx5mx0.3m?	
D	Concrete on site C40 ?	
E	Vibrating poker used?	
F	Leachate draiange blanket built up to 300mm above target pad?	
G	Geotextile deployed above haunch?	

	Site:	Date:
	Prepared by:	Job Number:

Pipework Joint Records and Pipework Layout Record Sketch

Date:		**Site:**	
Sheet No:	of	**CQA Engineer:**	

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