Caulmert Limited

Engineering, Environmental & Planning
Consultancy Services

Whisby IBA Processing Facility

Lincwaste Limited

Bespoke Environmental Permit Application

Operating Techniques & BAT Review Report

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Operating Techniques & BAT Review Report

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1.0 INTRODUCTION

1.1 Application 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 four cells (Cells 1-4) within the boundary of the permitted installation.

1.1.2 It is proposed to accept up to 70,000 tonnes per year of IBA wastes for processing at Whisby Landfill. 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'.

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) for export off-site and disposing of the remaining IBA residues by landfilling at Whisby.

1.2 Document Structure

1.2.1 This report comprises an integrated approach of the Activities & Operational Techniques in application form Part B3, a process description and also an assessment of compliance with Best Available Techniques (BAT). Activities are required to conform to BAT to show that operations at the site demonstrate that no significant pollution will be caused from the activity as a whole.

1.2.2 The Part B3 form requests information about the activities the application relates to and the operating techniques that will apply to them, which includes:

a) Types of activities;
b) Types of waste to be accepted;
c) Point source emissions (to air, water, sewers, land etc.);
d) Operating Techniques including technical standards;
e) General requirements in relation to managing emissions (dust, odour, noise or vibration etc.);
f) Types and amounts of raw materials; and,
g) Monitoring of point source emissions.

1.3 Site Location and Surrounding Land Use

1.3.1 Whisby Landfill Site is located approximately 8km to the southwest of Lincoln and 3km west of North Hykeham, accessed by Thorpe Road, in Whisby. The area of the proposed IBA Processing Facility (hereafter referred to as 'the Site') is within north-western portion of the Whisby Landfill Site permitted area, centred on National Grid Reference SK 89647 66699.

1.3.2 The landfill is already 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 waste code 10 01 15 (bottom ash, slag and boiler dust from co-incineration other than those mentioned in 10 01 14) is already listed within the permitted wastes for the landfill, which covers IBA.

1.3.3 The area proposed for the IBA treatment and storage pad within IBA Cell 1 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.

1.3.4 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.

1.3.5 Tarmac Whisby Sand and Gravel Quarry is located 25m to the north of the Site and 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.

1.3.6 An indicative site location plan of Whisby Landfill Site is shown below in Figure 1.

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

1.4 Site Plans

1.4.1 The following site plans have been included within the application:

Table 1 – List of Drawings within Application

Drawing ref.	Title	Drawing Location
WR7885 SRA 01	IBA Cell 1 Construction – Section Locations	Stability Risk Assessment ref. WR7885/SRA by Sirius (see Appendix 3 of Operating Techniques & BAT Review report ref. 5671-CAU-XX-XX-RP-V-0301)
WR7885_01_01	General Arrangement	Cell 1 Engineering Specification Report ref. WR7885_1 Rev1 by Sirius (see Appendix 4 of Operating Techniques & BAT Review report ref. 5671-CAU-XX-XX-RP-V-0301)
WR7885_01_02	Formation and Top of Liner Layout	
WR7885_01_03	Cell 1 Construction Details	
WR7885_01_04	Proposed Leachate Drainage Layout	
WR7885_01_05	Proposed Leachate Drainage Layout Optional Well Detail	
WR7885_01_06	Proposed Water Management	
722A167A	IBA Processing Pad – General Layout	Operating Techniques & BAT Review report ref. 5671-CAU-XX-XX-RP-V-0301
WR7855/1/001 Rev 3	Proposed IBA Pad & Cells Development	
5671-CAU-XX-XX-DR-V-1800	Sensitive Receptors Plan	Environmental Risk Assessment report ref. 5671-CAU-XX-XX-RP-V-0302
722M132	Environmental Monitoring Plan	Environmental Setting & Installation Design report ref. 5671-CAU-XX-XX-RP-V-0303
722A165	Annual Site Plan 2023	

1.5 Best Available Techniques

1.5.1 The proposed IBA waste processing activities will be a listed activity part of the permitted landfill installation which falls under the requirements of the Industrial Emissions Directive (IED) 2010/75/EU for waste treatment. The Best Available Techniques (BAT) within the IED document 'Best Available Techniques Reference Document for Waste Treatment' (2018) have been applied where applicable to the proposed operation of the IBA Processing Facility and associated infrastructure at Whisby Landfill Site. The following chapters are included within the waste treatment BAT document:

Chapter 1: General information on the waste treatment sector;
Chapter 2: Processes and techniques commonly used for waste treatment;
Chapter 3: Mechanical waste treatment;
Chapter 4: Biological waste treatment;
Chapter 5: Physico-chemical waste treatment.

1.5.2 The BAT Conclusions which apply to the proposed IBA treatment and disposal activities at the site is covered by Chapters 1, 2 and 5 of the IED for waste treatment. The BAT conclusions for the site are reviewed in Section 3 of this report.

2.0 PROCESS DESCRIPTION

2.1 Overview

2.1.1 IBA is the fraction left-over after waste is burnt in an incinerator, and if derived from municipal waste, can contain glass, brick, rubble, sand, grit, metal, stone, concrete, ceramics and fused clinker as well as combusted products such as ash and slag.

2.1.2 The source of the IBA to be treated at Whisby Landfill Site is from FCC-owned and permitted Energy from Waste (EfW) sites: FCC Eastcroft EfW and FCC Lincoln EfW.

2.1.3 The proposed IBA Processing Facility at Whisby will consist of mechanical processing plant and waste storage areas within the footprint of a fully engineered non-hazardous landfill cell for the IBA named 'IBA Cell 1' within this application (see Stability Risk Assessment in Appendix 3). Subsequent IBA Cells 2, 3 and 4 will be constructed after IBA Cell 1 has started being filled and these will be constructed and filled in a phased approach, as per drawing ref. WR7855/1/001 Rev 3. This area, where IBA Cells 1-4 are to be built, is within the existing permitted boundary of Whisby Landfill Site.

2.1.4 The purpose of the IBA processing will be to allow for the removal of ferrous and non-ferrous metals and IBA Aggregate (IBAA) for export off-site, prior to disposing of the remaining IBA residues within the landfill. The activity will require the temporary storage of unprocessed IBA and processed IBA waste (IBAA and IBA residues) in windrows/stockpiles and also the storage of the separated metal fractions. The IBA residues will be disposed of by mono-filling into the specially designed landfill cells at the site, whilst the recovered metals will be sent for recycling off-site. The IBA Aggregate (IBAA) will be exported off-site for re-use elsewhere.

2.2 IBA Storage & Processing Area

2.2.1 The processing plant will be stood on a hardstanding area (pad) within the base of the engineered landfill IBA Cell 1.This surface will allow for the movement of plant and machinery and storage of waste materials, including unprocessed IBA in windrows for maturation prior to processing. The layout of the IBA processing and storage area is shown on drawing ref. 722A167A.

2.2.2 The working surface will need to be sufficiently robust to prevent vehicular and plant damage during wet conditions. Therefore, a running surface of hard core imported from off-site (prior to operations commencing) is proposed to be installed at a minimum of 500mm thick. Once operations commence, IBAA produced from the processing activity can be used to improve, maintain and fill in potholes of the running surface. The total area of Cell 1 will be approximately 25,000m^2 in size, of which approximately half of this will be used for the pad. The treatment pad and storage area will be installed with a mobile dust suppression system around the perimeter, as per Appendix 1, or similar. The perimeter dust suppression system is shown on drawing ref. 722A167A.

2.2.3 It is proposed to begin operations by filling half of IBA Cell 1 to the top of the cell (minus 2m) with IBA wastes before moving onto filling the next engineered cells. There will be three additional IBA cells constructed in the same manner and filled in phases, as shown on drawing ref. WR7558/01/001 Rev 3. The engineered clay liner of the landfill cell(s) where the IBA will be deposited is designed to standard non-hazardous waste specifications and therefore will prevent potential leachable constituents from the stored and subsequently landfilled IBA from escaping to groundwater or surface water. Spine drains and a leachate collection sump are to be installed above the engineered clay liner and geotextile layer within IBA Cell 1.

2.3 Waste Acceptance

2.3.1 Strict waste acceptance procedures at the site will be adhered to, as per current procedures followed for wastes accepted into the landfill, ensuring only the permitted waste codes (as listed in Table 2 below) are to be accepted and treated at the site.

2.3.2 The IBA will be sampled at the source site before being transported to Whisby for storage pending analytical results. The IBA subsequently classified as non-hazardous waste will be kept on site for maturation and treatment. If any IBA is classified as hazardous waste, the IBA will be removed from Whisby Landfill Site and sent to an appropriately permitted site.

2.3.3 The IBA wastes will be delivered to site via the site entrance on the northern permit boundary of the site. The main access road off Eagle Road is shared with the existing Tarmac Sand and Gravel Quarry to the north of the landfill.

2.3.4 When the IBA waste arrives at the facility, incoming waste loads will be checked by trained site staff at the weighbridge by visual inspection. All wastes will be checked and verified against waste transfer documentation prior to the waste being offloaded onto the site. These checks will ensure waste descriptions and waste codes match the waste load being delivered.

2.3.5 If, upon tipping onto site, the waste load is discovered to be contaminated by other non-permitted wastes or found to be any way non-conforming to the permitted waste types listed in the permit (e.g. excessively wet, dusty or contaminated), the waste load will be reloaded and sent off-site. Where immediate removal from site is not possible, the waste load will be moved into the quarantine area until it can be removed from site as soon as practicable. No non-conforming wastes will be accepted into the IBA processing area.

2.3.6 Prior to the maturation stage, the IBA will be delivered and deposited on the pad in stockpiles. Stockpiles will be segregated and stored pending the results of chemical characterisation. The stockpiles will not be placed within close proximity to the perimeter bund of the containment pad or any surface water/drainage ditch.

2.3.7 Once the IBA is confirmed to be non-hazardous, the waste will be formed into windrows for a 2-3 week maturation period by mechanical front-loading shovel. Bulk items such as large lumps of stone or other aggregate will be removed from deposited waste loads and stored in a designated area. It is proposed up to 140,000 tonnes of IBA will be stored on the site at any one time.

2.3.8 The Operator will ensure that the facility has the necessary capacity to receive the waste for all storage areas (reception awaiting test results, maturation windrows, stockpiles of treated IBAA and metals post-processing) and treatment processes. Wastes are not received if capacity at the site is not available for storage or processing.

2.4 IBA Maturation

2.4.1 Once the analytical results are returned, if the IBA is confirmed as non-hazardous waste then the IBA will undergo maturation in windrows on the constructed storage containment pad for approximately 2-3 weeks in the open air (atmospheric carbon dioxide and rainwater being required). The maturation process should result in a reduction of pH and will stabilise any heavy metal leachability of the IBA prior to treatment.

2.5 Waste Rejection/Quarantine

2.5.1 Any non-conforming wastes will be rejected from the site or, where waste cannot be removed immediately, stored in a quarantine area temporarily, awaiting removal from site to a suitably permitted facility for treatment or disposal.

2.5.2 If any IBA is classified as hazardous waste once laboratory analytical results are returned, the IBA will be removed from Whisby Landfill Site and sent to an appropriately permitted site.

2.6 IBA Processing Plant

2.6.1 The IBA will be treated at Whisby by mechanical screening of the IBA to remove ferrous and non-ferrous metals, and also produce an IBA Aggregate (IBAA). Residual IBA wastes (finer material) will be landfilled in the engineered cells, IBA Cells 1-4. The site will also utilise dumper trucks and a front-loading shovel to move IBA wastes around site and feed IBA wastes into the processing plant. The processing plant will consist of:

<u>2 No. mobile sieves (on tracks) with hybrid engine (diesel/electric)</u>

- Machine No.1 screening fraction sizes 1-20mm, 20-55mm and >55mm
- Machine No.2 screening fraction sizes 0-4mm and 4-20mm

<u>3 No. hook-lift mobile metal separation machines with vibrating feeder</u>

- Eddy current separator Coarse (20-55mm)
- Eddy current separator Fines (0-4mm and 4-20mm)

<u>Hand sorting station (skid-based)</u>

- 10ft hand sorting container, with conveyors and overbelt magnet (electric)

2.6.2 A flow diagram showing the processing plant is shown below in Figure 2 (may be subject to change depending on requirements once operational):

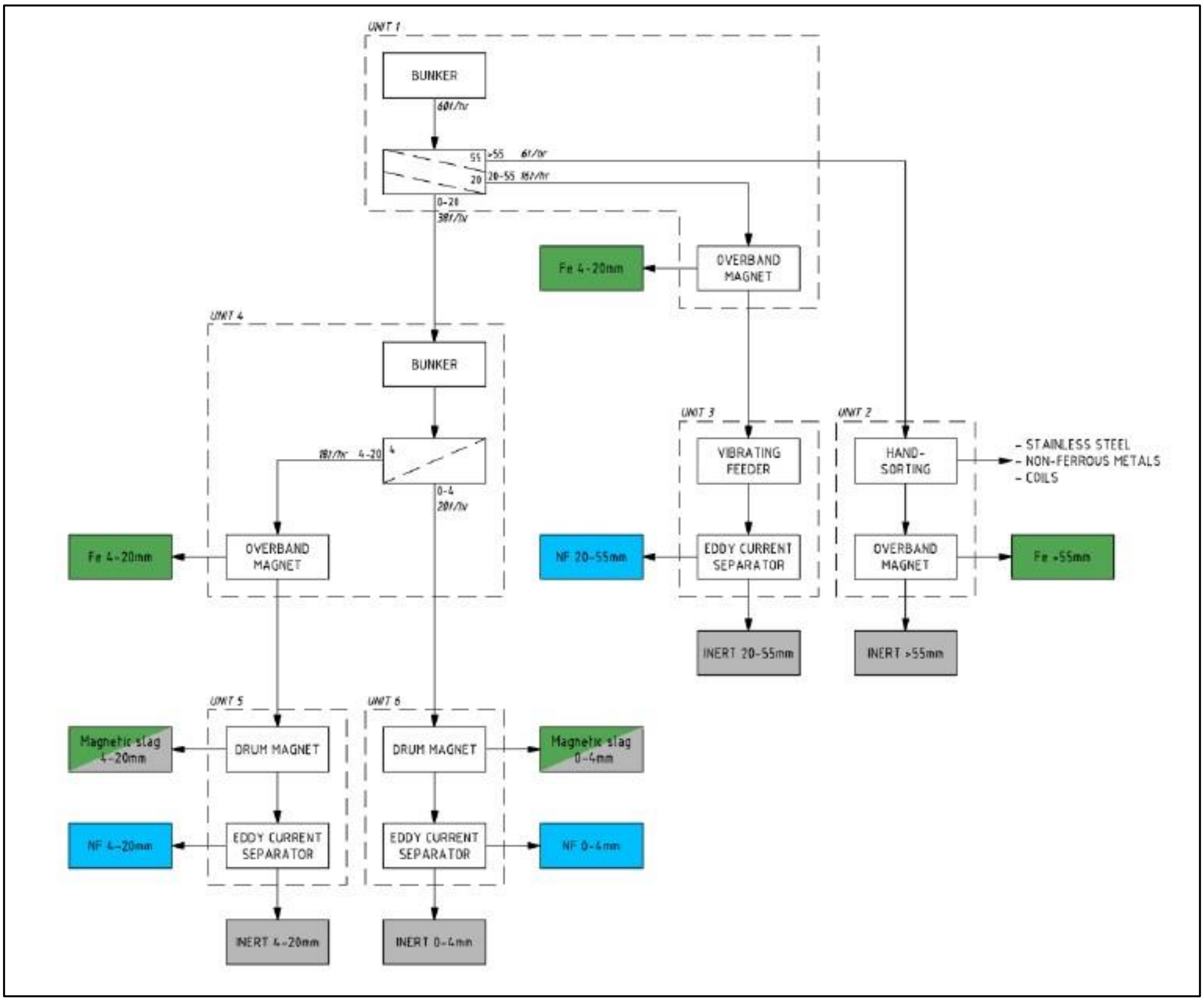

Figure 2 – Schematic Mobile IBA Processing Plant (extract from Appendix 2)

2.6.3 Further details on the processing plant, including specifications are provided in Appendix 2.

2.6.4 In addition, the following plant will be used on site:

- Front-loading shovels
- Dumper trucks

2.6.5 There are no fixed plant proposed as part of the IBA Processing Facility.

2.6.6 The approximate processing plant layout will consist of the below in Figure 3:

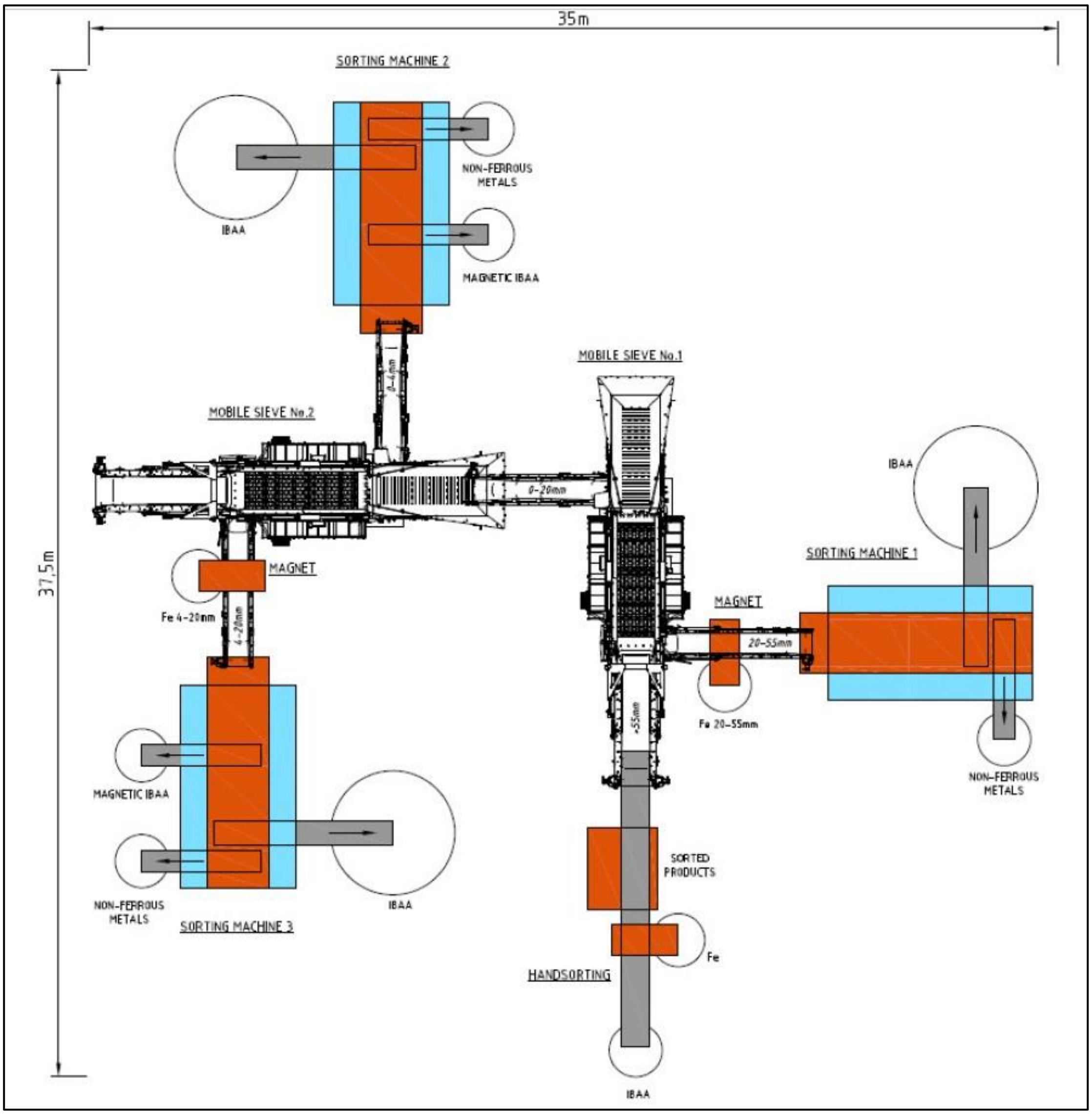

Figure 3 – Approximate Layout of Processing Plant (extract from Appendix 2)

2.6.7 The ferrous and non-ferrous metals will be separated out and stored temporarily in stockpiles pending removal from site for recycling. There is a market for metals recovered from IBA waste, so the Operator intends to screen the IBA to remove these for export for further recycling/sale. This is in line with the Waste Hierarchy and the promotion of recycling and diversion of waste from landfill.

2.6.8 In addition, of the IBA wastes coming into site, approximately 20,000 tonnes per annum of IBA Aggregate (IBAA) will be separated out by the processing plant and exported off-site.

2.7 IBA Disposal/Landfilling

2.7.1 It is proposed to undertake the construction of four landfill cells (IBA Cells 1-4) for the disposal of IBA up to agreed levels. This will be done in phases, beginning in IBA Cell 1, which will be half-filled before moving onto the next cell. The IBA processing plant will remain on the pad within IBA Cell 1 for the majority of the filling of the four cells. The phasing plan is shown in attached drawing ref. WR7855/01/001 Rev 3 'Proposed IBA Pad & Cells Development'.

2.7.2 The engineered clay liner of the landfill cell(s) where the IBA will be deposited is designed to standard non-hazardous waste specifications. The engineered clay liner of the landfill cell IBA Cell 1 will be protected by the installation of a geotextile layer above. The landfill is designed on the basis of hydraulic containment. Spine drains will be installed with a 300mm drainage cover along the top. A 0.5m thick protective layer of suitable materials will be placed above this to protect the clay liner and drains/drainage blanket from damage from overlying IBA wastes. IBA Cell 1 will also have a leachate collection sump installed, which the spine drains will feed into and this will be lined with clay and a plastic liner. A target pad will also be installed at the base of Cell 1 with 300mm drainage gravel above, should the need arise to re-drill another leachate sump in the future (this is standard landfill design). Leachate collected by the sump will be pumped out and tankered to either FCC-owned Knostrop or Ecclesfield sites for treatment prior to discharge to sewer.

2.8 Site Layout & Waste Storage

2.8.1 The site layout of the processing pad in IBA Cell 1, including locations of mobile plant and the temporary storage locations of waste materials, are shown on the General Layout Plan (ref. 722A167A) and are split into:

- Pre-processing IBA stockpiles
- Post-processing IBAA stockpiles – aggregate extracted from incoming IBA.
- Post-processing metals stockpiles – separated out ferrous and non-ferrous metals awaiting removal from site for recycling.
- Plant site area – location of mobile processing plant.

2.8.2 Stockpiles of unprocessed and processed wastes will not be mixed during storage.

2.9 Operational Hours

2.9.1 The IBA Processing Facility will only operate during the same operational hours as the Whisby Landfill Site:

7am – 6pm Monday to Friday
7am – 12pm Saturdays
Closed Sundays and Bank Holidays

2.9.2 Deliveries of IBA and collections of metals for recycling off-site and IBAA collections will also be undertaken during normal operational hours, using the existing landfill site entrance and haul roads off Eagle Road to the north of the site.

2.9.3 The site will be inspected daily when operational and subject to regular cleaning and maintenance, with remedial actions required to be fully documented in the site diary, which is to be kept at all times in the Site Offices.

2.10 Odour

2.10.1 The processing of IBA is unlikely to generate significant odours, as IBA does not contain biodegradable or putrescible materials and so is not considered to be malodourous or offensive. The IBA may have a distinctly earthy odour, but it is not considered that this has the potential to cause odour issues beyond the site boundary during normal operating conditions. The stockpiling of IBA for long periods has the potential to give rise to odour due to sulphates within the IBA being reduced to sulphides including hydrogen sulphide if the unprocessed stockpiles become anaerobic and malodour generation is possible from the surface. This can be prevented if stockpiles are kept to a minimum and not stored for long periods.

2.10.2 Odour is considered in more detail in the Environmental Risk Assessment (ERA) report ref. 5671-CAU-XX-XX-RP-V-0302, included within this permit variation application. It was advised in pre-application discussions that an odour management would be required, and this is provided as report ref. 5671-CAU-XX-XX-RP-V-0304.

2.11 Dust

2.11.1 Dust emissions to air could arise during the processing of IBA wastes which includes sending the wastes through the processing plant, but also during the movement of stockpiled materials, deposition of treated IBA into the landfill, dust from the site surfaces, movement of vehicles across site or windblown action across stockpiles.

2.11.2 As shown on drawing ref. 722A167A, the entire IBA storage and processing area will be installed with a perimeter mobile dust suppression system (brown dashed line on drawing). This will be a Pacific 250 system (see Appendix 1) or similar and will be a high-pressure system that pumps water (and additives if required) through nozzles that create a fine atomised mist across the site. This system will ensure dust is actively controlled during operations and will minimise water consumption and leachate generation in IBA Cell 1.

2.11.3 Dust is considered in more detail in the Environmental Risk Assessment (ERA) report ref. 5671-CAU-XX-XX-RP-V-0302, included within this permit variation application. Dust management and control measures for site activities are further set out in the Dust & Emissions Management Plan (DEMP) for the site, report ref. 5671-CAU-XX-XX-RP-V-0305.

2.12 Noise

2.12.1 Noise and vibrations are likely to be generated by the mobile plant proposed to be used on site. As such noise and vibrations have been considered in the Environmental Risk Assessment (ERA) document ref. 5671-CAU-XX-XX-RP-V-0302.

2.12.2 A Noise Impact Assessment was undertaken by Bureau Veritas UK Ltd. (ref. UK.17811589/00) as part of the planning application for the site (see Appendix 5) and the assessment concluded that the noise impact of the site operation would be below the Lowest Observed Adverse Effect Level at the nearest residential receptors, and that operational traffic generated by the development would have a negligible noise impact on off-site receptors.

2.12.3 A planned preventative maintenance (PPM) programme will be in place for all parts of the mobile plant and will include routine maintenance and servicing of parts that could give rise to increases in noise. Noise and vibration emissions will be checked as part of routine daily site inspections and throughout the day by site staff.

2.13 Management System

2.13.1 An Environmental Management System (EMS) is a formal system to demonstrate compliance with environmental objectives. It is a technique which complies with BAT allowing operators to address environmental issues in a systematic and demonstrable way and are most effective when they form an inherent part of the overall management and operation of a site.

2.13.2 FCC Environment (UK) Limited (of which Lincwaste Limited is a wholly owned subsidiary) has implemented an accredited ISO14001 Environmental Management System (EMS) across the whole company and its subsidiaries to control the operations at their sites. Whisby Landfill Site and associated activities on site are managed by the Operator in accordance with the management system which meets the standards set out in the Environment Agency Guidance 'Develop a management system: environmental permits' (Published February 2016)[1]. The management of the operations will continue to be in line with ISO14001:2015 standard for environmental management. A summary of the EMS and certificates is included within document ref. 5671-CAU-XX-XX-RP-V-0307 in Appendix 2 of the Supporting Document of this application.

2.13.3 Incorporated into the EMS for the site will be the following documents as part of this permit application:

- Environmental Risk Assessment ref. 5671-CAU-XX-XX-RP-V-0302
- Odour Management Plan ref. 5671-CAU-XX-XX-RP-V-0304
- Dust & Emissions Management Plan ref. 5448-CAU-XX-XX-RP-V-0305

2.14 Accidents & Incidents

2.14.1 An emergency action plan will form part of the plant operational procedures, ensuring that all foreseeable accidents are mitigated against, and action plans prepared which should be followed by site staff in the event of an accident occurring. The emergency plan will identify

[1] Environment Agency Guidance, 'develop a management system: environmental permits' https://www.gov.uk/guidance/develop-a-management-system-environmental-permits

the hazards and assess the risks of each scenario and set out control measures to reduce the risk of a potential accident occurring on site.

2.14.2 The emergency action plan will cover the following aspects:

- Transfer of substances (e.g. moving waste materials across site);
- Over-loading stockpiles;
- Emissions from plant or equipment (e.g. leakages from joints, over pressurisation of hydraulics);
- Failure of containment (e.g. physical failure of drainage sumps or engineered liner);
- Spillages and leaks of hazardous substances (e.g. spills of fuels and oils)
- Failure of mains services (e.g. power, mains water);
- Fire;
- Operator error; and,
- Vandalism.

2.14.3 Following an assessment of the risk of the hazards identified the emergency actions plan will identify the techniques and control measures in place necessary to reduce the risks:

- There will be an up-to-date inventory of substances, present or likely to be present, which could have environmental consequences if they escape. This will include apparently innocuous substances that can be environmentally damaging if they escape. The permit will require the regulator to be notified of any significant changes to the inventory.

- Storage arrangements for raw materials, products and wastes will be designed and operated to minimise risks to the environment.

- Automatic process controls will be backed-up by manual supervision, both to minimise the frequency of emergency situations and to maintain control during emergency situations. Instrumentation will include, where appropriate, alarms and emergency stop switches.

- Physical protection in place where appropriate (e.g. barriers to prevent damage to equipment from the movement of vehicles).

- Appropriate secondary containment providing 110% capacity of the stored potentially polluting liquids (e.g. bunds, catchpits, containment).

- Security systems to prevent unauthorised access should be provided where appropriate.

- Formal systems for the logging and recording of all incidents, near-misses, abnormal events, changes to procedures and significant findings of maintenance inspections.

- Procedures for responding to and learning from incidents, near-misses, etc.
- The roles and responsibilities of personnel involved in incident management formally specified.
- Clear guidance available on how each accident scenario might best be managed (e.g. containment or dispersion, to extinguish fires or to let them burn).
- Procedures in place to avoid incidents occurring as a result of poor communications between staff at shift change or during maintenance or other engineering work.
- Safe shutdown procedures in place.
- Communication channels with emergency services and other relevant authorities established, and available for use in the event of an incident. Procedures will include the assessment of harm following an incident and the steps needed to redress this.
- Appropriate control techniques in place to limit the consequences of an accident, such as isolation of drains, provision of oil spillage equipment, alerting of relevant authorities and evacuation procedures.
- Personnel training requirements will be identified, and training provided.
- Spill contingency procedures will be in place to minimise accidental release of raw materials, products and waste materials and then to prevent their entry into water.
- Any potentially contaminated site drainage waters, emergency firewater, chemically contaminated waters and spillages of chemicals will be contained.
- Consideration will be given to the possibility of containment or abatement of accidental emissions. Where this may be inadvisable on safety grounds, attention should be focused on reducing the probability of the emission.

3.0 ACTIVITIES & OPERATING TECHNIQUES – PART B3 FORM

3.1 Q1a What activities are you applying for?

3.1.1 The permit variation application is to add a proposed IBA Processing Facility to permit ref. EPR/BW2978ID, within the permitted installation boundary of Whisby Landfill Site, located in Whisby, approximately 8km southwest of Lincoln.

3.1.2 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'. This activity will involve processing Incinerator Bottom Ash (IBA) wastes at the site to remove ferrous and non-ferrous metals for recycling, and IBA Aggregate for export off-site, prior to disposing of the IBA residues by mono-filling into IBA Cell 1 (and later in subsequent IBA Cells 2, 3 and 4) at Whisby. The facility will accept and treat up to 70,000 tonnes per year of IBA waste, with no more than 140,000 tonnes of waste stored at any one time.

3.2 Q1b Types of Waste

3.2.1 The non-hazardous waste types to be accepted at the site for the proposed treatment activity at the IBA Processing Facility will be as follows in Table 2:

Table 2 – Types of waste proposed to be treated at the IBA Processing Facility

Waste code:	Description:
10	**WASTES FROM THERMAL PROCESSES**
10 01	**Wastes from thermal processes**
10 01 15	bottom ash, slag and boiler dust from co-incineration other than those mentioned in 10 01 14

3.2.2 There will be no changes to the permitted waste types accepted for landfilling. The relevant waste codes for disposal of IBA residues, soils and cover layers into the landfill are already included within the waste list in Table S2.1 of the Permit.

3.3 Q2 Emissions to Air, Water and Land

<u>Point source emissions to air</u>

3.3.1 There will be no point source emissions to air as part of the activities at the site.

<u>Point source emissions to water (other than sewers)</u>

3.3.2 There will be no point source emissions to water as part of the activities at the site. Site surface water run-off and leachate within IBA Cell 1 will be collected by a sump and pumped out and tankered to either FCC-owned Knostrop or Ecclesfield sites for treatment.

3.3.3 There are existing surface water emission points relating to the landfill activity, however no direct discharge to surface water will occur as part of this IBA processing or landfilling activity.

The landfill cells for the IBA will be hydraulically contained with fully engineered lining and drainage system and no discharges to surface water are proposed.

Point source emissions to sewers, effluent treatment plants or other transfer off-site

3.3.4 There will be no point source emissions to sewers or effluent treatment plants from the site as a result of the proposed operations. The only discharge to sewer will be domestic foul waters from the site offices, toilets and canteen, as per the existing landfill infrastructure, which is external to the proposed IBA Processing Facility area.

3.3.5 Site surface water run-off and leachate within IBA Cell 1 will be collected by a sump and pumped out and tankered off-site to either FCC-owned Knostrop or Ecclesfield sites for treatment.

Point source emissions to land

3.3.6 There will be no point source emissions to land as part of the activities at the site. Processed IBA wastes will be disposed of within the specially engineered cells at Whisby Landfill.

3.4 Q3a Technical Standards

3.4.1 The following guidance and reports for the technical standards for this permit application:

- Environment Agency guidance 'Control and monitor emissions for your environmental permit' last updated 24th November 2022;
- Environment Agency guidance 'Risk assessment for your environmental permit' last updated 31st August 2022;
- Environment Agency guidance 'Application for an environmental permit: Part B3 new bespoke installation' last updated 7th December 2021;
- Environment Agency guidance 'Non-hazardous and inert waste: appropriate measures for permitted facilities' last updated 8th December 2022;
- Industrial Emissions Directive 2010/75/EU (IPPC) Best Available Techniques (BAT) Reference Document for Waste Treatment' (2018);
- Lincwaste Limited (FCC Environment (UK) Limited) Management System & Waste Acceptance Procedures;
- Operating Techniques & BAT Review report ref. 5671-CAU-XX-XX-RP-V-0301;
- Environmental Risk Assessment report ref. 5671-CAU-XX-XX-RP-V-0302;
- Odour Management Plan ref. 5671-CAU-XX-XX-RP-V-0304; and,
- Dust & Emissions Management Plan ref. 5671-CAU-XX-XX-RP-V-0305.

3.5 Q3b General Requirements

3.5.1 An Environmental Risk Assessment is provided as part of this permit variation as report ref. 5671-CAU-XX-XX-RP-V-0302. The risks from accidents (leaks, spills), fire, contaminated surface water run-off, litter, pests, noise and mud and debris are considered to be low, if control measures are in place, so do not require further assessment. Management plans for odour and dust are considered to be required for the proposed operations and these are listed below:

- Odour Management Plan ref. 5671-CAU-XX-XX-RP-V-0304
- Dust & Emissions Management Plan ref. 5671-CAU-XX-XX-RP-V-0305

3.5.2 A Noise Impact Assessment was undertaken by Bureau Veritas UK Ltd. (ref. UK.17811589/00) as part of the planning application for the site (see Appendix 5) and the assessment concluded that the noise impact of the site operation would be below the Lowest Observed Adverse Effect Level at the nearest residential receptors, and that operational traffic generated by the development would have a negligible noise impact on off-site receptors.

3.6 Q3c Types and Amounts of Raw Materials

3.6.1 There are no raw materials to be used during the treatment process of the IBA. Water usage is to be small and limited to dust suppression misting when required and general cleaning/domestic use at the site. Water usage will be limited as much as possible to reduce leachate generation.

3.6.2 Any fuels or lubricants used for the mobile plant on-site will be stored in secure containers with at least 110% secondary containment. Spill kits will be stored in accessible positions around site for use in the event of an accidental spillage or leak. Re-fuelling will only be undertaken in a designated area, most likely outside of the IBA Cell 1 on another part of the landfill site, with impermeable surfacing and supervised by trained site staff, trained in the use of the spill kits and emergency response procedures.

3.6.3 The operator will select the least harmful products to use in the operation wherever possible.

3.6.4 The operator will keep Safety Data Sheets for all products used at the facility and will monitor the quantity of materials used. This will provide data for regular reviews of raw materials usage at the facility.

3.7 Q4a Monitoring Point Source Emissions

3.7.1 There are no specific point source emissions from the proposed waste operations at the site.

3.7.2 Emissions monitoring for odour, dust and noise will be undertaken as per the monitoring proposed in the relevant management plans, as listed above in answer to Q3b and as part of routine daily site inspections.

3.7.3 Other potential emissions arising from the proposed site activities have been assessed in the Environmental Risk Assessment ref. 5671-CAU-XX-XX-RP-V-0302 and the overall risk from these is considered low if control measures are implemented as per site procedures.

3.7.4 Monitoring of potential fugitive emissions will be undertaken daily as part of daily site inspections and if detected or complaints received, will be dealt with as per procedures in the site's management system and control measures at the site reviewed accordingly.

3.8 Appendix 4 Question 1: For the landfill sector, provide your Environmental Setting and Installation design (ESID) report and any other risk assessments to control emissions

3.8.1 An Environmental Setting and Installation Design (ESID) addendum report to the original ESID has been provided as part of this permit variation as document ref. 5671-CAU-XX-XX-RP-V-0303.

3.8.2 An Environmental Risk Assessment report ref. 5671-CAU-XX-XX-RP-V-0302 for the IBA Processing Facility has been included as part of this permit variation application.

3.9 Appendix 4 Question 2: For Hazardous Waste on Land Activities, provide your Waste Acceptance Procedures (including Waste Acceptance Criteria)

3.9.1 Not relevant to this application.

3.10 Appendix 4 Question 3: Provide your Hydrogeological Risk Assessment (HRA) for the site.

3.10.1 The Hydrogeological Risk Assessment for the site has been updated as part of this permit variation application and is included as document ref. 5671-CAU-XX-XX-RP-O-0300.

3.11 Appendix 4 Question 4: Provide your Outline Engineering Plan for the site

3.11.1 Not relevant to this application.

3.12 Appendix 4 Question 5: Provide your Stability Risk Assessment (SRA) for the site.

3.12.1 Attached as Sirius document ref. WR7885/SRA.

3.13 Appendix 4 Question 6: Provide your Landfill Gas Risk Assessment (LFGRA) for the site

3.13.1 The Landfill Gas Risk Assessment for the site has been updated as part of this permit variation and is included as document ref. 5671-CAU-XX-XX-RP-V-0308.

3.14 Appendix 4 Question 7: For recovery of hazardous waste on land activities, have you completed a monitoring plan for the site?

3.14.1 Not relevant to this application.

3.15 Appendix 4 Question 8: Have you completed a proposed plan for closing the site and your procedures for looking after the site once it has closed?

3.15.1 Not relevant to this application.

4.0 BEST AVAILABLE TECHNIQUES (BAT) REVIEW

4.1 Overview

4.1.1 The IBA Processing Facility at Whisby Landfill Site will be operated in accordance with Best Available Techniques (BAT), where applicable, for waste treatment.

4.2 Review of BAT Conclusions

4.2.1 The BAT Conclusions for waste treatment (2018) are reviewed within Table 3 below. The activities at the site will include IBA waste treatment for recovery and disposal, primarily producing an IBA Aggregate (IBAA) and extracting metals from the IBA, and the temporary storage of unprocessed and processed IBA wastes and disposal of the IBA residues by mono-filling into IBA Cell 1 (and subsequent IBA Cells 2, 3 and 4) of the landfill.

Table 3 – BAT Conclusions Review

BAT Conclusion Number	Description	Applicable? Yes/No	Reference
	Overall Environmental Performance		
1.	**In order to improve the overall environmental performance, BAT is to implement and adhere to an environmental management system (EMS) that incorporates all of the following features (I – XV)**	Yes	• See Section 2.13. • FCC Environment (UK) Limited (of which Lincwaste Limited is a wholly owned subsidiary) has implemented an accredited ISO14001 Environmental Management System (EMS) across the whole company and its subsidiaries to control the operations at their sites. • The EMS summary is provided in Appendix 2 of the Supporting Document of this permit variation application. • The EMS establishes an organisational structure, responsibilities, practices, procedures and resources for achieving, reviewing and maintaining the company's commitment to environmental protection. The operation of an EMS is an assurance to the regulator, neighbouring businesses, stakeholders, and others alike that the operations at the facility are undertaken in strict compliance with the regulations in force and with the management seeking continual improvements. It requires the company to work in a transparent way, to maintain and improve the confidence of regulators and neighbours, and to have a proactive approach to environmental improvement. The operator will continue to use and develop documented management procedures and written work instructions which incorporate environmental considerations into the construction and operation of the facility. • An Environmental Risk Assessment (ERA) has been carried out for the purpose of this application which assesses the environmental risks and potential emissions from the activities proposed to be covered by the permit (document ref. 5671-CAU-XX-XX-RP-V-0302). • An Odour Management Plan has been produced as document ref. 5671-CAU-XX-XX-RP-V-0304.

			• A Dust & Emissions Management Plan has also been produced to cover the proposed activities at the site (document ref. 5671-CAU-XX-XX-RP-V-0305). • All the above risk assessments and management plans for the proposed activities at the site include control measures and procedures to prevent environmental pollution and nuisance to sensitive receptors from potential emissions from the site. These will be incorporated into the EMS for the site.
2.	**In order to improve the overall environmental performance of the plant, BAT is to use all of the techniques given below (a – g).**	Yes	• See Section 2.3 for a description of the strict waste acceptance procedures to be adhered to at the site for incoming waste loads. • See Section 2.8 for information on the storage of unprocessed and processed wastes, including IBA and metals. Stockpiles of unprocessed and processed wastes will not be mixed during storage. • The Operator has implemented a Competency Management System (CMS) which has been certified by its accrediting body LRQA and is attached in Appendix 2 of the Supporting Document for this permit variation application. The Competency Management System is an alternative mechanism to the Certificate of Technical Competence (COTC) / Technically Competent Management (TCM) regime for demonstrating competence at sites with environmental permits. • The roles of site staff are clearly defined within the procedures in the Environmental Management System (EMS) and staff will only undertake activities for which they have received suitable training. • All staff undertaking waste acceptance procedures will receive suitable training in the waste acceptance procedures, as well as in waste handling and the relevant health and safety and environmental procedures in place.
3.	**In order to facilitate the reduction of emissions to water and air, BAT is to**	Yes	• See Section 2.2.2 about proposed drainage and leachate sump. Wastewater is not proposed to be produced as part of the storage and processing activities on site, except for leachate and surface run-off from rainwater, occasional dust suppression activities and site

	establish and to maintain an inventory of waste water and waste gas streams, as part of the environmental management system (see BAT 1), that incorporates all of the following features (i. – iii.).		maintenance/cleaning. It is not envisaged that there will be a need for regular cleaning and washing down of processing equipment. Any site surface run-off will be contained by site drainage. Water usage for cleaning and washing down can be further minimised by: • Vacuuming, scraping or mopping in preference to hosing down; • Re-using wash water (or recycled water) where practicable; and, • Using trigger controls on all hoses, hand lances and washing equipment. • There will be no waste gas streams at the site.
4.	**In order to reduce the environmental risk associated with the storage of waste, BAT is to use all of the techniques given below (a – d).**	Yes	• See Sections 2.8 for information on the storage of IBA wastes pre- and post-treatment and the storage of extracted metals. The IBA Processing and landfilling will be undertaken within the IBA Cell 1, which will be a fully engineered non-hazardous landfill cell, complete with drainage blanket and sump for the collection and containment of any leachate. • The attached site layout plan ref. 722A167A shows the locations of the proposed waste storage areas and other infrastructure including mobile plant area. Any potentially polluting materials will be stored appropriately bunded and contained to prevent release of emissions to the environment.
5.	**In order to reduce the environmental risk associated with the handling and transfer of waste, BAT is to set up and implement handling and transfer procedures**	Yes	• Handling and transfer of waste will be undertaken in accordance with procedures and control measures as set out in the site's Environmental Management System (IMS) and management plans for dust and odour to minimise fugitive emissions during operations and to ensure the site is kept clean and tidy for practicality and safety of site operatives. • The Operator has implemented a Competency Management System (CMS) which has been certified by its accrediting body LRQA and is attached in Appendix 2 of the Supporting Document for this permit variation application. The Competency Management System is an alternative mechanism to the Certificate of Technical Competence (COTC) / Technically Competent Management (TCM) regime for demonstrating competence at sites with environmental permits.

			• The roles of site staff are clearly defined within the EMS procedures and staff will only undertake activities for which they have received suitable training. • All staff undertaking waste acceptance procedures will receive suitable training in the waste acceptance procedures, as well as in waste handling and the relevant health and safety and environmental procedures in place • All staff will receive training and refresher training on correct handling and transfer of waste around site, as part of training programmes included within the EMS. Drop heights of waste will be minimised to reduce dust and noise emissions and operations will be undertaken during normal site operational hours. • The risks from spillages of potentially polluting substances or wastes is assessed in the Environmental Risk Assessment report ref. 5671-CAU-XX-XX-RP-V-0302.
	Monitoring		
6.	**Monitoring – for relevant emissions to water as identified by the inventory of waste water streams (see BAT 3), BAT is to monitor key process parameters at key locations**	Yes	• There will be no point source emissions to water as part of the activities at the site. • Surface water run-off from the treatment and storage pad will fall towards a sump within IBA Cell 1 and pumped out and tankered to either FCC-owned Knostrop or Ecclesfield sites for treatment.
7.	**BAT is to monitor emissions to water with at least the frequency given below and in accordance with EN standards.**	No	• See above response to BAT 6. • No other point source emissions to water (other than sewer) proposed.
8.	**BAT is to monitor channelled emissions to air with at least the frequency given below**	No	Not applicable to this application – no point source emissions to air identified.

	and in accordance with EN standards.		
9.	**Bat is to monitor diffuse emissions of organic compounds to air from the regeneration of spent solvents, the decontamination of equipment containing POPs with solvents, and the physico-chemical treatment of solvents for the recovery of their calorific value, at least once per year using one or a combination of the techniques given below (a – c).**	No	Not applicable to this application.
10.	**BAT is to periodically monitor odour emissions.**	Yes	• Odour will be monitored daily during site inspections. The risks of odour being generated by the proposed activities is covered in the Environmental Risk Assessment report ref. 5671-CAU-XX-XX-RP-V-0302 and further detail and control measures presented in the Odour Management Plan ref. 5671-CAU-XX-XX-RP-V-0304.
11.	**BAT is to monitor the annual consumption of water, energy and raw materials as well as the annual generation of residues and waste water, with a frequency of at least once per year.**	No	Not applicable to this application.

	Emissions to Air		
12.	**In order to prevent or, where that is not practicable, to reduce odour emissions, BAT is to set up, implement and regularly review an odour management plan, as part of the environmental management system (see BAT 1), that includes all of the following elements (a – d)**	Yes	• See response to BAT 10 about odour control and a site-specific odour management plan.
13.	**In order to prevent or, where that is not practicable, to reduce odour emissions, BAT is to use one or a combination of the techniques given below (a – c).**	Yes	• See response to BAT 10 about odour control.
14.	**In order to prevent or, where that is not practicable, to reduce emissions to air, in particular of dust, organic compounds and odour. BAT is to use an appropriate combination of the techniques given (a – h).**		• See response to BAT 10 for odour. • The risks of emissions such as odour, dust and noise from the proposed operations have been assessed in the Environmental Risk Assessment report ref. 5671-CAU-XX-XX-RP-V-0302. • A Dust & Emissions Management Plan has been produced as part of this permit application, as document ref. 5671-CAU-XX-XX-RP-V-0305. This document contains control measures which will be implemented at the site to minimise emissions of dust.
15.	**BAT is to use flaring only for safety reasons or for non-**	No	Not applicable to this application.

	routine operation conditions (e.g. start-ups, shut downs) by using techniques (a – b).		
16.	**In order to reduce emissions to air from flares when flaring is unavoidable, BAT is to use the techniques detailed (a – b).**	No	Not applicable to this application.
	Noise and Vibrations		
17.	**In order to prevent, or where that is not practicable, to reduce noise and vibration emissions, BAT is to set up, implement and regularly review a noise and vibration management plan as part of the environmental management system.**	Yes	• Noise will be generated by delivery vehicles, the mobile plant used during processing and movement of waste around site (front-loading shovel, dumper trucks). • A Noise Impact Assessment has been produced as part of the planning application, as document ref. UK.17811589/00, and it was concluded that the predicted impact to sensitive receptors from noise is negligible. • A planned preventative maintenance (PPM) programme will be in place for all parts of the plant and will include routine maintenance and servicing of parts that could give rise to increases in noise and vibrations and as part of the routine site checks, noise and vibration emissions will be checked. • Noise and vibrations have also been considered in the Environmental Risk Assessment document ref. 5671-CAU-XX-XX-RP-V-0302.
18.	**In order to prevent or where that is not practicable, to reduce noise and vibration emissions, BAT is to use of or**	Yes	• See response to BAT 17.

	a combination of the techniques given (a – e).		
	Emissions to Water		
19.	**In order to optimise water consumption, to reduce the volume of waste water generated and to prevent or, where that it not practicable, to reduce emissions to soil and water, BAT is to use an appropriate combination of the techniques given (a – i).**	Yes	• See responses to BAT 3 and BAT 6. • The site will benefit from an impermeable surface, that will be inspected daily for cracks or damage and made-good as soon as practicable. The site will also be surrounded by bunding and surface water sump to isolate any run-off that becomes contaminated with any potentially polluting substance. This will ensure the surrounding surface water and ground water environment are protected from accidental release of pollution from the site. • Surface water run-off from the treatment and storage pad will fall towards a sump within IBA Cell 1 and pumped out and tankered to either FCC-owned Knostrop or Ecclesfield sites for treatment.
20.	**In order to reduce emissions to water, BAT is to treat waste water using an appropriate combination of techniques (a – r).**	No	Not applicable to this application. Wastewater will not be treated as a result of the proposed operations.
	Emissions from Accidents and Incidents		
21.	**In order to prevent or limit the environmental consequences of accidents and incidents, BAT is to use all for the techniques given below, as part of the accident management plan (a – c).**	Yes	• See Section 2.14 'Accidents & Incidents'. • An Environmental Risk Assessment document ref. 5671-CAU-XX-XX-RP-V-0302 has been produced as part of this permit application, which considers the potential risks from accidents and incidents at the site, such as spills and leaks, fire, flooding etc. from the proposed operations. • The site's Management System will include written procedures for handling, investigating, communicating and reporting environmental complaints and implementation of appropriate actions. Dust, odour and noise complaints handling procedure and recording forms are included in the dust and odour management plans within this permit variation application.

	Material Efficiency		
22.	**In order to use materials efficiently, BAT is to substitute materials with waste.**	No	Not applicable to this application.
	Energy Efficiency		
23.	**In order to use energy efficiently, BAT is to use both of the techniques given below:** **a) Energy Efficiency plan** **b) Energy balance record**	Yes	• Housekeeping measures including maintenance and operational procedures are in place for all areas of the site where the breakdown of machinery could lead to an impact upon the environment or compromise the operator's ability to undertake normal site activities. • These measures will be reviewed every year to determine if additional energy savings could be made and will include: - • Switching off equipment when not in use; • Careful operation and maintenance of plant & equipment; and, • Regular cleaning of plant & equipment.
	Re-Use of Packaging		
24.	**In order to reduce the quantity of waste sent for disposal, BAT is to maximum the reuse of packaging, as part of the residues management plan.**		Not applicable to this application.
	General BAT conclusions for the mechanical treatment of waste		
25.	**In order to reduce emissions to air of dust, and of particulate-bound metals, PCDD/F and dioxin-like**	Yes	• As shown on drawing ref. 722A167A, the entire IBA storage and processing area will benefit from a mobile dust suppression system around the perimeter (brown dashed line on drawing). This will be a Pacific 250 system (see Appendix 1) or similar and will be a high-pressure system that pumps water (and additives is required) through nozzles that create a

	PCBs, BAT is to apply BAT 14d and to use one or a combination of the techniques given below.		fine atomised mist. The IBA wastes to be processed are non-hazardous and unlikely to contain any hazardous components, due to strict waste acceptance procedures to be adhered to on site.
	BAT conclusions for the mechanical treatment in shredders of metal waste		
26.	**In order to improve the overall environmental performance, and to prevent emissions due to accidents and incidents, BAT is to use BAT 14g and all of the techniques given (a – c).**	No	Not applicable to this application.
27.	**In order to prevent deflagrations and to reduce emissions when deflagrations occur, BAT is to use technique a. and one or both of the techniques b. and c. given below.**	No	Not applicable to this application.
28.	**In order to use energy efficiently, BAT is to keep the shredder feed stable.**	No	Not applicable to this application.
	BAT conclusions for the treatment of WEEE containing VFCs and/or VHCs		
29. to 30.	**BAT conclusions 29-30**	No	Not applicable to this application.
	BAT conclusions for the mechanical treatment of waste with calorific value		

31.	**BAT conclusion 31**	No	Not applicable to this application.
	BAT conclusions for the mechanical treatment of WEEE containing mercury		
32.	**BAT conclusion 32**	No	Not applicable to this application.
	General BAT conclusions for the biological treatment of waste		
33. to 35.	**BAT conclusions 33-35**	No	Not applicable to this application.
	BAT conclusions for the aerobic treatment of waste		
36. to 37.	**BAT conclusions 36-37**	No	Not applicable to this application.
	BAT conclusions for the anaerobic treatment of waste		
38.	**BAT conclusion 38**	No	Not applicable to this application.
	BAT conclusions for the mechanical biological treatment (MBT) of waste		
39.	**BAT conclusion 39**	No	Not applicable to this application.
	BAT conclusions for the physico-chemical treatment of solid and/or pasty waste		
40.	**In order to improve the overall environmental performance, BAT is to monitor the waste input as part of the waste pre-acceptance and acceptance procedures (see BAT 2).**	Yes	• Solid waste (non-hazardous IBA waste) is to be accepted at the site and strict waste acceptance protocols will be followed prior to acceptance of waste loads onto site to ensure the waste types conform with those listed in the permit (Table 1). • See response to BAT 2.
41.	**In order to reduce emissions of dust, organic compounds and NH_3 to air, BAT is to apply BAT 14d and to use one or a combination of the techniques given (a-d).**	Yes	• See response to BAT 8 and BAT 10 for control of dust emissions on-site.
	BAT conclusions for the re-refining of waste oil		
42. to 44.	**BAT conclusions 42-44**	No	Not applicable to this application.
	BAT conclusions for the physico-chemical treatment of waste with calorific value		
45.	**BAT conclusion 45**	No	Not applicable to this application.

	BAT conclusions for the regeneration of spent solvents		
46. to 49.	**BAT conclusions 46-49**	No	Not applicable to this application.
	BAT conclusions for the water washing of excavated contaminated soil		
50.	**BAT conclusion 50**	No	Not applicable to this application.
	BAT conclusions for the decontamination of equipment containing PCBs		
51.	**BAT conclusion 51**	No	Not applicable to this application.
	BAT conclusions for the treatment of water-based liquid waste		
52. to 53.	**BAT conclusions 52-53**	No	Not applicable to this application.

5.0 REFERENCES

- Integrated Pollution Prevention and Control (IPPC), 2018 - 'Best Available Techniques (BAT) Reference Document for the Waste Treatment', Industrial Emissions Directive 2010/75/EU.

- Environment Agency and DEFRA – 'Risk assessments for your environmental permit', from GOV.UK website: https://www.gov.uk/guidance/risk-assessments-for-your-environmental-permit. (last updated 31st August 2022).

DRAWINGS

722A167A IBA Processing Pad - General Layout
WR7855/01/001 Rev 3 Proposed IBA Pad & Cells Development

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:

- 18 — Contours
- LCP — 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

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FCC Environment

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

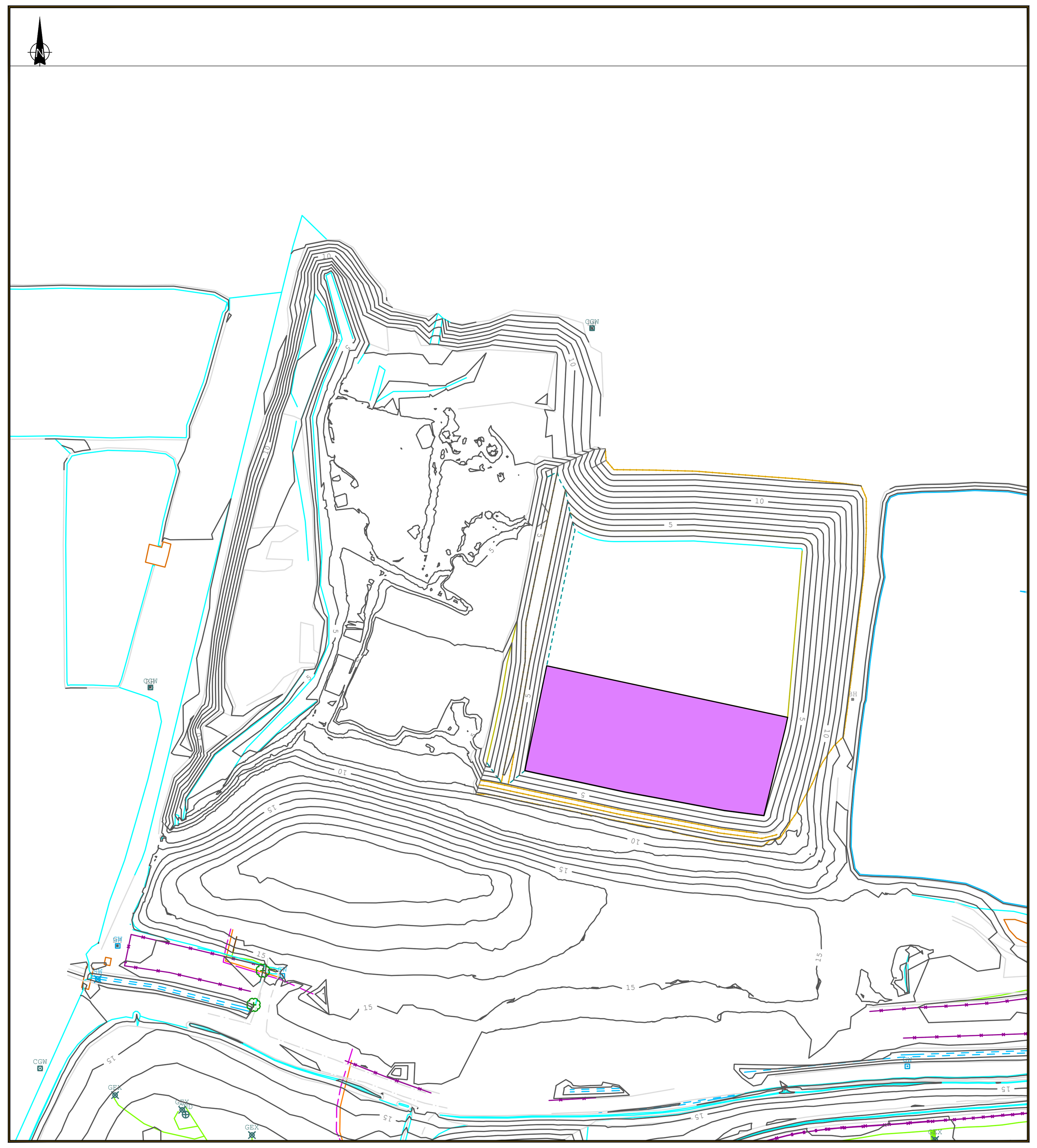
Site: **WHISBY LANDFILL SITE**

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	-

Last Saved By: benst Date: 14-Jun-23Plot By: ben stocks Date: 15-Jun-23



CELL 1 & IBA PAD - 2023 WORKS
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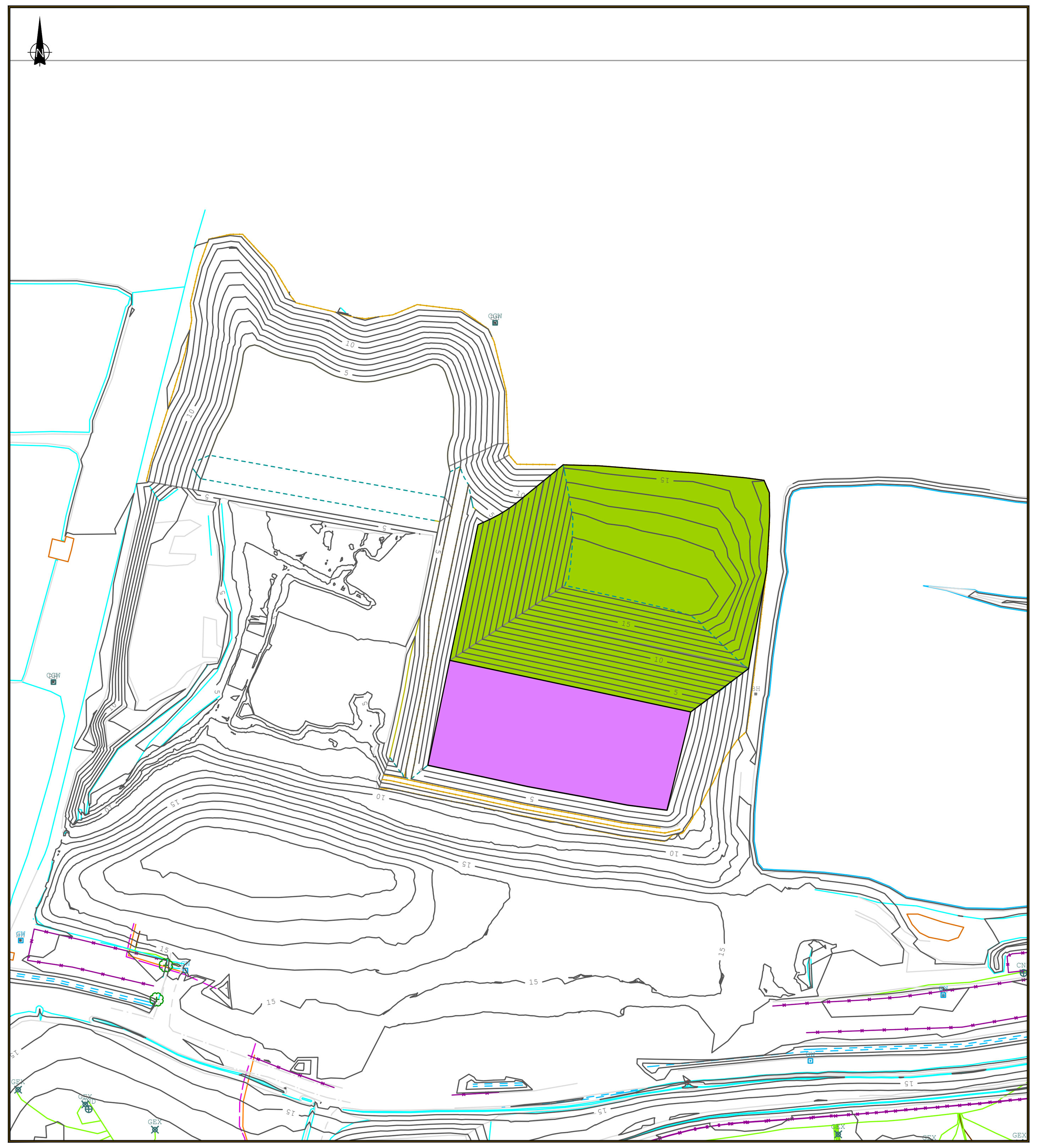

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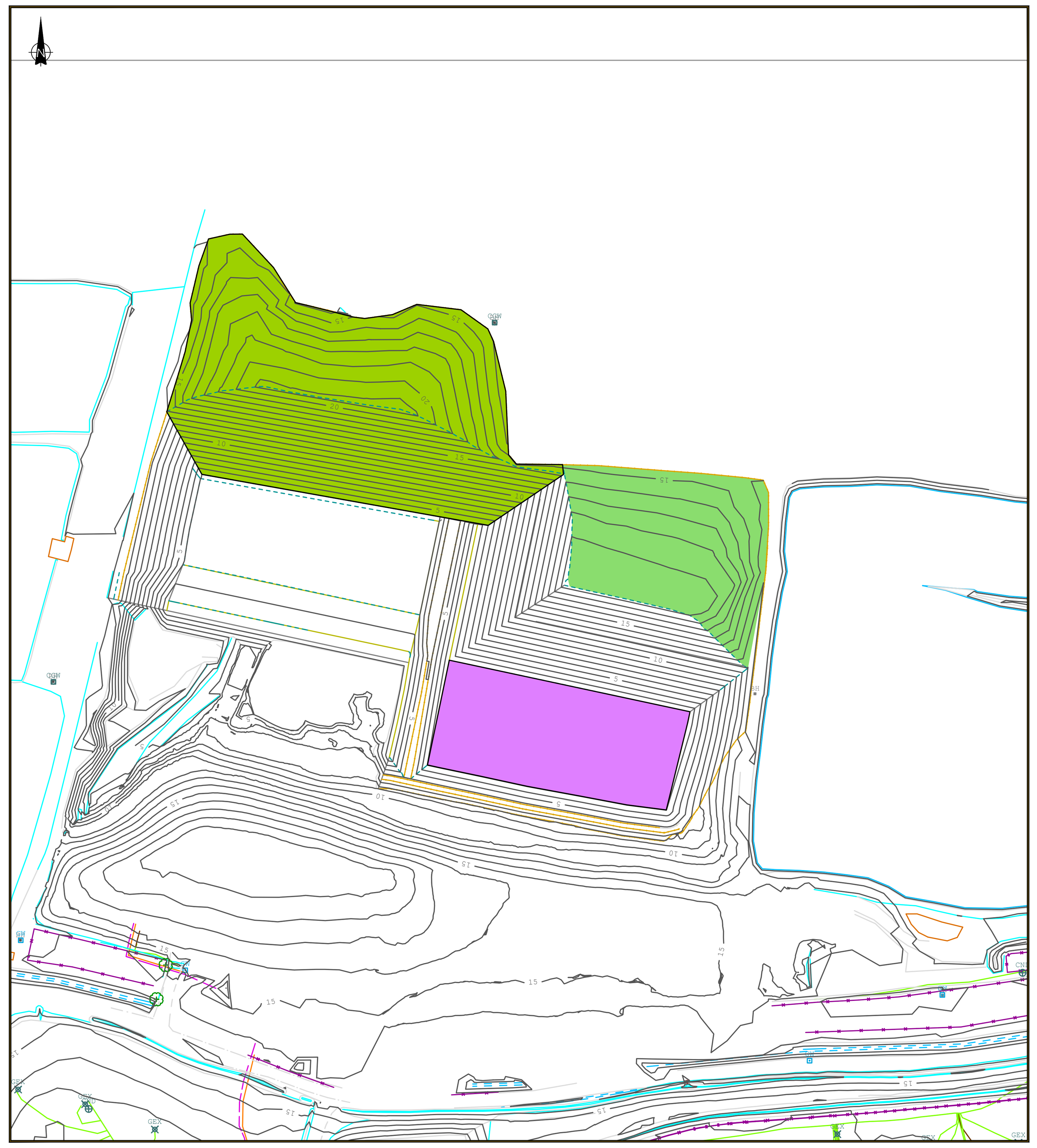
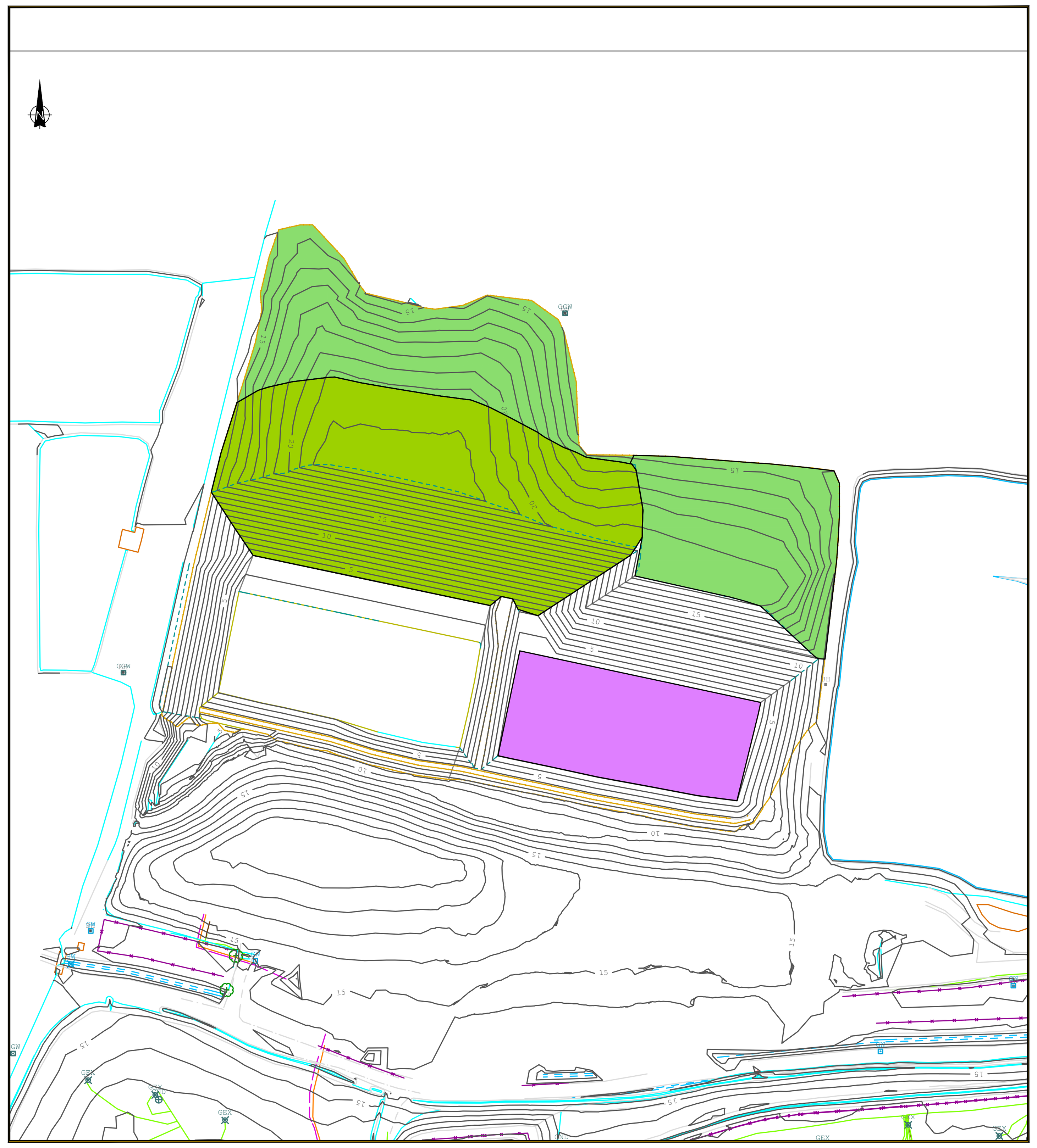
SCALE 1:1250



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

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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

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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

APPENDIX 1

Dust Suppression System

Dispersal equipment
Misting systems

Pacific 75/125/250

Dust suppression and odour control misting systems

The Pacific is a high-pressure system that pumps water or water and *Odr* additive, though nozzles to create a fine atomised mist. The system operates with either mains or generator supplied power (240V/415V) and mains supplied potable water.

The cabinet is available in either GRP or stainless steel, with all key componants in an IP65 rated enclosure. The 7-day timer control, remote facility and pulse mode allow the system to function without frequent operator attention and ensures reduced running costs and maintenance.

The Pacific system is available in three standard static forms, the Pacific 75, Pacific 125 or Pacific 250, with 75,125 or 250 nozzles respectively, and in bespoke form, designed to meet your specific requirements. It is also available in a mobile, trailer mounted form as the Pacific Mobile for use where extra flexibility is required.

Typical Applications:

- Waste transfer stations
- Landfill sites
- Composting sites
- Remediation sites

For more information contact:
E: Enquiry@AirSpectrum.com
T: +44(0)1905 362100
F: +44(0)1905 362101

Air Spectrum Environmental LImited continually strives to improve its products and therefore reserves the right to introduce modifications to their product range without notice.

www.AirSpectrum.com

Pacific model			Features
75	125	250	
•	•	•	Nozzle available as 1m or 2m spacing option
•	•	•	70 Bar, 1000 Psi delivery system
75	125	250	Maximum number of nozzles possible (upgradeability)
•	•	•	7 day timer control with remote relay and optional weather station controller
•	•	•	Low level water and product indicators
•	•	•	User adjustable doing levels
•	•	•	Heated cabinet
•	•	•	240V or 415V supply
•	•	•	Stainless steel or GRP cabinet
•	•	•	CE marked
•	•	•	Pulse control
•	•		Dimensions 1080mm (h) x 800mm (w) x 300mm (d)
		•	Dimensions 1135mm (h) x 850mm (w) x 350mm (d)

The design and specification may alter dependent on the individual needs of the project and the unit may subsequently differ in appearance to the one shown.

APPENDIX 2

IBA Processing Plant Specifications

Mobile IBA processing plant

Quotation: **23345**

Client:	**FCC Environment**
Contact:	Mehrdad Heshmati, mehrdad.heshmati@fccenvironment.co.uk, Tel. 0044-7734979715
Customer reference:	**22017**
Contact :	Jorrit Tuip, j.tuip@trs-nl.com, +31(0)683564099
	TRS BV Molenlei 7 1921 CX, Akersloot The Netherlands
Date:	**14-03-2023**

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1. Process description

1.1 General description

This offer consists of a 70,000 tpa complete mobile IBA processing plant to allow an IBA aggregate to be produced. This including two mobile sieves, three hook-lift mobile metal separation machines, overbelt magnets and hand sorting station for the processing of bottom ash material (IBA). The total layout is a combination of equipment on tracks (sieve), hooklift frames (eddy current separator) and skid-based hand sorting station.

The construction will comply to all relevant legislation and regulations for UK operations.

Full operating and maintenance manuals will be provided and trained to relevant staff during the commissioning stage by TRS.

The IBA shall be a maximum moisture content of 14% to optimize recovery percentages.

Metal recovery rate – 85% recovery rate will be achieved with this proposed set-up.

Foundation requirement – This need to be of a hard standing platform.

Design life – 10 years on frame works. Manufactures warranties for all other parts.

. **Staff requirement** – Based on one shift, the staffing requirement will be 6/8 depending on company operating standards.

Steel Steps and Walkways – these are made of an open grid structure but are not completely conform to all regulations due to its mobile states. This includes shaper inclines to staircases for transportation and moveability. All non-conforming items can be assessed and altered but this will remove the true mobile nature of the plant.

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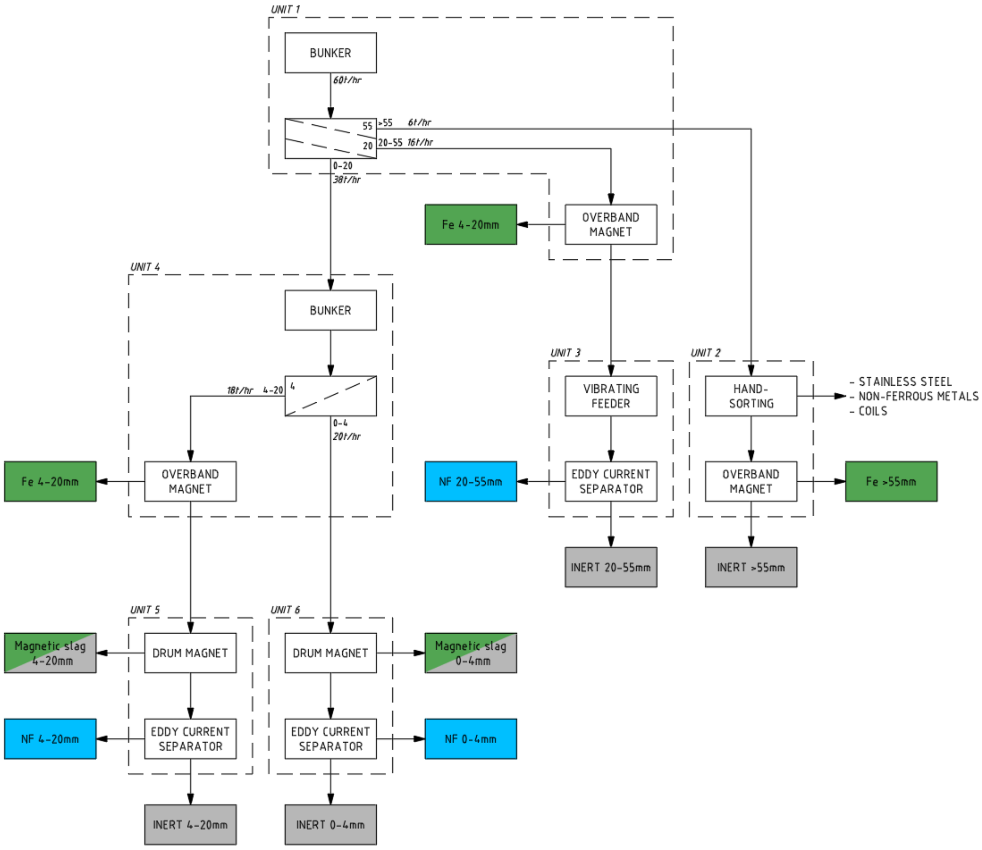
1.2 Flow diagram

The offer is based on following flow diagram. This can be adapted on further investigation of the incoming IBA.



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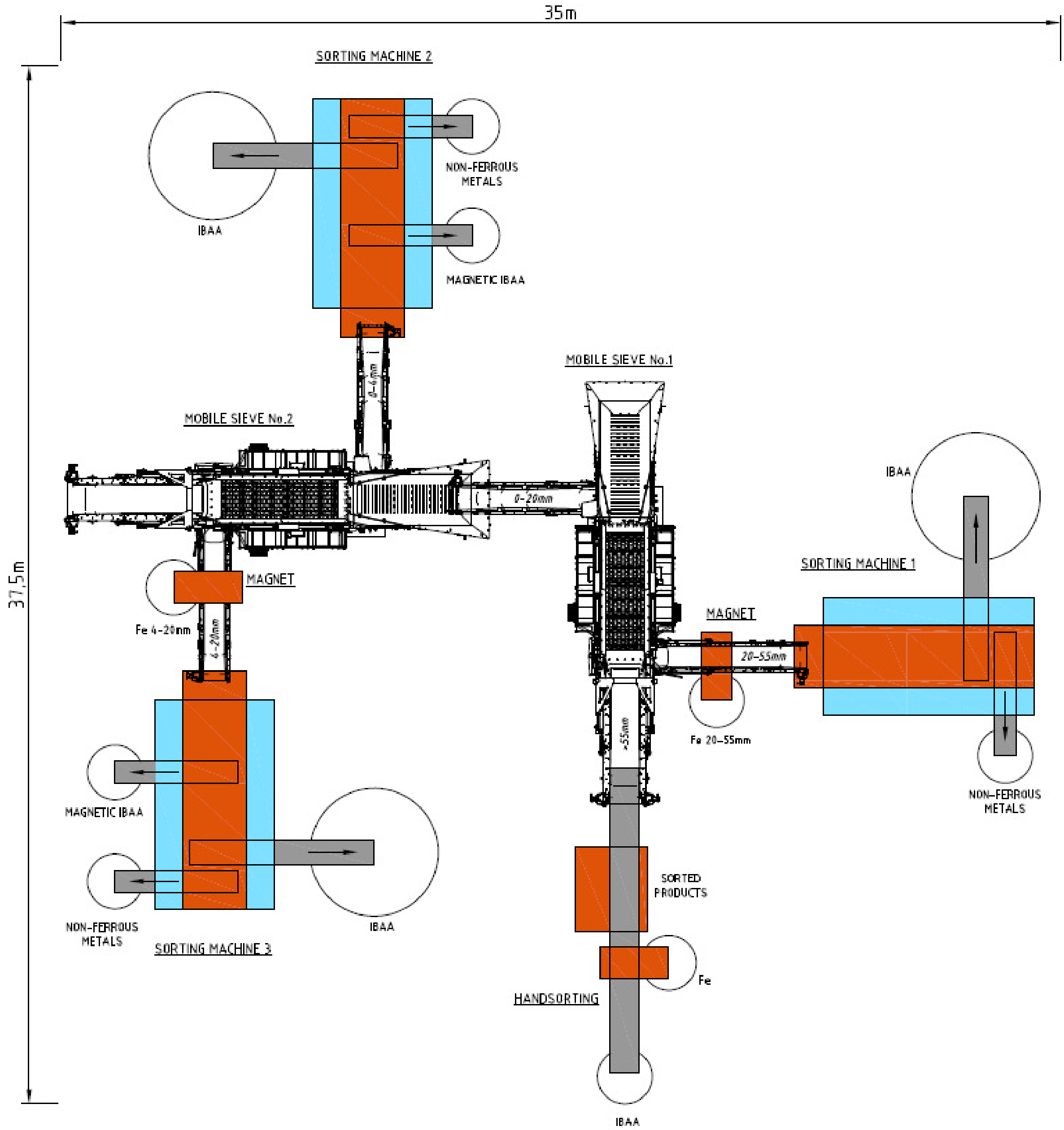
1.3 Layout drawing

The offer is based on following layout drawing. This can be adapted on further investigation of the incoming IBA.



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2 . Specifications

2.1 Mobile sieve no. 1 (55mm&20mm) & no. 2 (4mm)

The machine will be equipped with a SPALECK screen box. The screening fraction size;

Machine No.1:
- 0-20 mm
- 20-55mm
- >55mm

Machine No. 2:
- 0-4 mm
- 4-20mm

Dimensions
- Width in working position: 12.729 mm.
- Length in working position: 14.915 mm.
- Height in working position: 4.382 mm.
- Weight: ± 30 tons

Bunker
- Volume: 10 m^3
- Filling height: 3.520 mm
- Plate belt fitted with heavy metal slats.

Engine & drive
- Drive: Hybrid (diesel/electro)
- Diesel engine: Caterpillar C4.4 - 98kW/131 hp, constant speed

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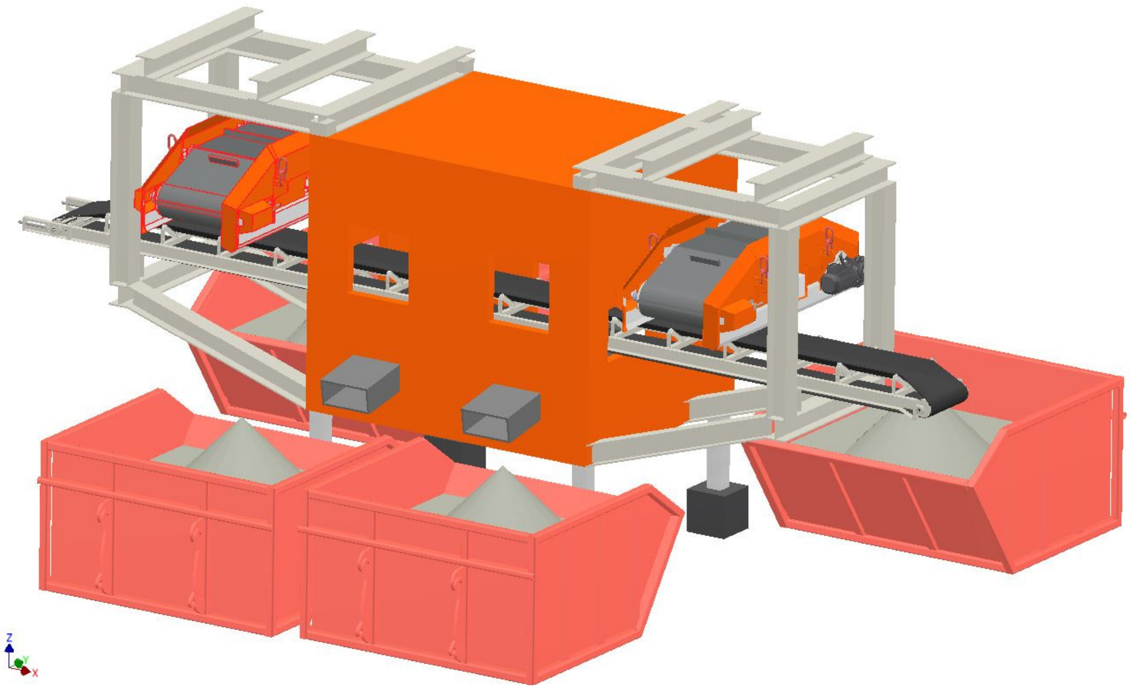
2.2 Handsorting station



(Overbelt magnet placed either in front or begin sorting position)

Conveyor

- Width: 650mm
- Length: 10m
- Design/set-up: sorting section +/-2800mm + stainless steel section below magnet

Handsorting container

- Container: 10ft sorting container, L2.991 x W2.438 x H2.896 wooden floor and 2,5kW aircon.

Overbelt magnet

- Type: Electro

Control + cabling

- Cabinet: Electrical cabinet built in container
- Other: Start/stop button, belt speed by frequency controller to be adjusted inside the container

Frame

- Stairs and a small walkway to provide an accessible entrance to the container.
- All steelworks hot dip galvanized (with exception of machinery and thin plate work
- Manual adjustable legs for positioning and leveling of machinery.

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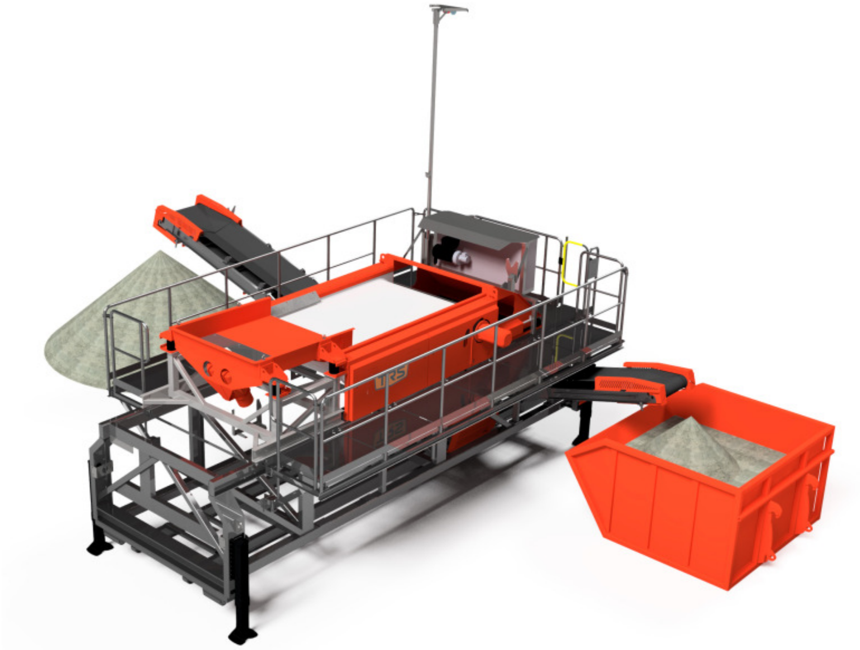
2.3 Hooklift Eddy Current separator Coarse (20-55mm)



Vibrating feeder

- Width: 1.450mm

Eddy Current Separator

- Type: High Gradient
- Working width: 1500mm
- Separation plate: Electrical adjustment
- IBA version: hot galvanized frame, stainless steel covers/doors

Discharge conveyors non-ferrous material

- Width: 650mm
- Length: ± 5,0m

Discharge conveyor residual material

- Width: 800mm
- Length: ± 7,5m

Control + cabling

- Cabinet: Stainless Steel cabinet (outdoor usage)
- Power supply: 3P + N + E (63A plug)

Hydraulic system

Frame

- Heavy duty hook-lift frame for support and transportation of machinery, walkway at three sides, foldable for transportation, width 0,8m (on hook-lift side an easily accessible safety stairway is situated). All steelworks hot dip galvanized (with exception of machinery and thin plate works). Hydraulic operation of 4 support legs for positioning and leveling of machinery.

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2.4 Hooklift Eddy Current separator fines (0-4 & 4-20mm)

Feeding conveyor with product distribution module and magnetic head pulley

- Width: 1.600mm

Eddy Current Separator

- Type: High Gradient
- Working width: 1500mm
- Separation plate: Electrical adjustment
- IBA version: hot galvanized frame, stainless steel covers/doors

Discharge conveyors non-ferrous material

- Width: 650mm
- Length: ± 5,0m

Discharge conveyor residual material

- Width: 800mm
- Length: ± 7,5m

Control + cabling

- Cabinet: Stainless Steel cabinet (outdoor usage)
- Power supply: 3P + N + E (63A plug)

Hydraulic system

Frame

- Heavy duty hook-lift frame for support and transportation of machinery, walkway at three sides, foldable for transportation, width 0,8m (on hook-lift side an easily accessible safety stairway is situated). All steelworks hot dip galvanized (with exception of machinery and thin plate works). Hydraulic operation of 4 support legs for positioning and leveling of machinery.

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2.5 Generator Stage 5

An Atlas Copco QAS+ 450 is offered for powering all TRS equipment. The power requirements for the TRS plant will be 280kW. If additional power is required for client's needs this needs to be calculated in the generator's capacity.

- Voltage: 400V
- Rated frequency: 50Hz
- Prime power: 450kVA
- Fuel tank capacity: 1300l
- Fuel consumption at 75% load: 62,4l/h
- Dimension: 4250 x 1500 x 2120mm (L x W x H)
- Weight: 5615kg

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3. Benefits TRS offered mobile plant

- Market leader in IBA mobile recycling machinery
- Wide spreading of the materials creates many advantages further in the installation with all separation technology. Staying wide is essential for optimal grade/recovery efficiency!
- High grade magnets and Eddy Current separators for optimal recovery.
- TRS complete management of the contract to give the client the best knowledge to achieve the best results.
- All frame works are galvanized, meaning IBA wear-proof (long lifetime of the installation).
- A-brand Equipment for optimal working.
- Proven TRS technology across multiple operations
- Flexible layout, easy and quickly expendable
- Minimal set-up requirements
- Compact and easily transportable
- TRS rental scheme to allow the client the best without compromise.

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4. Preliminary program

Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
Contract	Engineering								Production

Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17	Week 18	Week 19	Week 20

Week 21	Week 22	Week 23	Week 24	Week 25	Week 26	Week 27	Week 28	Week 29	Week 30
FAT			Site assembly			Commissioning		Take over	

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5. Pricing

5.1 Price breakdown

1. Mobile sieve 55&20mm incl. overband magnet:	€ 410.000,-
2. Handsorting station:	€ 190.000,-
3. Hooklift eddy current separator coarse	€ 350.000,-
4. Mobile sieve 4mm:	€ 397.000,-
5. Hooklift eddy current separator fines (4-20mm):	€ 385.000,-
6. Hooklift eddy current separator fines (0-4mm):	€ 385.000,-
7. Generator (stage 5)	€ 150.000,-
8. Electrical integration equipment	€ 100.000,-
9. Transport	€ 35.000,-
10. Assembly and commissioning on site	€ 80.000,-
TOTAL:	€ 2.482.000,-

** These prices are all budget prices of single units, total layout and options need to be determined upon final agreement/ site allocation*

5.2 Services / works

Including:

- engineering,
- project management,
- assembly works and testing in TRS factory.

Excluding:

- ground works at site,
- electricity connection at site,
- rental of necessary crane(s), Manitou, scissor-lift, et cetera,
- total water management for the site

5.3 Changes

This offer is a budgetary offer and subject to any changes resulting out of plant configuration changes and/or other deviations in relation to the flow-scheme and drawing proposal belonging to this offer, and there for subject to final engineering.

We have based our price on the condition that the complete site will be at our disposal, and we have no other parties working on the same site. We should be able to perform our works

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without interruptions or delays caused by third parties. If delays occur due to third parties, we may need to charge additional costs.

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6. Delivery & Payment conditions

On all our offers and concluded contracts we apply our general TRS Terms and Conditions. In case of conflicting conditions between offer and TRS terms and conditions, the offer prevails.

Contract:	Price is based on contract according TRS terms and conditions. Other forms of contract need to be assessed before updated price.
Delivery:	Delivered at site Lincolnshire
VAT:	Prices excluding VAT
Delivery time:	To be agreed.
Payment:	30% at order, payment within 7 days 30% at start assembly in workshop, payment within 7 days 40% after take-over in TRS factory and prior to Ex Works delivery
Warranty:	12 months at maximum of 2.000 operation hours, with the exclusion of wear parts, drives and electrical components.
Surface treatment:	Steelworks hot dip galvanized, thin plate works and machinery in RAL color of choice.
Documentation:	All documentation are according to CE including general operation manual, manuals of each part of equipment, electrical system, maintenance schedules and parts list will be presented in the desired language, according to the relevant guidelines.
Validity offer:	30 days.

We thank you very much for your interest in our products and services. We herewith trust to have made you a suitable proposal and we look forward to your feedback. Please do not hesitate to call us or contact by email if you have any further questions.

Please also visit our NEW website: www.trs-nl.com

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APPENDIX 3

Stability Risk Assessment

Stability Risk Assessment: WR7885/SRA
March 2023

STABILITY RISK ASSESSMENT
for
IBA CELL 1 CONSTRUCTION
at
WHISBY LANDFILL SITE

Prepared
for
LINCWASTE LIMITED
(FCC ENVIRONMENT (UK) LIMITED)

Prepared by

SIRIUS ENVIRONMENTAL LIMITED
4245 PARK APPROACH
THORPE PARK
LEEDS
WEST YORKSHIRE
LS15 8GB

TELEPHONE: 0113 264 9960

Project Quality Assurance
Information Sheet

Stability Risk Assessment – IBA CELL 1 CONSTRUCTION
WHISBY LANDFILL SITE

Stability Risk Assessment	:	WR7885/SRA	**Report Status**	:	For Approval
Report Date	:	March 2023			
Prepared for	:	FCC Environment (UK) Limited 6 Sidings Court White Rose Way Doncaster Yorkshire DN4 5NU			

Prepared by:

Joe Camfield MEng (Hons) GMICE
Graduate Engineer

Reviewed by:

Richard Hanley BEng (Hons) CEng CEnv CRWM MICE MCIWM
Technical Director

Approved by:

Andrew Kirk
Design Director

STABILITY RISK ASSESSMENT
IBA CELL 1 CONSTRUCTION
WHISBY LANDFILL SITE

CONTENTS

LIST OF APPENDICES

STABILITY RISK ASSESSMENT
for
IBA CELL 1 CONSTRUCTION
at
WHISBY LANDFILL SITE

1 INTRODUCTION

1.1 Report Context

Sirius Environmental Limited (Sirius) were commissioned by **FCC Environment (UK) Limited** (FCC) to prepare a Stability Risk Assessment (SRA) for Whisby Landfill Site, to support a permit variation for the disposal of Incinerator Bottom Ash (IBA) at the site. This SRA accompanies the design for IBA Cell 1, which is proposed to be constructed in the central area of the site. The purpose of this SRA is to assess the stability and integrity of the landfill containment system, and the stability of the waste mass, during the construction of IBA Cell 1 and the subsequent waste infilling works.

This Stability Risk Assessment (SRA) considers the different components of the landfill containment system for IBA Cell 1, and assesses how they may be affected by the construction works and the subsequent waste infilling, including waste tipping which will be completed following the construction of further IBA Cells on the eastern side of IBA Cell 1. The effect of the construction and infilling of IBA Cell 1 on the stability of the existing leachate lagoon bund / dam (located on the eastern side of the proposed development) is also assessed in this SRA.

This SRA has been prepared using guidance contained within the **Environment Agency R&D Technical Report P1-385/TR2** (hereinafter referred to as 'The Guidance').

1.1.1 Outline of the Installation

Whisby Landfill Site is located approximately 1km south-west of the village of Whisby, and approximately 9km to the south-west of Lincoln City. The site entrance is at Ordnance Survey National Grid Reference **SK 897 669**. The address of the site is:

Whisby Landfill Site,
Thorpe Road,
Whisby,
Lincolnshire,
LN6 9BT.

1.1.2 Summary of Previous Work

1.1.2.1 Whisby Landfill Site – PPC Application Volume 1 - Section A – Environmental Setting and Installation Design – *Golder Associates (UK) Limited* – May 2004

The ESID report was written in support of the PPC Permit Application for Whisby Landfill Site, on behalf of *Lincwaste Limited*, and presents a conceptual model of the site, and details the site specific source-pathway-receptor linkages. The report contains details of the site setting, such as the geology and hydrogeology, as well as a description of the landfill construction for different phases / cells.

1.1.2.2 Whisby Landfill Site – PPC Application Volume 2 - Section B – Hydrogeological Risk Assessment – *Golder Associates (UK) Limited* – May 2004

The HRA report was written in support of the PPC Permit Application for Whisby Landfill Site, on behalf of *Lincwaste Limited*. The HRA assesses the risk of groundwater contamination due to the presence of the landfill and outlines monitoring requirements and limits (trigger and control levels) on certain parameters, including leachate levels. The HRA includes leachate level monitoring data for the years leading up to the PPC Permit Application. The HRA includes details of the hydrogeology on site.

1.1.2.3 Whisby Landfill Site – PPC Application Volume 2 - Section C – Stability Risk Assessment – *Golder Associates (UK) Limited* – May 2004

The SRA report was written in support of the PPC Permit Application for Whisby Landfill Site, on behalf of *Lincwaste Limited*. This SRA assessed the risks of the stability of the lining system during construction, the stability of subsequent waste placement, and the liner stability during the infilling of the landfill. This report also assessed the stability and integrity of the capping system. This SRA found that suitable factors of safety were returned for all areas assessed, and made recommendations for quality control, and monitoring, during landfill construction, and during (and following) waste infilling. The SRA contains geological and hydrogeological information for the site, as well as geotechnical material parameters for the various components of the landfill modelled.

1.1.2.4 Whisby Landfill Site – PPC Application Volume 3 – Appendices – Golder Associates (UK) Limited – May 2004

As an appendix of the PPC Permit Application for Whisby Landfill Site, borehole logs up to the time of the application where provided, showing the various soil / rock strata beneath the site.

1.1.2.5 Whisby Landfill Permit Variation – Stability Risk Assessment – *Golder Associates (UK) Limited* – September 2011

This SRA report was written in support of a PPC Permit Variation Application for Whisby Landfill Site, on behalf of *Waste Recycling Group Limited*. The permit variation was to allow for hazardous waste to be accepted at the site. This SRA assessed the risks of basal heave and waste stability for the proposed hazardous cells. This SRA found that suitable factors of safety were returned for all areas assessed. The basal heave assessment includes a recommended backwall drainage system, and a recommended strategy for preventing basal heave in individual cells.

1.1.2.6 Whisby Quarry – Lagoon L9 and Bund B1 – Geotechnical Assessment – *Key GeoSolutions Limited* – January 2020

This geotechnical assessment undertaken to assess the stability of Lagoon L9 and the associated Bund B1 (immediately to the east of the IBA Cells area), which has been designated as a significant hazard and registered as a 'Notifiable Tip' with the HSE. This report contains a stability risk assessment for the bund considering the water level in the lagoon and the situation where the lagoon is filled with silt. The SRA found that suitable factors of safety were returned for all scenarios assessed, and made recommendations for inspections, and monitoring.

1.2 Conceptual Stability Site Model

The following sub-sections present a summary of the natural geological and fill materials (including engineered fill and un-engineered infill) used in the model, relating specifically to the components identified in **Form IPPC Landfill Part B**, and from the guidance contained within the **Environment Agency R&D Technical Report P1385/TR2**.

1.2.1 Geology and Ground Conditions

Geological information used in this SRA has been compiled with respect to the PPC Permit Application documents (ESID, HRA and SRA reports described above), borehole information for the site, and the British Geological Society (BGS) map for the area (Map 114 Lincoln).

The superficial geology at the site consists of Pleistocene and recent drift deposits comprising sands and gravel. 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.

Boreholes at the site show topsoil / made ground overlying the sands and gravels, ranging from 0-~7.4m deep, but generally the topsoil is shallow (<1m deep) or not present.

The sands and gravels are underlain by the Lower Lias Clay, which is comprised of firm to stiff grey slightly silty clays, and weak to moderately strong grey mudstones, with rare bands of very weak to moderately strong grey limestone. These limestone bands dip gently towards the south-east. The Lower Lias Clay is approximately 120m deep beneath the site. The level of top of the Lower Lias Clay deposits varies from **12.33mAOD** on the northern boundary of the site (near the existing sand and gravel quarry) to **3.84mAOD** in the central eastern area of the site. The interface between the sands and gravels and the Lower Lias Clay has been modelled for the IBA Cells area at **6mAOD** in this SRA.

As part of previous site investigations, 28 boreholes were drilled across the site, passing through the upper sands and gravels into the Lower Lias Clay. The limestone bands were found within the Lower Lias Clay within several of these boreholes, with a maximum level of **~4mAOD**. The limestone bands found had thicknesses of up to ~1m. The location of limestone bands beneath the IBA Cells area is uncertain. For simplicity, the limestone bands have not been modelled within the Lias Clay beneath the site in this SRA, as the compressibility / strength of this material will be high and not impact on the landfill cells above.

1.2.2 Hydrogeology and Groundwater

Groundwater is present within both the sand and gravels and the limestone bands in the Lias Clay.

The sands and gravels are classified as a minor aquifer. The sands and gravels have a relatively high permeability compared to the Lower Lias Clay and have moderate groundwater storage attributes. Natural groundwater levels in the sands and gravels range between **8 and 10m AOD**. Groundwater is monitored in several boreholes across site. Monitoring from before the PPC permit gives a wide range of levels, between of **~4 to ~11mAOD** groundwater level. Groundwater is currently abstracted from the Toe Drain sump located at the western edge of the landfill (**Cells 7 and Cell 8**), as well as from **Area A,** the existing excavation where the IBA Cells are to be constructed.

Drawing ESID11 (in the PPC ESID report) shows the November 2003 groundwater levels across the site, based on monitoring levels in boreholes on site. Groundwater flow beneath the site was shown to be towards the north / north-west, probably due to the dewatering operations in Area A (at the time of the PPC permit). Groundwater levels were shown to be highest to the east and south-east of the site, at **~8.5-10mAOD**. In the centre of the site, groundwater levels were at **~4-7mAOD**.

In Area A, the groundwater levels from 2003 were much lower due to the dewatering operations, ranging between ~-**3mAOD and 3mAOD.** Dewatering operations are ongoing in this area, but groundwater levels have risen, with the surface of the current groundwater 'lake' within the excavation of Area A being at around **6.65mAOD**. A natural groundwater level of **8mAOD** has been modelled in the sands and gravels in this SRA, reduced to **6.65mAOD** in the existing excavation. Following the excavation works for the IBA Cells and associated dewatering, **the 6.65mAOD** level has been drawn down in the modelling to the base of the excavation, at around **2.5mAOD**. This level has been applied during the construction and infilling of IBA Cell 1 in the modelling of this SRA, assuming that any groundwater flowing towards this area within the sands and gravels will be picked up by the backwall drainage system and not enter the landfill area.

The Lower Lias Clay is classed as a non-aquifer, having a very low permeability of k=~$1x10^{-11}$m/s. However, the limestone bands within the Lias Clay have a higher permeability (particularly due to fracturing in the rock), at around k=~$1x10^{-6}$m/s. The groundwater within the limestone bands can be semi-artesian (piezometric level is close to ground level). In monitoring boreholes installed in the Lower Lias Clay, water levels have been recorded at between **16.4 – 22.5mAOD** (from the limestone bands), as presented in the PPC ESID Report for the site. Due to the uncertainty regarding the presence of these limestone bands immediately beneath the IBA Cells area, these bands and the associated high groundwater levels have not been modelled in this SRA. It has been assumed that any groundwater pressures from limestone bands immediately beneath the IBA Cells will be relieved using suitable dewatering measures during the construction phase.

The groundwater level modelled for the Lower Lias Clay has been set below the base of the IBA Cells at **-5mAOD**.

1.2.3 Stability Section Selection

The stability sections utilised in this SRA has been selected as they represent the worst-case scenarios for stability and integrity associated with the first IBA Cell proposed to be constructed at Whisby Landfill Site. The sections and allow for analysis to be undertaken on all aspects of the proposed engineering works and waste infilling operations associated with IBA Cell 1. This includes analysis of final waste placement within IBA Cell 1, which can only be completed following the construction of the IBA Cells to the west. Two cross-sections were used while undertaking the assessment. **Section 1-1'** runs from south to north through IBA Cell 1, incorporating the full height northern side-slope, and a temporary waste flank within the cell. **Section 2-2'** runs from west to east through IBA Cell 1 and the existing surface water lagoon and associated dam which is located on the eastern edge of the cell, and also includes a temporary waste flank within the cell. A drawing showing the positions of the sections is presented in **Appendix SRA1**. The geometry of each section is shown in **Appendix SRA2**.

1.2.4 Basal Subgrade Model

The basal subgrade for IBA Cell 1 shall consist of the Lower Lias Clay Formation. Areas of unsuitable soft material which remain following the excavation works for the cell are to be removed. The cell formation levels are to be at ~3mAOD. Cohesive engineered fill material may be placed in localised areas to achieve the required formation levels for the cell.

If groundwater bearing limestone bands are found in the immediate basal subgrade, then these shall be removed and replaced with suitable engineered clay liner material (the same material as placed on the cell side-slopes). Appropriate measures shall be taken if required during the construction phase to relieve any groundwater pressures / inflow of groundwater from limestone bands within / below the basal subgrade.

1.2.5 Side Slope Subgrade Model

The side-slope subgrade for IBA Cell 1 shall consist of the sands and gravels on the upper side-slopes, and the Lower Lias Clay on the lower side-slopes. In areas where engineered fill is required to bring the side-slope levels up to the formation levels / replace unsuitable material, the immediate side-slope subgrade for the cell shall consist of cohesive engineered fill, with a side-slope gradient of 1 in 3. 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. This geocomposite layer has been activated as a drain in the modelling in this SRA, to ensure that any groundwater pressures developed in the model are relieved.

On the eastern side of IBA Cell 1, the side-slope subgrade shall consist of the existing dam / bund which separates the construction area from the existing surface water lagoon. It has been assumed that this dam has been constructed from cohesive (low permeability) engineered fill.

1.2.6 Basal Lining System Model

No basal lining system is proposed for IBA Cell 1, as the in situ Lower Lias Clay provides a thick low permeability barrier beneath the site.

1.2.7 Side-Slope Lining System Model

The side-slope lining system for IBA Cell 1 shall be comprised of:

- 1,000mm (1m) compacted clay liner (CCL) with average permeability of k=1 x 10^{-9} m/s.

The side-slope lining system is to be constructed at a gradient of **1 in 3.** On the western side of the cell, an inter-cell bund is to be constructed, at 3m high, a side-slope gradient of **1 in 2**, and a crest width of 2m.

1.2.8 Waste Mass Model

The waste mass within IBA Cell 1 is to be comprised of incinerator bottom ash (IBA), which generally contains **concrete, ceramics, glass, brick, clinker, and some metals**. The IBA waste mass has been modelled to achieve the approved restoration contours for the site. Temporary waste flanks within the cell have been modelled at a gradient of **1 in 3.**

The leachate level in the IBA waste has been set at **4.5mAOD**, which is the licensed leachate level for the site. This level has only been applied in the final phase of waste placement in the IBA Cells (as modelled on **Section 1-1'**), as leachate will take some time to build up following placement of the waste.

The IBA waste mass phasing applied in the modelling has been based on the proposed phasing for the IBA Cells. On **Section 1-1'**, it was necessary to model the final phase of waste placement in the IBA Cells, as this includes further waste placement in IBA Cell 1. The cell construction and in-filling timeframe which has been modelled in this SRA represents an accurate timeframe and sequence for the site, and is as set out in **Table SRA1** below.

TABLE SRA1: CONSTRUCTION TIMEFRAME USED IN THE MODEL	
Construction Description	**Timescale (Days)**
Excavate IBA Cell 1 Area	30 Days
Install GDL on the Northern and Southern Side-slopes of IBA Cell 1	7 Days
Placement of Engineered Fill to Formation Levels of IBA Cell 1	14 Days
Construct Engineered Clay Liner on Side-slopes of IBA Cell 1 and Eastern Intercell Bund	14 Days
IBA Waste Infill in Cell 1 (Temporary Waste Flanks at 1 in 3)	182 Days
Section 1-1' Only: Wait 1 Year (no Activity)	365 Days
Section 1-1' Only: Final IBA Waste Infill in Cell 1	182 Days

1.2.9 Capping System Model

The capping system proposed for the IBA Cells (if installed) is to be the same as that used for the previous non-hazardous waste cells at the site. No changes are proposed to the capping system from that assessed in previous stability risk assessments and therefore this has not been assessed further.

1.2.10 Surface Water Lagoon and Dam Model

The existing lagoon immediately to the east of IBA Cell 1 contains surface water runoff from the site. The water level within the lagoon is significantly higher than groundwater levels in the sands and gravels, at around **11.6mAOD**. This level has been applied in the lagoon in the modelling, sloping down through the bund / dam to the **6.65mAOD** level within the existing excavation in the IBA Cells area. Following the excavation of the IBA Cells area and associated pumping of groundwater, the water level on this side of the dam has been drawn down further to the base of the sands and gravels at **6mAOD.**

It has been assumed that the lagoon dam (bund) has been constructed using cohesive engineered fill. The outer side-slope of the lagoon bund (towards the IBA Cells) has been modelled at a gradient of **1 in 3**. The inner side-slope (on the water side) has been modelled at a gradient of **1 in 2**, with a 1m thick engineered clay liner. It has been assumed that the lagoon was excavated down to the top of the Lower Lias Clay, at **6mAOD.**

The modelling in this SRA includes 2 (two) scenarios where the water level in the lagoon is drawn down (due to pumping), as described below:

- **'Draw-down' Scenario 1**: the water level is drawn down to the base of the lagoon over a period of 2 weeks, based on the current ground conditions in the IBA Cells area (no construction);
- **'Draw-down' Scenario 2**: the water level is drawn down to the base of the lagoon over a period of 2 weeks, following the construction and infilling of IBA Cell 1 (with the weight of the IBA waste on the other side of the lagoon bund).

For both scenarios, the 'draw-down' of the water level will remove the confining water pressure on the lagoon side of the dam. At the same time as this 'draw-down', pore water pressures within the dam/bund will begin to reduce. However, the rate of change is dependent on the permeability soils within the bund, and can have a significant impact (reduction) on the stability bund (especially where pore-water pressures within the bund remain high, delaying the increase in shear strength accompanied by an increase in effective stress as pore water pressures dissipate). This change (and the impact of this on the stability of the bund/dam) has been examined using 'Plaxflow' (a groundwater flow module within PLAXIS) so that the reduction in pore-water pressures are modelled in 'real-time'. The 'draw-down' modelled lowers the water level from **11.6mAOD** to **6mAOD,** and calculates the reduction in pore-water pressures in real-time**.** The timeframes modelled for this water 'draw-down' are outlined in **Table SRA2** below.

TABLE SRA2: WATER 'DRAW-DOWN' PHASES TIMEFRAME USED IN THE MODEL	
Phase Description	**Timescale (Days)**
2 Week Wait (no activity) following Initial model Phase	14 Days
'Draw-down' Scenario 1: Water 'Draw-down' to Base of Lagoon over 2 Weeks	14 Days
2 Week Wait (no Activity) Following Final IBA Waste Infill in Cell 1	14 Days
'Draw-down' Scenario 2: Water 'draw-down' to Base of Lagoon over 2 Weeks	14 Days

The water levels in the modelled in the dam before and after the draw down are shown on the geometry printouts in **Appendix SRA2**.

2 STABILITY RISK ASSESSMENT

The six principal components of the conceptual stability site model have been considered and the various elements of each component have been assessed with regard to stability and integrity.

The principal components considered are the:

- Basal subgrade;
- Side-slope subgrade;
- Basal lining system;
- Side-slope lining system;
- Waste; and
- Capping System.

2.1 Risk Screening

Issues relating to stability and integrity for each principal component of the landfill have been subject to a preliminary review ('screening') to determine the need to undertake further detailed geotechnical analyses. The following sections present the results of this screening exercise.

2.1.1 Basal Subgrade Screening

The basal subgrade shall be comprised of the *in-situ* Lower Lias Clay, and discrete areas of engineered fill where required. The key considerations for the basal subgrade and the implications for stability and integrity are presented in **Table SRA3** below.

TABLE SRA3: SCREENING FOR BASAL SUBGRADE		
Excessive Deformation	Compressible Subgrade	The basal subgrade for the IBA Cells is comprised of the Lower Lias Clay which is relatively incompressible. Areas of engineered fill placed will be more compressible. However, these compressible materials will not have an impact on the lining system integrity of IBA Cell 1, as no basal lining system is to be constructed. Therefore, the impact of the basal subgrade on the integrity of the landfill will not be assessed further in this report.
	Heave	There is a potential risk of basal heave during the excavation and construction of the IBA Cells. This is due to the presence semi-artesian groundwater being present in the limestone bands within the Lower Lias Clay; these bands may be present at a shallow depth beneath the base of the IBA Cells. Following the infilling of the IBA Cells, there will no longer be a risk of basal heave, as the confining weight of the IBA waste will prevent this occurring. Basal heave should not cause integrity issues in the lining system, as no basal lining system is to be constructed, but may potentially disrupt the works due to disturbance of the ground and groundwater outbreaks. Suitable groundwater pressure relief / dewatering works are to be employed where required during the construction works to mitigate basal heave at this time. As this is a construction phase issue and there is not basal lining system which could potentially be damaged by heave, basal heave will not be assessed further in this report.
	Cavities in Subgrade	None anticipated.

2.1.2 Side-Slope Subgrade Screening

The side-slope subgrade shall be comprised of *in-situ* sands and gravels beneath the upper side-slopes, and *in-situ* Lower Lias Clay beneath the lower side-slopes. The side-slope subgrade for the eastern side-slope of IBA Cell 1 shall be comprised of the existing dam / bund containing the surface water lagoon, this dam is assumed to have been constructed from cohesive engineered fill. Further areas of cohesive engineered fill are to be placed on the IBA Cell 1 side-slopes where required to achieve the formation levels / replace unsuitable material. The key considerations for the side-slope subgrade and the implications for stability and integrity are presented in **Table SRA4** below.

TABLE SRA4: STABILITY COMPONENTS FOR SIDE-SLOPE SUBGRADE		
Excessive Deformation	Compressible subgrade	Where the side-slope subgrade is comprised of *in-situ* sands and gravels or Lower Lias Clay, this material is relatively incompressible and is unlikely to lead to significant movements / integrity issues in the overlying lining system. Where the side-slope subgrade is to be comprised of placed cohesive engineered fill, this material is relatively compressible and susceptible to movement during construction. The existing engineered fill dam retaining the surface water lagoon will also be relatively compressible. The impact of these compressible materials on the stability and integrity of the lining system will be assessed further in this report.
	Heave	The groundwater within the in-situ sands and gravels will be lowered by pumping during the works, and managed by a backwall drainage system (geocomposite and pipe drains) under the side-slope lining system following construction. Any groundwater from limestone bands which could potentially be present close to the base of the side-slopes will also be managed by the backwall drainage system. Therefore, heave of the side-slope subgrade is not anticipated and has not been assessed further in this report.
	Cavities in subgrade	None anticipated.

2.1.3 Basal Lining System Screening

No basal lining construction works are planned as part of these works; therefore, this has not been assessed further.

2.1.4 Side-Slope Lining System Screening

The key considerations for the side slope lining system and the implications for stability, and integrity, are presented in **Table SRA5** below.

TABLE SRA5: STABILITY COMPONENTS FOR SIDE-SLOPE LINING SYSTEM		
Un-confined	Stability	The liner will be least stable when the slope is un-confined, and no waste has been placed against it. As waste is placed against the side-slope the factor of safety will increase as the waste provides a passive resistance wedge at base of the slope. The stability of the side-slope lining system while it is constructed / unconfined will be assessed in this report.
	Integrity	An assessment will be made of the shear strains in the side slope lining system during its construction. The results of these analyses will be compared with the work of the most recently published papers concerning the long-term integrity of liners.
Confined	Stability	Confinement of the side-slope lining system will increase the factor of safety from that of an un-confined slope, as the waste will provide passive resistance, and added stability to the system. The confined slope will be assessed in this report.
	Integrity	An assessment will be made of the shear strains in the side-slope lining system during waste placement. The results of these analyses will be compared with the work of the most recently published papers concerning the long-term integrity of liners.

2.1.5 Waste Mass Screening

The controlling factors that influence the stability of the IBA waste mass are presented in **Table SRA6** below.

TABLE SRA6: STABILITY COMPONENTS OF WASTE SLOPES			
Failure wholly in waste	Stability		The IBA waste will be placed in horizontal layers, thereby reducing slope angles of the waste, improving stability. Temporary waste flanks will be constructed in the waste. Following the completion of the IBA Cells infilling, final waste flanks will be shallower and less critical for stability. The stability of temporary waste flanks and the final waste placement will be assessed further in this report.
Failure involving liner and waste	Mineral Clay	Stability	Loading of the waste against the liner may cause the waste to fail along / through the lining system, causing damage to the liner. This will be assessed further in this report.
		Integrity	An assessment will be made of the shear strains in the side-slope lining system after each lift of waste placement, as the placement of waste may apply additional strains to the liner. The results of these analyses will be compared with the work of the most recently published papers concerning the long-term integrity of liners.
Failure involving surface water lagoon dam and waste	Lagoon Dam	Stability	Loading of the waste against the surface water lagoon dam (on the western side), could potentially impact on the stability of the dam, with slope movements towards the lagoon side. The draw down of water in the dam could increase the risk of a stability failure. This scenario will be assessed further in this report.

2.1.6 Capping System Screening

No changes to the site-wide capping system design are proposed as part of the IBA Cells construction works. Therefore, the stability and integrity of capping systems does not require assessment in this SRA.

2.2 Justification for Modelling Approach and Software

In order to perform a comprehensive stability risk assessment (SRA), the components of the landfill containment systems have to be considered not only individually, but also in conjunction with one another, where relevant. Any analytical techniques adopted for such an assessment should adequately represent all of the considered scenarios for both the un-confined and confined conditions (where appropriate). The methodology and the software should also achieve the desired output parameters for the assessment. This equates to the determination of factors of safety for stability assessments, or the calculation of strains within liner components for integrity assessments.

The analytical methods used in this stability risk assessment include:

(a) **Finite element analyses** for the determination of the stability of the landfill, during the construction of IBA Cell 1, the subsequent IBA waste placement phases, and following the 'draw-down' of water in the adjacent surface water lagoon, and the **calculation of factors of safety**; and

(b) **Finite element analyses** for the determination of the **shear strains** in the mineral component of the side-slope lining system, during the construction of IBA Cell 1 and the subsequent waste placement phases.

2.2.1 Finite Element Analyses

The proprietary software **PLAXIS 2D** (2020) has been used for the stability assessments. This is a two-dimensional finite element programme intended for the analysis of deformation and stability in geotechnical engineering. It is equipped for the simulation of non-linear, time dependent and anisotropic behaviour of soils and rock. In addition, since soil is multi-phase material, special procedures are required to deal with hydrostatic and non-hydrostatic pore pressures in the soil. **PLAXIS 2D** was originally developed for geotechnical engineers studying river embankments on the soft soils of the lowlands of Holland. In subsequent years, **PLAXIS 2D** has been extended to cover most other areas of geotechnical engineering. It is therefore well suited for application to the IBA Cell 1 construction at Whisby Landfill Site stability risk assessment.

2.2.2 Phi-C Reduction

A safety analysis in PLAXIS is undertaken by reducing the strength parameters of the soils. This process is termed 'Phi-C reduction' and is carried out as a separate calculation mode. Phi-C reduction is used when it is required to calculate a factor of safety, for the situation under consideration.

In the Phi-C reduction approach, the strength parameters $\tan\varphi$ and c of the soils (and interface shear strengths) are incrementally reduced until failure of the system occurs. The strengths of interfaces, if used, are reduced in the same way. The strength of structural objects like plates and anchors are not influenced by the Phi-C reduction.

The total multiplier ΣMsf is used to define the value of the soil strength parameters as a given stage in the analysis:

$$\sum Msf = \frac{\tan\varphi_{input}}{\tan\varphi_{reduced}} = \frac{c_{input}}{c_{reduced}}$$

A Phi-C reduction calculation is performed using the load advancement number of steps procedure. The incremental multiplier Msf is used to specify the increment of the strength reduction of the first calculation step. The increment is by default set to 0.1, which is generally found to be a good starting value. The strength parameters are successively reduced automatically until all Additional steps have been performed. In this case, the factor of safety can be given by:

$$SF = \frac{\textit{available strength}}{\textit{strength at failure}} = \text{value of } \sum Msf \text{ at failure}$$

If a failure mechanism has not fully developed, then the calculation is repeated with a larger number of additional steps.

To capture the failure of the system accurately, the use of arc-length control in the iteration procedure is required. The use of a tolerated error of no more than 3% is also required. Both requirements are complied with when using the Standard setting of the iterative procedure.

When using Phi-C reduction in combination with advanced soil models, these models will actually behave as a standard Mohr-Coulomb model, since stress-dependant stiffness behaviour and hardening effects are excluded. The stress-dependent stiffness modulus (where this is specified in the advanced model) at the end of the previous step is used as a constant stiffness modulus during the Phi-C reduction calculation.

For slopes, the **Phi-C reduction** approach resembles the method of calculating safety factors as conventionally adopted in traditional slip-circle analyses.

2.3 Selection of Appropriate Factors of Safety

The factor of safety is the numerical expression of the degree of confidence that exists for a given set of conditions, against a particular failure mechanism occurring. It is commonly expressed as the ratio of the load or action that would cause failure against the actual load or actions likely to be applied during service. This is readily determined for some types of analysis, for example limit equilibrium slope stability analyses. However, greater consideration must be given to analyses that do not report factors of safety directly. For example, a finite difference analysis of strains within a capping system would not usually indicate overall failure of the model even though the strains could be high enough to indicate a failure of the integrity of the system. In such cases, it is necessary to define an upper limit for shear strains and to express the factor of safety as the ratio of allowable strain to actual strain.

For the integrity assessment, it is proposed to present the maximum strains determined from the analyses and compare these with the conclusions of the latest research relating to this aspect of landfill design, in order to determine acceptability.

Assessing the short and long-term integrity of the lining system will be based on the work of Edelmann et al (1999), Jessberger and Stone (1991), Arch at al (1996) and Needham et al (1999), as well as the Guidance. The full references for all these papers are included at the end of this report, but a summary of their conclusions (and their applicability to the situation here) will be documented in the assessment section.

The factor of safety adopted for each component of the model would be related to the consequences of a failure.

<u>BS6031 - Code of Practice for Earthworks</u> (Clause 6.5.1.2 Safety Factors) states that suitable safety factors in a particular case can only be arrived at after careful consideration of all the relevant factors, and the exercise of sound engineering judgement. The factors to be considered include:

a) The complexity of the soil conditions;
b) The adequacy of the site investigation;
c) The certainty with which the design parameters represent the actual in-situ conditions;
d) The length of time over which the stability has to be assured;
e) The likelihood of unfavourable changes in groundwater regime in the future;
f) The likelihood of unfavourable changes in the surface profile in the future;
g) The speed of any movement which might take place; and
h) The consequences of any failure.

A minimum factor of safety of 1.3 is considered acceptable for stability and integrity, if reasonably conservative values are used.

2.4 Justification for Geotechnical Parameters Selected for Analysis

Geotechnical data for the analyses has been obtained from several sources. These sources include the previous stability risk assessments and published (conservative) data applicable to the analyses as well as Sirius's recent experience on other stability risk assessments.

The parameters selected for material properties consider the analysis undertaken to be conservative of conditions that are present on site.

It has been assumed that the both the Engineered Fill and the Engineered Clay Liner will be comprised of the same clay fill material, but will be undergo different levels of compactive effort / different compaction methodologies. The existing lagoon dam/bund has been modelled using the same cohesive fill material as engineered fill placed during the works.

The stiffness values chosen for the Engineered Fill, as presented in **Table SRA7** below, have been chosen as typical values for cohesive engineered fill as it is placed in the ground. The Hardening Soil model used within PLAXIS models increasing stiffness with effective stress (and thus depth below the ground surface). The reference stiffness values chosen are based on an effective stress of 20kPa, which is typical of engineered fill during placement / close to the surface.

The engineered clay liner (ECL) has been modelled using the *Mohr-Coulomb* soil model in PLAXIS. The Young's Modulus (E) value of 6MPa (as presented in **Table SRA8**) is applied to the material regardless of stress conditions / depth. This value is considered to be reasonably conservative for an Engineered Clay Liner, during placement and following confinement with waste.

2.5 Summary of Material Parameters for Finite Element Analyses

Table SRA7 below summarises the effective stress parameters utilised in the analyses (Hardening Soil model type). **Table SRA8** below summarises the effective stress parameters utilised in the analyses (*Mohr Coulomb* soil model).

TABLE SRA7: SUMMARY OF EFFECTIVE STRESS MATERIAL PARAMETERS FOR FINITE ELEMENT ANALYSES – HARDENING SOIL MODEL

Material	Unit Weight	Effective Cohesion	Effective Angle of Friction	Permeability	E_{50}^{ref}	E_{oed}^{ref}	E_{ur}^{ref}	power
	kN/m³	kN/m²	°	m/s	kN/m²	kN/m²	kN/m²	(m)
Lower Lias Clay	19.0-20.0	7.0	23.0	K=1E-11	10,000	10,000	30,000	1.0
Sands and Gravels	18.0-20.0	0.5	35.0	K=1E-5	20,000	20,000	60,000	0.5
Engineered Fill	19.5-20.0	5.0	30.0	K=5E-9	5,000	5,000	15,000	1.0
IBA Waste	12.0-15.0	1.0	35.0	K=1E-7	10,000	10,000	30,000	0.5

TABLE SRA8: SUMMARY OF EFFECTIVE STRESS MATERIAL PARAMETERS FOR FINITE ELEMENT ANALYSES – MOHR COULOMB SOIL MODEL

Material	Unit Weight	Effective Cohesion	Effective Angle of Friction	Permeability	E'	v' (nu)
	kN/m³	kN/m²	°	m/s	kN/m²	-
Engineered Clay Liner	19.5-20.0	5.0	30.0	K=1E-9	6,000*	0.25*

A PLAXIS printout of the material parameters can be found in **Appendix SRA2** of this report.

3 ANALYSIS

3.1 Introduction

The key areas of IBA Cell 1 at Whisby Landfill Site which require analysis are:

- **Stability Analysis**: The stability of the side-slope lining system and IBA waste during construction, the subsequent waste infilling and the 'draw-down' of water in the adjacent surface water lagoon; and
- **Mineral Liner Integrity Analysis:** The integrity of the side-slope lining system during cell construction, and the subsequent IBA waste infilling above the lining system.

3.2 Effective Stress Stability Analysis

A summary of the factors of safety from the PLAXIS Phi-C reduction runs for the stability model during the construction and infilling of IBA Cell 1 are presented in **Table SRA9 and Table SRA10** below, for **Section 1-1'** and **Section 2-2'** respectively.

The factors of safety for the PLAXIS Phi-C reduction runs for the stability model for the water 'draw-down' in the lagoon (**Section 2-2'**) are presented in **Table SRA11** below.

TABLE SRA9: SUMMARY OF PHI-C REDUCTION RUNS FOR CONSTRUCTION AND WASTE MODEL STABILITY (SECTION 1-1')		
Description	**Critical slope identified during analysis**	**Factor of Safety**
Excavate to Formation for IBA Cell 1	Near-Circular failure in northern side-slope subgrade of IBA Cell 1	3.278
Engineered Fill to Formation on side-slopes of IBA Cell 1	Circular failure within Engineered Fill on northern side-slope of IBA Cell 1	1.908
Engineered Clay Liner constructed on side-slopes of IBA Cell 1	Circular failure through Engineered Fill and Engineered Clay Liner on northern side-slope of IBA Cell 1	1.648
IBA Waste Infilling in Cell 1, Temporary Waste Flank at 1 in 3	Deep Near-Circular failure through IBA Temporary Waste Flank and Lower Lias Clay below IBA Cell 1 base	1.622
Final IBA Waste Infilling in IBA Cell 1 following construction of other IBA Cells	Shallow Circular failure through Permanent IBA Waste Flank above northern side-slope of IBA Cell 1.	3.370

TABLE SRA10: SUMMARY OF PHI-C REDUCTION RUNS FOR CONSTRUCTION AND WASTE MODEL STABILITY (SECTION 2-2')

Description	Critical slope identified during analysis	Factor of Safety
Excavate to Formation for IBA Cell 1	Circular failure through flank of Lagoon Dam facing IBA Cell 1	1.603
Engineered Fill to Formation on side-slopes of IBA Cell 1	Circular failure through flank of Lagoon Dam facing IBA Cell 1	1.629
Engineered Clay Liner constructed on side-slopes of IBA Cell 1	Shallow Circular failure through Engineered Clay Liner and Engineered Fill on Lagoon Dam	1.333
IBA Waste Infilling in IBA Cell 1, Temporary Waste Flank at 1 in 3	Deep Near-Circular failure through IBA Temporary Waste Flank and Lower Lias Clay below IBA Cell 1 base	1.636

TABLE SRA11: SUMMARY OF PHI-C REDUCTION RUNS FOR WASTE AND DAM MODEL STABILITY WITH WATER 'DRAW-DOWN' IN LAGOON (SECTION 2-2')

Description	Critical slope identified during analysis	Factor of Safety
'Draw-down' Scenario 1: 'draw-down' in Surface Water Lagoon over 14 days – No IBA Cells Construction	Circular failure through lagoon side flank of Lagoon Dam	1.523
'Draw-down' Scenario 2: 'draw-down' in Surface Water Lagoon over 14 days – Following Construction and Infilling of IBA Cell 1	Circular failure through lagoon side flank of Lagoon Dam	1.561

Graphical representations of the stability analyses (including failure modes) are shown in **Appendix SRA3**.

3.3 Side-Slope Liner Integrity Analysis

The following analysis is for the integrity of the side-slope lining system, during the construction of IBA Cell 1 and for the subsequent phases of waste placement. The integrity of the liner relates to shear strains that develop in the material. Strains within the clay liner can be directly analysed within the PLAXIS model.

A summary of the maximum shear strains in the engineered clay liner in each relevant phase of the modelling for the construction and infilling of IBA Cell 1 are presented in **Table SRA12** and **Table SRA13** below, for **Section 1-1'** and **Section 2-2'** respectively.

TABLE SRA12: SUMMARY OF MAXIMUM SHEAR STRAINS & LOWEST FACTOR OF SAFETY FOR THE ENGINEERED CLAY LINER – SECTION 1-1'

Model Description	1000mm Thick Clay Liner
	Maximum Shear Strain (%)
Engineered Clay Liner constructed on side-slopes of IBA Cell 1	1.287%
IBA Waste Infilling in IBA Cell 1, Temporary Waste Flank at 1 in 3	1.311%
Final IBA Waste Infilling in IBA Cell 1 following construction of other IBA Cells	1.309%
Strain Guidance Limit (Arch et al)	**10%** (Arch et al, 1996)
Factor of Safety	**7.63**

TABLE SRA13: SUMMARY OF MAXIMUM SHEAR STRAINS & LOWEST FACTOR OF SAFETY FOR THE ENGINEERED CLAY LINER – SECTION 2-2'

Model Description	1000mm Thick Clay Liner
	Maximum Shear Strain (%)
Engineered Clay Liner constructed on side-slopes of IBA Cell 1	1.544%
IBA Waste Infilling in IBA Cell 1, Temporary Waste Flank at 1 in 3	1.043%
Strain Guidance Limit (Arch et al)	**10%** (Arch et al, 1996)
Factor of Safety	**6.48**

Graphical representations of the analyses and the resulting strains in the side-slope lining system are presented in **Appendix SRA4**.

4 ASSESSMENT

The assessments outlined above are presented in the order described.

4.1 Effective Stress Stability Assessment

Table SRA9 and **Table SRA10** above outline the factors of safety for stability of the proposed cell construction and infilling works for IBA Cell 1 at Whisby Landfill Site. **Table SRA11** above outlines the factors of safety for stability for the scenarios modelled for rapid water 'draw-down' in the existing lagoon to the east of the IBA Cells area, at Whisby Landfill Site.

The lowest factor of safety for stability is recorded during the construction of the engineered clay liner on **Section 2-2'**. The factor of safety is **FOS=1.333**, for a shallow circular failure mode which passes through the engineered clay liner and underlying cohesive engineered fill on the eastern side-slope of IBA Cell 1, constructed on the existing surface water lagoon dam / bund. As the fill / engineered clay liner material is placed there is a build-up of excess positive pore water pressures within the material which cannot easily dissipate due to the low-permeability nature of the fill and subgrade, meaning there is no increase in the effective stress of the material until the pore water pressures start to dissipate. As the waste is subsequently placed against the side-slope, the factor of safety increases as the waste confines the side slope, reducing the height of the unconfined slope, increasing the factor of safety. Dissipation of positive excess pore water pressure within the low permeability material within the side-slope results in an increase in the effective stress of the material, which also improves the stability over time.

The northern and southern side-slopes of IBA Cell 1, as modelled on **Section 1-1'**, are less critical for stability, due to the presence of higher permeability subgrade (sands and gravels) beneath the engineered fill, and the geo-composite drainage layer (helping to reduce the drainage path lengths for excess pore-water). This allows for excess pore water pressures within the side-slope to dissipate faster during and following the construction of the side-slope, with the associated increase in effective stress within the fill material being faster; these slopes have greater stability (higher FOS) in the model.

Temporary waste flanks modelled within IBA Cell 1 are stable in the modelling, with factors of safety of FOS>1.6.

For the water 'draw-down' scenarios modelled in the surface water lagoon (rapid 'draw-down' in the lagoon due to pumping), the failure surface is through the lagoon side of the dam for both **Scenario 1** (before IBA Cells construction) and **Scenario 2** (following the construction and infilling of IBA Cell 1 to the west). The infilling of IBA Cell 1 with IBA waste does <u>not</u> generate a large failure mode through both the waste and the dam. As a result, the factor of safety for **Scenario 2** is **very similar** to the factor of safety for **Scenario 1,** with both factors of safety being **between FOS=1.5 and FOS=1.6**. If the parameters of the engineered fill in the lagoon dam were modified in the modelling (particularly if the permeability of this material was lowered), then the factor of safety of the lagoon dam slope following water 'draw-down' would be reduced. However, this failure mechanism would remain independent of the construction of IBA Cell 1 to the west. Therefore, it can be concluded that the construction and infilling of IBA Cell 1, immediately to the west of the existing surface water lagoon, should not impact on the stability of the existing lagoon dam. The worst-case scenario for stability has been considered where the water level in the lagoon is rapidly 'drawn-down' following the cell construction and infilling.

The reported factors of safety for the stability analyses for construction, waste infilling and water 'draw-down' scenarios are all above the minimum required FOS=1.3. Therefore, the stability of IBA Cell 1 is deemed to be acceptable.

4.2 Side-Slope Liner Integrity Assessment

Tables SRA12 and **Table SRA13** above detail the shear strains reported in the engineered clay liner on the side-slopes of IBA Cell 1.

It is important that the permeability of the mineral liner is maintained during the operation (functional lifespan) of the landfill, to prevent downward migration of leachate. Therefore, it is necessary to be able to assess how the strains within the clay liner affect the permeability of the material.

No site-specific data on the relationship between strain and permeability exists. However, research by Arch et al (1996) has shown that the permeability of compacted clay decreases for strains up to the yield point of the material (typically 6%), after which increases in permeability are exhibited. Considering the initial decrease in permeability, values above the original permeability of the compacted clay are only achieved after strains of around 11%. For the purposes of this report, a design value of 10% shear strain has been adopted, since this represents a point at which permeability adheres to the specification for the liner.

The maximum shear strain predicted by the modelling for the engineered clay liner is **1.544%**, which occurs following the construction of the engineered clay liner on the eastern side-slope of IBA Cell 1, where the lining system is constructed against the existing lagoon bund / dam. Comparing the worst-case shear strain of 1.544% against the recommended maximum of 10% gives a factor of safety of **FOS=6.48**. This factor of safety is above the minimum required FOS=1.3; the integrity of the side-slope lining system is maintained. Therefore, the proposed IBA Cell 1 construction and infilling works are unlikely to diminish the integrity of the engineered clay liner which is to form the side-slope lining system; the permeability requirement (set out in the approved HRA for the site) can be relied upon.

The critical shear strain occurs at the back edge of the lining system mid-height on the side-slope, above the cohesive engineered fill placed beneath, as shown in the integrity printouts in **Appendix SRA4**. This is because further settlement of the engineered fill subgrade occurs during the construction of the engineered clay liner.

The in-filling of the IBA waste against the side-slope of IBA Cell 1 only leads to a small increase in the shear strains in the engineered clay liner on **Section 1-1'**, while there is a decrease in the shear strains on **Section 2-2'**. Following the final IBA waste placement in IBA Cell 1 (modelled on **Section 1-1'**), when waste is placed against the southern side-slope of the cell, the maximum shear strain on **Section 1-1'** remains in the engineered clay liner on the northern side-slope of the cell.

5 CONCLUSIONS & RECOMMENDATIONS

This stability risk assessment (SRA) has addressed the stability and the integrity of the waste containment system, and the stability of the IBA waste mass, as a result of the construction and infilling of IBA Cell 1 at Whisby Landfill Site. The impact of the construction (and infilling) of 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).

Analyses have been based on the available site investigation information, conservative materials parameters, and a worst-case interpretation.

The assessments have indicated acceptable factors of safety for the stability and integrity of the proposed landfill containment system, and the associated infilling.

However, a number precautions (recommendations) have been identified, and these are outlined below.

<u>Side-Slope Lining System Stability (Fill Depth to Side-Slope Formation)</u>

The critical element relating to the stability of the landfill containment system construction is the depth (and extent) of low permeability (cohesive) engineered fill deposited to form the side-slope formation of IBA Cell 1. The stability of the side-slope lining system is very sensitive the depth, and extent, of the fill to formation placed, and the permeability of that fill.

It is recommended that the construction timeframes modelled in this SRA are followed (<u>not</u> exceeded) to ensure that the side-slope lining system of the cell remains stable during, and following, construction. Also, if the depth of engineered fill (to formation) placed on the cell side-slopes increases (from that modelled in this SRA), the analyses would need to be re-run, and the <u>initial</u> side-slope construction lift height <u>may</u> need to be lowered (before confinement, and completion of the side-slope to full height).

<u>Existing Surface Water Lagoon Dam Stability ('Rapid Draw-Down')</u>

The construction and infilling of IBA Cell 1 should not negatively impact on the stability of the existing surface water lagoon dam immediately to the east. This SRA has considered the worst-case scenario where the water level (within the lagoon) would be rapidly' drawn-down' (as a result of pumping) in the lagoon before, during construction, and following the infilling of IBA Cell 1. The potential failure mechanism (and factor of safety) for the lagoon dam remains independent of the IBA Cell 1 construction and infilling.

<u>Side-Slope Subgrade Groundwater Seepages (Control System)</u>

This SRA has been carried out assuming that all groundwater seepages from the side-slope subgrade of IBA Cell 1 will be relieved (allowed to drain freely by gravity) during the construction phase, and that a permanent side-slope subgrade groundwater seepage drainage (collection and control) system will be installed below the cell side-slopes, extending down to the basal levels.

Construction & Infilling Restrictions

Should there be any increase in the IBA waste in-filling rate, a change in the waste types being accepted, a change in the soil fill to be used for the fill to formation, or a variation in the cell geometry (side-slope length/gradient) from those modelled in this SRA, then the models would need to be revisited, to ensure that acceptable factors of safety for stability and integrity are maintained.

Future IBA Cells

The other IBA Cells which are to be constructed (after IBA Cell 1) will require further SRA work, in particular considering the amount (thickness/depth) of engineered fill placed below the side-slope lining system, to ensure that the stability and integrity of the landfill containment system, and landfilled waste, would be maintained.

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APPENDIX SRA1

DRAWINGS

LAYOUT SHOWING PROPOSED TOP OF LINER WITH STABILITY SECTION LOCATIONS

SCALE NTS

THIS INFORMATION IS CONFIDENTIAL AND THE PROPERTY OF SIRIUS. IT IS RELEASED ON CONDITION THAT NONE OF THE INFORMATION SHALL BE DISCLOSED TO ANY THIRD PARTY OR REPRODUCED IN WHOLE OR PART WITHOUT THE PRIOR CONSENT IN WRITING OF SIRIUS.

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 SIRIUS ENVIRONMENTAL PRIOR TO CONSTRUCTION WORKS COMMENCING.

4. FOR SECTION DETAILS SEE DRAWING WR7885 01 03

LEGEND

- 18.5 — SITE SURVEY
- 19.5 — PROPOSED TOP OF LINER
- 19.0 — PROPOSED TOP OF FORMATION / INSITU CLAY BELOW CLAY / OVERBURDEN INTERFACE
- LCP — 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

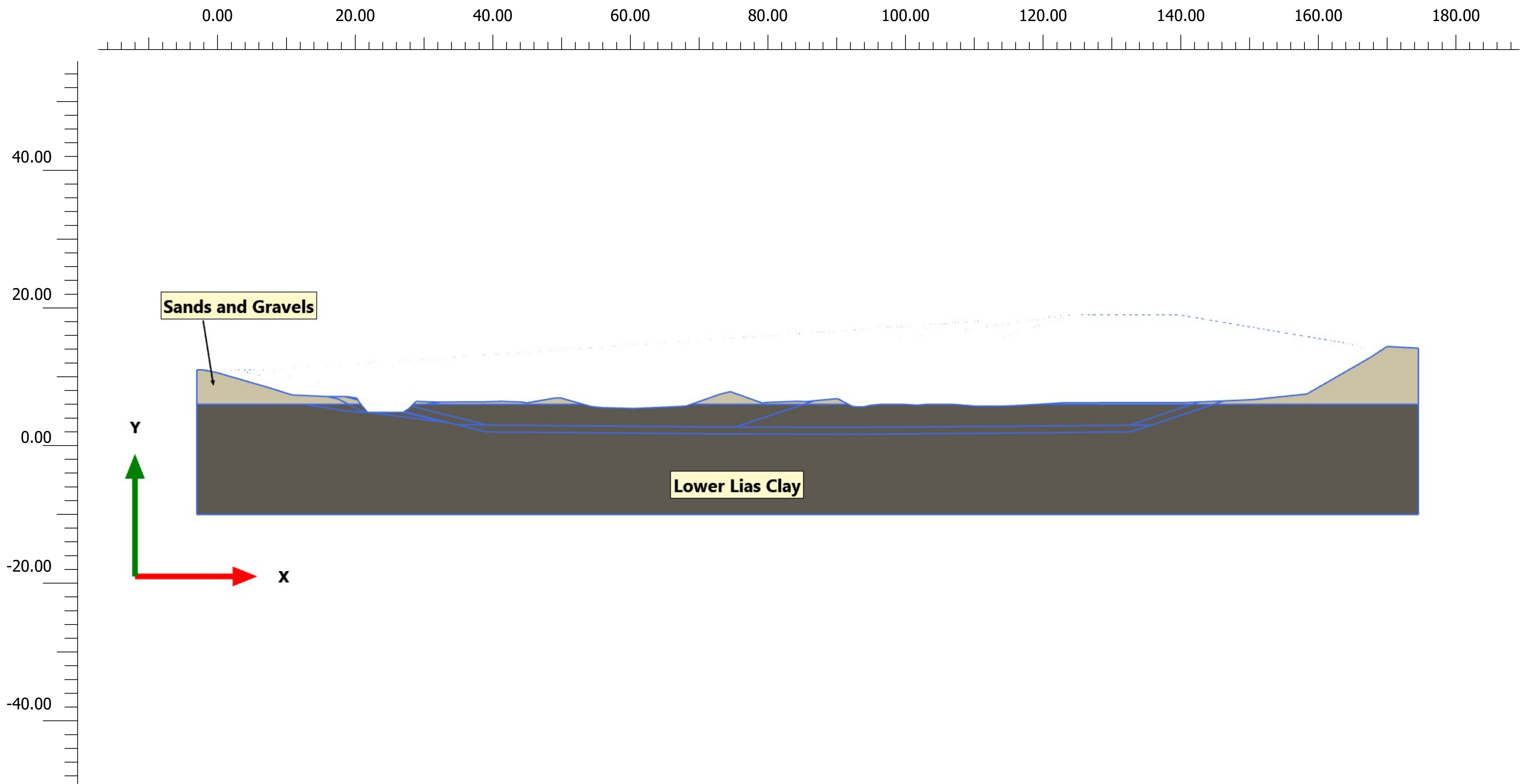
DRAWN	DATE	APPROVED	DATE
JC	03/03/2023	A.K	03/03/2023

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

APPENDIX SRA2

MODEL GEOMETRY AND MATERIAL PARAMETERS

Output Version 21.1.0.479

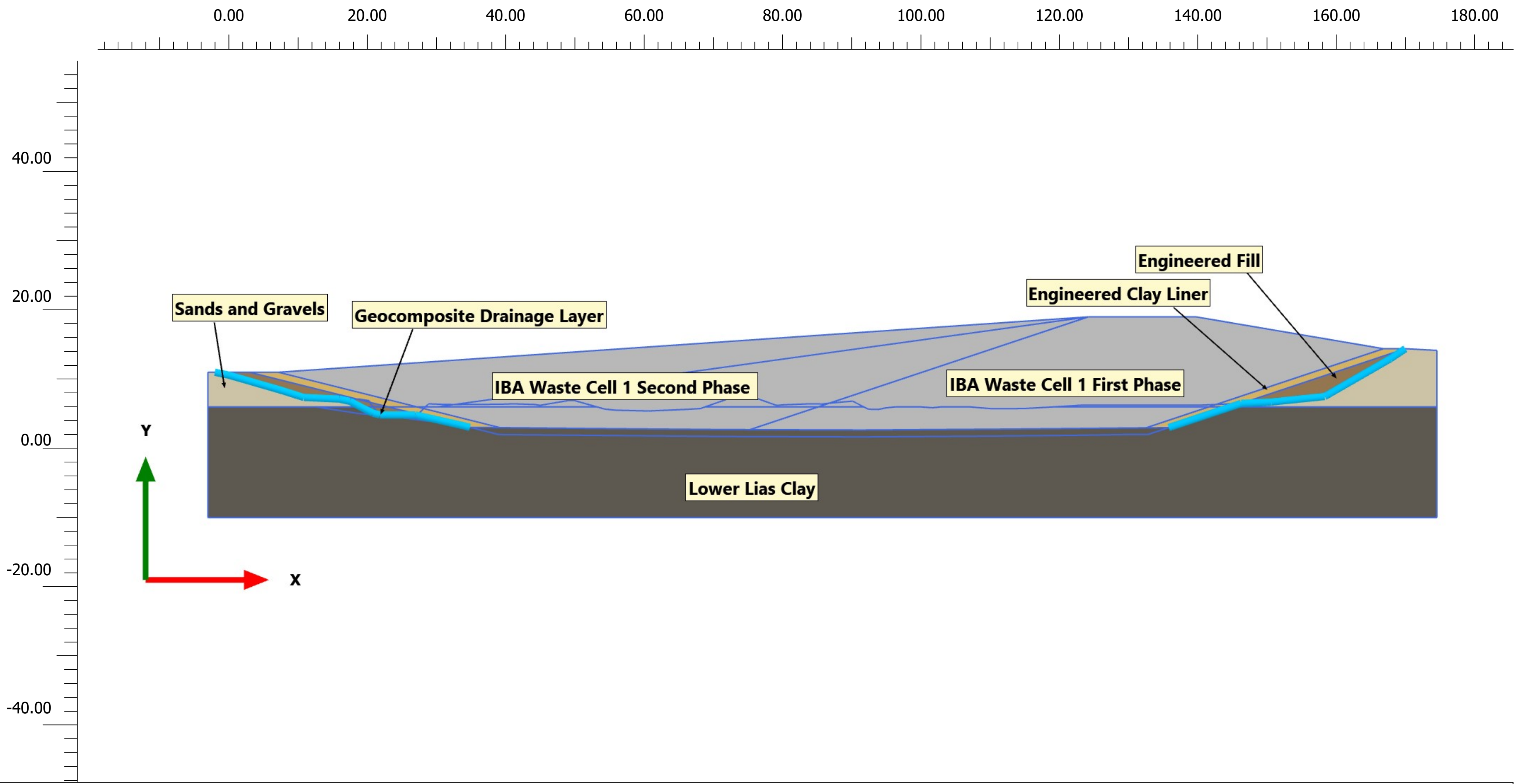


Section 1-1' Initial Geometry

Project description	Date
Whisby IBA Cells SRA	06/03/2023

Project filename	Step	Company
South-North Section 1-1' D3	9	Sirius Environmental Ltd

Output Version 21.1.0.479

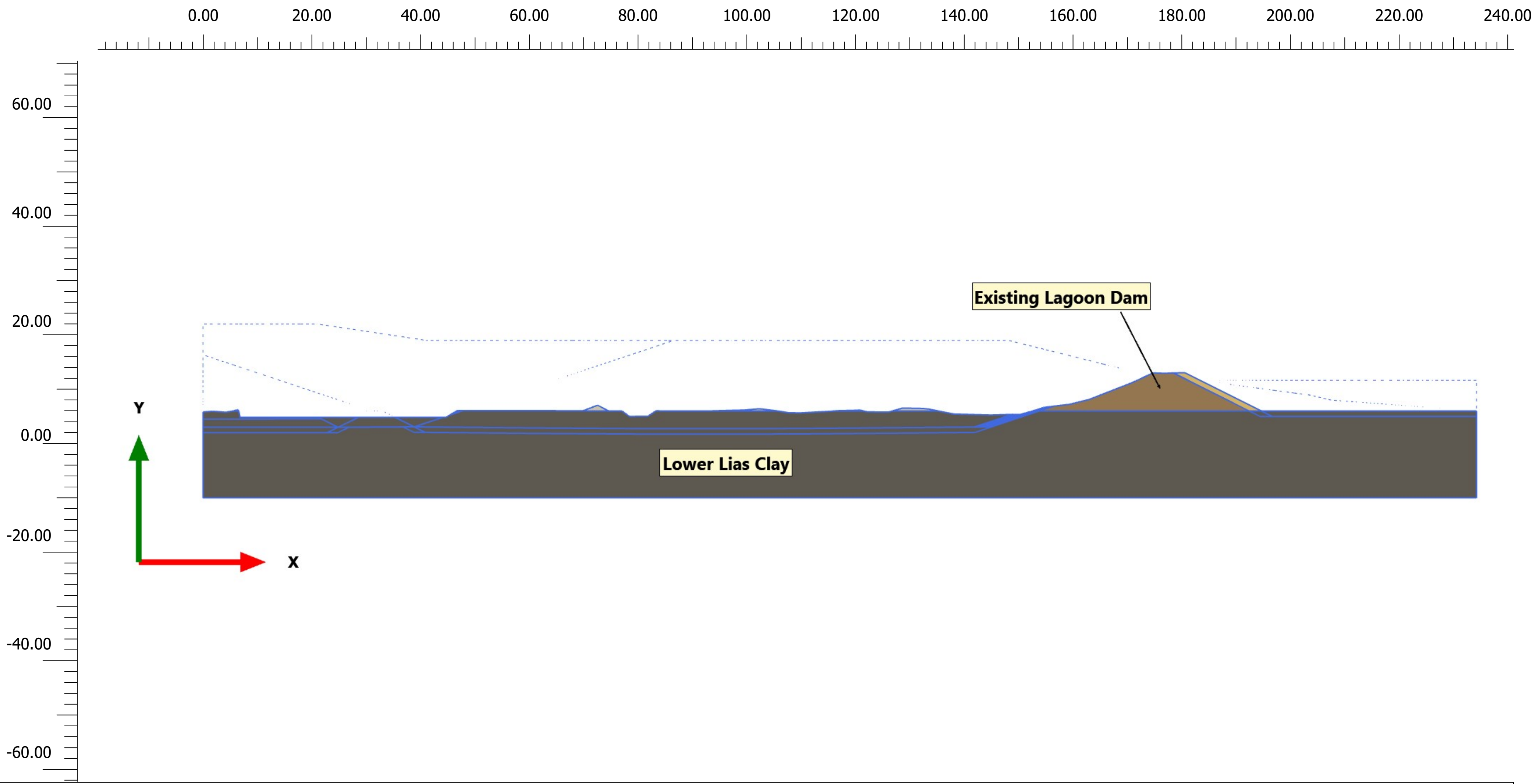


Section 1-1' Final Geometry

Project description	Date
Whisby IBA Cells SRA	06/03/2023

Project filename	Step	Company
South-North Section 1-1' D3	539	Sirius Environmental Ltd

Output Version 21.1.0.479

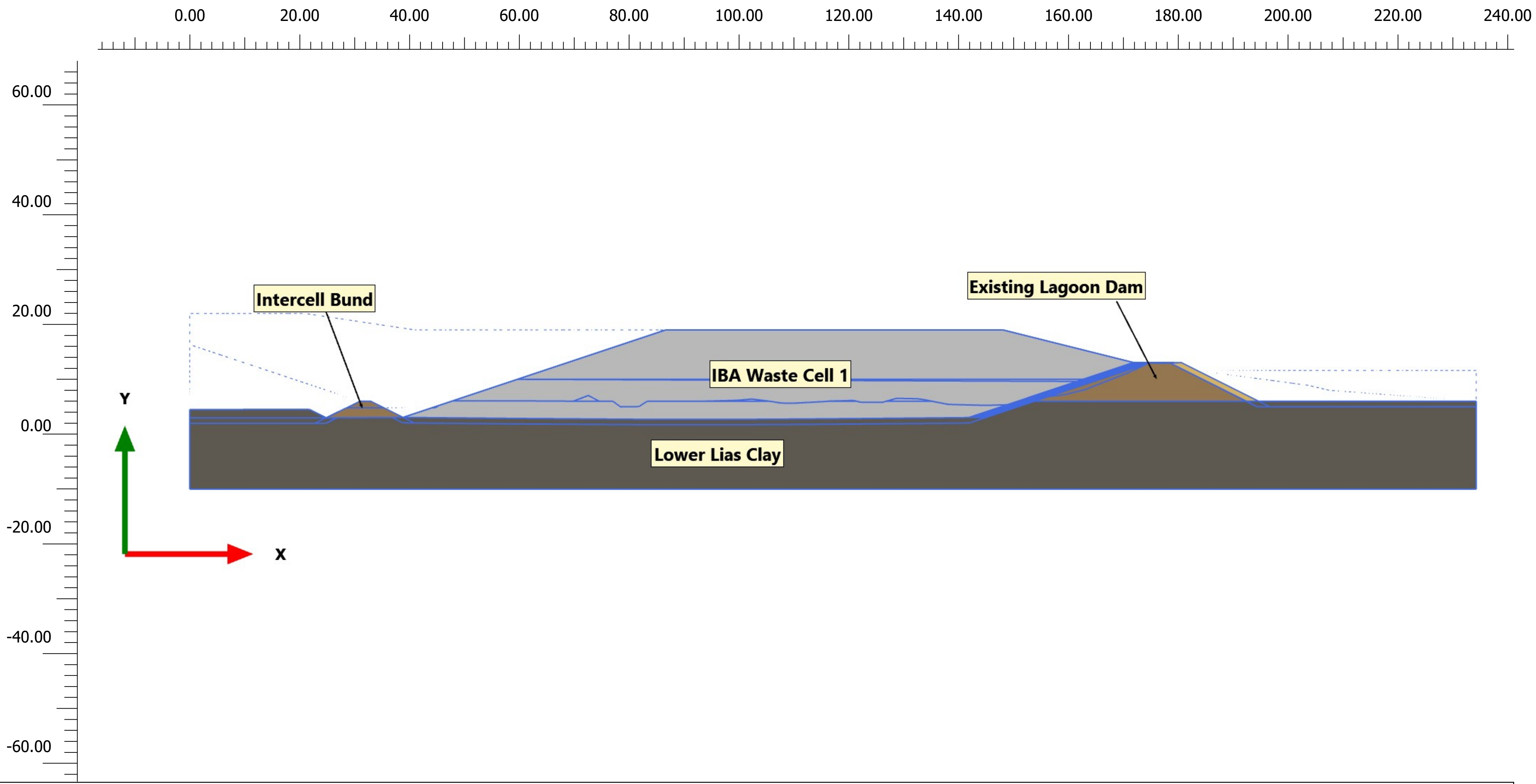


Section 2-2' Initial Geometry

Project description Whisby IBA Cells SRA			Date 06/03/2023
Project filename West-East Section 2-2' D3	Step 10	Company Sirius Environmental Ltd	

sirius Environmental

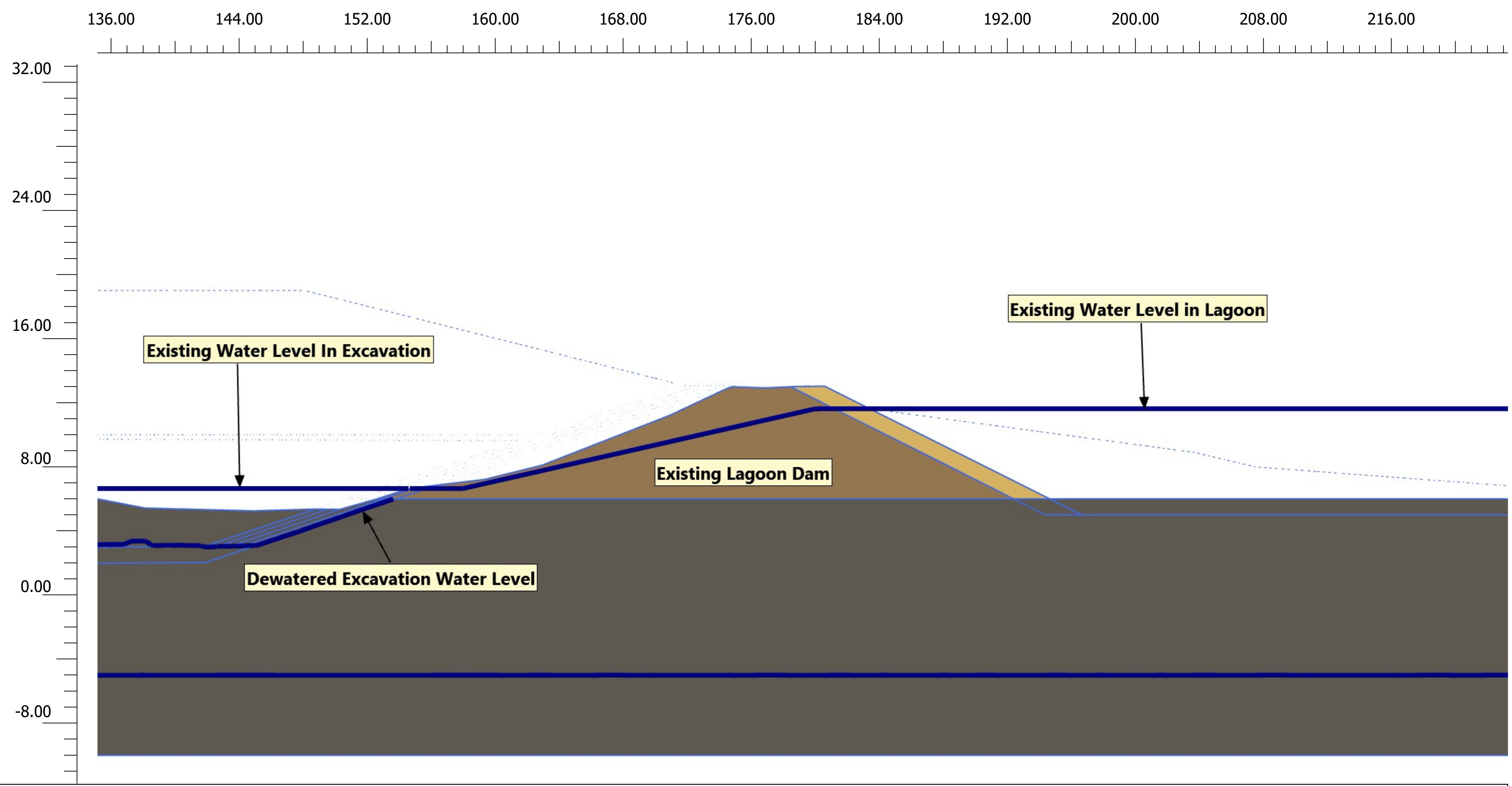
Output Version 21.1.0.479



Section 2-2' Final Geometry

Sirius Environmental	*Project description* Whisby IBA Cells SRA		*Date* 06/03/2023
	Project filename West-East Section 2-2' D3	*Step* 138	*Company* Sirius Environmental Ltd

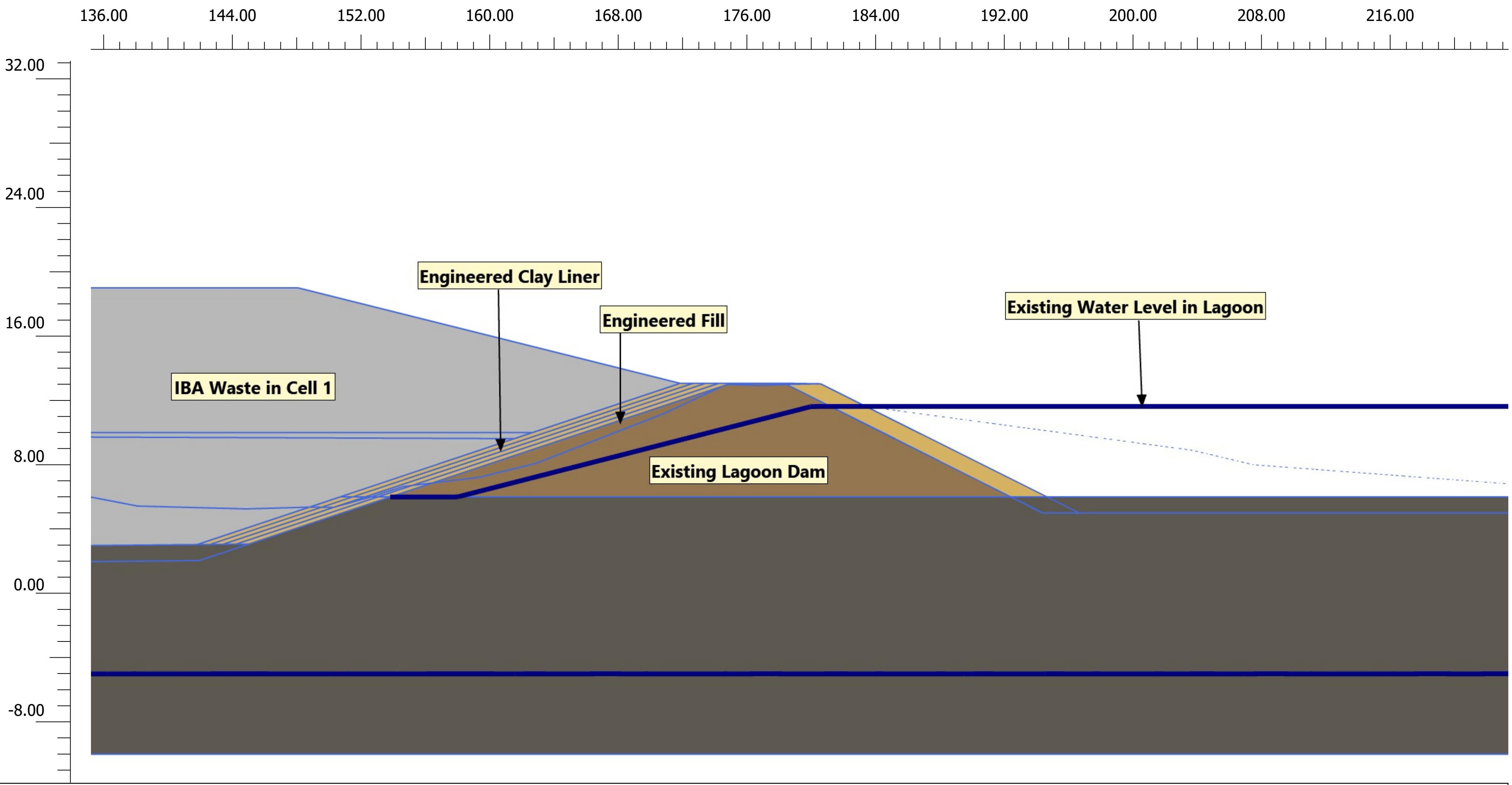
Output Version 21.1.0.479



Section 2-2' Initial Dam Water Levels

Project description Whisby IBA Cells SRA		*Date* 06/03/2023
Project filename West-East Section 2-2' D3	*Step* 10	*Company* Sirius Environmental Ltd

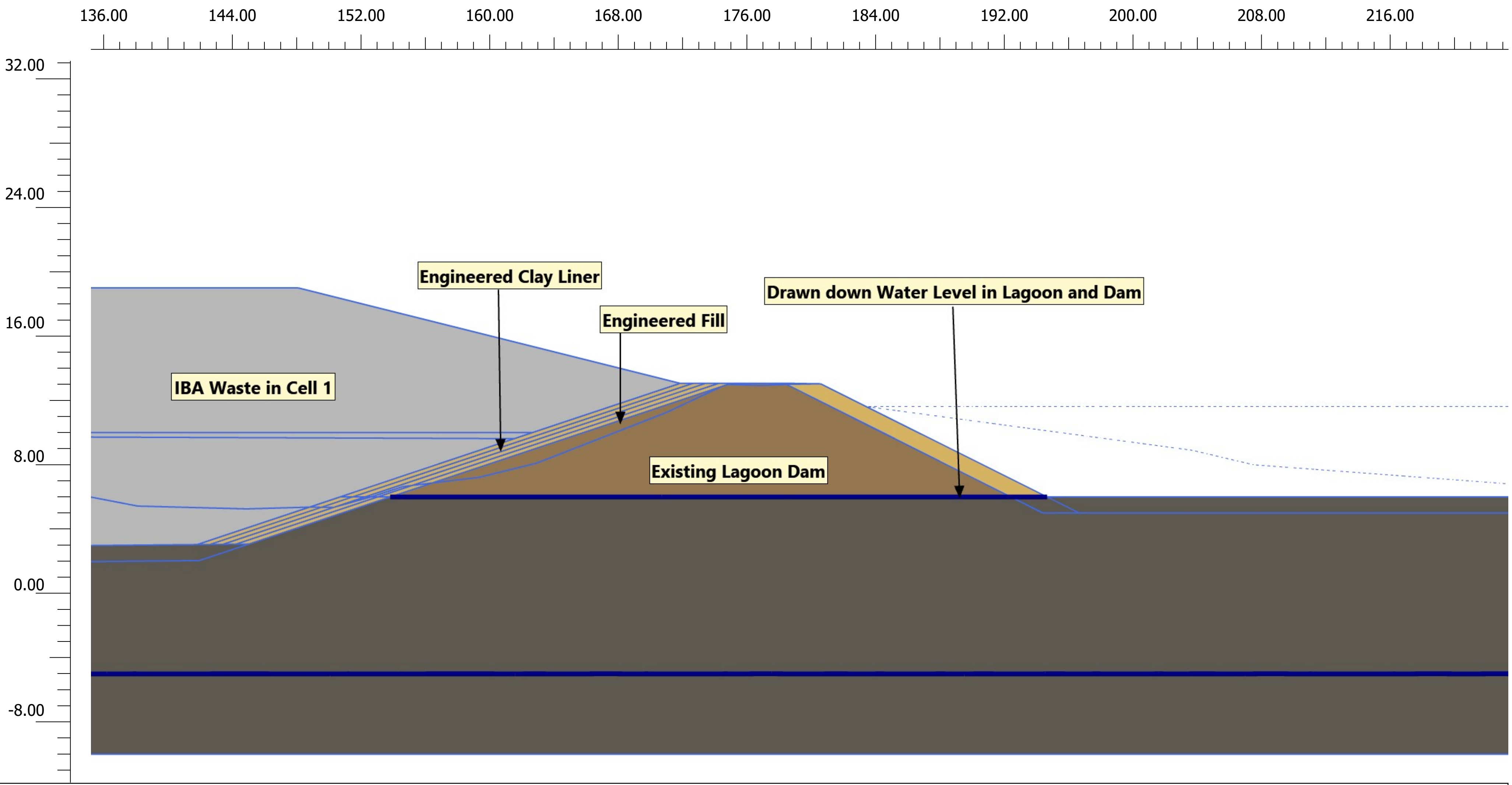
Output Version 21.1.0.479



Section 2-2' Post-Construction Dam Water Levels

	Project description Whisby IBA Cells SRA		*Date* 06/03/2023
	Project filename West-East Section 2-2' D3	*Step* 138	*Company* Sirius Environmental Ltd

Output Version 21.1.0.479



Section 2-2' Drawn Down Dam Water Levels

Project description	*Date*
Whisby IBA Cells SRA	06/03/2023

Project filename	*Step*	*Company*
West-East Section 2-2' D3	125	Sirius Environmental Ltd

Material set			
Identification number		1	2
Identification		Lias Clay	Sands and Gravels
Material model		Hardening soil	Hardening soil
Drainage type		Undrained (A)	Undrained (A)
Colour		RGB 91, 86, 77	RGB 197, 188, 160
Comments			
General properties			
γ_{unsat}	kN/m³	19.00	18.00
γ_{sat}	kN/m³	20.00	20.00
Advanced			
Void ratio			
Dilatancy cut-off		No	No
e_{init}		0.5000	0.5000
e_{min}		0.000	0.000
e_{max}		999.0	999.0
Damping			
Rayleigh α		0.000	0.000
Rayleigh β		0.000	0.000
Stiffness			
E_{50}^{ref}	kN/m²	10.00E3	20.00E3
E_{oed}^{ref}	kN/m²	10.00E3	20.00E3
E_{ur}^{ref}	kN/m²	30.00E3	60.00E3
power (m)		1.000	0.5000
Alternatives			
Use alternatives		No	No
C_c		0.03450	0.01725
C_s		0.01035	5.175E-3
e_{init}		0.5000	0.5000
Strength			
c_{ref}	kN/m²	7.000	0.5000
φ (phi)	°	23.00	35.00
ψ (psi)	°	0.000	5.000

Identification		Lias Clay	Sands and Gravels
Advanced			
Set to default values		Yes	Yes
Stiffness			
ν_{ur}		0.2000	0.2000
p_{ref}	kN/m²	100.0	100.0
K_0^{nc}		0.6093	0.4264
Strength			
c_{inc}	kN/m²/m	0.000	0.000
y_{ref}	m	0.000	0.000
R_f		0.9000	0.9000
Tension cut-off		Yes	Yes
Tensile strength	kN/m²	0.000	0.000
Undrained behaviour			
Undrained behaviour		Standard	Standard
Skempton-B		0.9866	0.9866
ν_u		0.4950	0.4950
$K_{w,ref}$ / n	kN/m²	1.229E6	2.458E6
Stiffness			
Stiffness		Standard	Standard
Strength			
Strength		Rigid	Rigid
R_{inter}		1.000	1.000
Consider gap closure		Yes	Yes
Real interface thickness			
δ_{inter}		0.000	0.000
Groundwater			
Cross permeability		Impermeable	Impermeable
Drainage conductivity, dk	m³/day/m	0.000	0.000
Thermal			
R	m² K/kW	0.000	0.000

Identification		Lias Clay	Sands and Gravels
K0 settings			
K_0 determination		Automatic	Automatic
$K_{0,x} = K_{0,z}$		Yes	Yes
$K_{0,x}$		0.6093	0.4264
$K_{0,z}$		0.6093	0.4264
Overconsolidation			
OCR		1.000	1.000
POP	kN/m²	0.000	0.000
Model			
Data set		Standard	Standard
Soil			
Type		Coarse	Coarse
< 2 μm	%	10.00	10.00
2 μm - 50 μm	%	13.00	13.00
50 μm - 2 mm	%	77.00	77.00
Flow parameters			
Use defaults		None	None
k_x	m/day	0.8640E-6	0.8640
k_y	m/day	0.8640E-6	0.8640
$-\psi_{unsat}$	m	10.00E3	10.00E3
e_{init}		0.5000	0.5000
S_s	1/m	0.000	0.000
Change of permeability			
c_k		1000E12	1000E12

Identification		Lias Clay	Sands and Gravels
Parameters			
c_s	kJ/t/K	0.000	0.000
λ_s	kW/m/K	0.000	0.000
ρ_s	t/m^3	0.000	0.000
Solid thermal expansion		Volumetric	Volumetric
α_s	1/K	0.000	0.000
D_v	m^2/day	0.000	0.000
f_{Tv}		0.000	0.000
Unfrozen water content		None	None

Material set			
Identification number		3	5
Identification		Engineered Fill	IBA Waste
Material model		Hardening soil	Hardening soil
Drainage type		Undrained (A)	Undrained (A)
Colour		RGB 143, 116, 77	RGB 178, 178, 178
Comments			
General properties			
γ_{unsat}	kN/m³	19.50	12.00
γ_{sat}	kN/m³	20.00	15.00
Advanced			
Void ratio			
Dilatancy cut-off		No	No
e_{init}		0.5000	0.5000
e_{min}		0.000	0.000
e_{max}		999.0	999.0
Damping			
Rayleigh α		0.000	0.000
Rayleigh β		0.000	0.000
Stiffness			
E_{50}^{ref}	kN/m²	5000	10.00E3
E_{oed}^{ref}	kN/m²	5000	10.00E3
E_{ur}^{ref}	kN/m²	15.00E3	30.00E3
power (m)		1.000	0.5000
Alternatives			
Use alternatives		No	No
C_c		0.01380	0.03450
C_s		4.140E-3	0.01035
e_{init}		0.5000	0.5000
Strength			
c_{ref}	kN/m²	5.000	1.000
φ (phi)	°	30.00	35.00
ψ (psi)	°	0.000	0.000

Identification		Engineered Fill	IBA Waste
Advanced			
Set to default values		No	Yes
Stiffness			
ν_{ur}		0.2000	0.2000
p_{ref}	kN/m²	20.00	100.0
K_0^{nc}		0.5000	0.4264
Strength			
c_{inc}	kN/m²/m	0.000	0.000
y_{ref}	m	0.000	0.000
R_f		0.9000	0.9000
Tension cut-off		Yes	Yes
Tensile strength	kN/m²	0.000	0.000
Undrained behaviour			
Undrained behaviour		Standard	Standard
Skempton-B		0.9866	0.9866
ν_u		0.4950	0.4950
$K_{w,ref}$ / n	kN/m²	614.6E3	1.229E6
Stiffness			
Stiffness		Standard	Standard
Strength			
Strength		Rigid	Rigid
R_{inter}		1.000	1.000
Consider gap closure		Yes	Yes
Real interface thickness			
δ_{inter}		0.000	0.000
Groundwater			
Cross permeability		Impermeable	Impermeable
Drainage conductivity, dk	m³/day/m	0.000	0.000
Thermal			
R	m² K/kW	0.000	0.000

Identification		Engineered Fill	IBA Waste
K0 settings			
K_0 determination		Automatic	Automatic
$K_{0,x} = K_{0,z}$		Yes	Yes
$K_{0,x}$		0.5000	0.4264
$K_{0,z}$		0.5000	0.4264
Overconsolidation			
OCR		1.000	1.000
POP	kN/m²	0.000	0.000
Model			
Data set		Standard	Standard
Soil			
Type		Coarse	Coarse
< 2 μm	%	10.00	10.00
2 μm - 50 μm	%	13.00	13.00
50 μm - 2 mm	%	77.00	77.00
Flow parameters			
Use defaults		None	None
k_x	m/day	0.4320E-3	8.640E-3
k_y	m/day	0.4320E-3	8.640E-3
$-\psi_{unsat}$	m	10.00E3	10.00E3
e_{init}		0.5000	0.5000
S_s	1/m	0.000	0.000
Change of permeability			
c_k		1000E12	1000E12

Identification		Engineered Fill	IBA Waste
Parameters			
c_s	kJ/t/K	0.000	0.000
λ_s	kW/m/K	0.000	0.000
ρ_s	t/m³	0.000	0.000
Solid thermal expansion		Volumetric	Volumetric
α_s	1/K	0.000	0.000
D_v	m²/day	0.000	0.000
f_{Tv}		0.000	0.000
Unfrozen water content		None	None

Material set			
Identification number		6	7
Identification		Historic Waste	Restoration Soils
Material model		Hardening soil	Hardening soil
Drainage type		Undrained (A)	Undrained (A)
Colour		RGB 155, 184, 187	RGB 119, 92, 34
Comments			
General properties			
γ_{unsat}	kN/m³	11.00	19.00
γ_{sat}	kN/m³	11.50	20.00
Advanced			
Void ratio			
Dilatancy cut-off		No	No
e_{init}		0.5000	0.5000
e_{min}		0.000	0.000
e_{max}		999.0	999.0
Damping			
Rayleigh α		0.000	0.000
Rayleigh β		0.000	0.000
Stiffness			
E_{50}^{ref}	kN/m²	20.00E3	5000
E_{oed}^{ref}	kN/m²	20.00E3	5000
E_{ur}^{ref}	kN/m²	60.00E3	15.00E3
power (m)		0.7500	0.9000
Alternatives			
Use alternatives		No	No
C_c		0.01725	0.06900
C_s		5.175E-3	0.02070
e_{init}		0.5000	0.5000
Strength			
c_{ref}	kN/m²	5.000	5.000
φ (phi)	°	25.00	25.00
ψ (psi)	°	0.000	0.000

Identification		Historic Waste	Restoration Soils
Advanced			
Set to default values		Yes	Yes
Stiffness			
ν_{ur}		0.2000	0.2000
p_{ref}	kN/m²	100.0	100.0
K_0^{nc}		0.5774	0.5774
Strength			
c_{inc}	kN/m²/m	0.000	0.000
y_{ref}	m	0.000	0.000
R_f		0.9000	0.9000
Tension cut-off		Yes	Yes
Tensile strength	kN/m²	0.000	0.000
Undrained behaviour			
Undrained behaviour		Standard	Standard
Skempton-B		0.9866	0.9866
ν_u		0.4950	0.4950
$K_{w,ref}$ / n	kN/m²	2.458E6	614.6E3
Stiffness			
Stiffness		Standard	Standard
Strength			
Strength		Rigid	Rigid
R_{inter}		1.000	1.000
Consider gap closure		Yes	Yes
Real interface thickness			
δ_{inter}		0.000	0.000
Groundwater			
Cross permeability		Impermeable	Impermeable
Drainage conductivity, dk	m³/day/m	0.000	0.000
Thermal			
R	m² K/kW	0.000	0.000

Identification		Historic Waste	Restoration Soils
K0 settings			
K_0 determination		Automatic	Automatic
$K_{0,x} = K_{0,z}$		Yes	Yes
$K_{0,x}$		0.5774	0.5774
$K_{0,z}$		0.5774	0.5774
Overconsolidation			
OCR		1.000	1.000
POP	kN/m²	0.000	0.000
Model			
Data set		Standard	Standard
Soil			
Type		Coarse	Coarse
< 2 μm	%	10.00	10.00
2 μm - 50 μm	%	13.00	13.00
50 μm - 2 mm	%	77.00	77.00
Flow parameters			
Use defaults		None	None
k_x	m/day	8.640E-3	0.8640E-3
k_y	m/day	8.640E-3	0.8640E-3
$-\psi_{unsat}$	m	10.00E3	10.00E3
e_{init}		0.5000	0.5000
S_s	1/m	0.000	0.000
Change of permeability			
c_k		1000E12	1000E12

Identification		Historic Waste	Restoration Soils
Parameters			
c_s	kJ/t/K	0.000	0.000
λ_s	kW/m/K	0.000	0.000
ρ_s	t/m^3	0.000	0.000
Solid thermal expansion		Volumetric	Volumetric
α_s	1/K	0.000	0.000
D_v	m^2/day	0.000	0.000
f_{Tv}		0.000	0.000
Unfrozen water content		None	None

Material set		
Identification number		8
Identification		Silt
Material model		Hardening soil
Drainage type		Undrained (A)
Colour		RGB 216, 217, 217
Comments		
General properties		
γ_{unsat}	kN/m³	17.00
γ_{sat}	kN/m³	18.00
Advanced		
Void ratio		
Dilatancy cut-off		No
e_{init}		0.5000
e_{min}		0.000
e_{max}		999.0
Damping		
Rayleigh α		0.000
Rayleigh β		0.000
Stiffness		
E_{50}^{ref}	kN/m²	4000
E_{oed}^{ref}	kN/m²	4000
E_{ur}^{ref}	kN/m²	12.00E3
power (m)		0.8000
Alternatives		
Use alternatives		No
C_c		0.08625
C_s		0.02587
e_{init}		0.5000
Strength		
c_{ref}	kN/m²	1.000
φ (phi)	°	25.00
ψ (psi)	°	0.000

Identification		Silt
Advanced		
Set to default values		Yes
Stiffness		
ν_{ur}		0.2000
p_{ref}	kN/m²	100.0
K_0^{nc}		0.5774
Strength		
c_{inc}	kN/m²/m	0.000
y_{ref}	m	0.000
R_f		0.9000
Tension cut-off		Yes
Tensile strength	kN/m²	0.000
Undrained behaviour		
Undrained behaviour		Standard
Skempton-B		0.9866
ν_u		0.4950
$K_{w,ref}$ / n	kN/m²	491.7E3
Stiffness		
Stiffness		Standard
Strength		
Strength		Rigid
R_{inter}		1.000
Consider gap closure		Yes
Real interface thickness		
δ_{inter}		0.000
Groundwater		
Cross permeability		Impermeable
Drainage conductivity, dk	m³/day/m	0.000
Thermal		
R	m² K/kW	0.000

Identification		Silt
K0 settings		
K_0 determination		Automatic
$K_{0,x} = K_{0,z}$		Yes
$K_{0,x}$		0.5774
$K_{0,z}$		0.5774
Overconsolidation		
OCR		1.000
POP	kN/m²	0.000
Model		
Data set		Standard
Soil		
Type		Coarse
< 2 μm	%	10.00
2 μm - 50 μm	%	13.00
50 μm - 2 mm	%	77.00
Flow parameters		
Use defaults		None
k_x	m/day	8.640E-3
k_y	m/day	8.640E-3
$-\psi_{unsat}$	m	10.00E3
e_{init}		0.5000
S_s	1/m	0.000
Change of permeability		
c_k		1000E12

Identification		Silt
Parameters		
c_s	kJ/t/K	0.000
λ_s	kW/m/K	0.000
ρ_s	t/m³	0.000
Solid thermal expansion		Volumetric
α_s	1/K	0.000
D_v	m²/day	0.000
f_{Tv}		0.000
Unfrozen water content		None

Material set		
Identification number		4
Identification		Engineered Clay Liner
Material model		Mohr-Coulomb
Drainage type		Undrained (A)
Colour		RGB 206, 173, 95
Comments		
General properties		
γ_{unsat}	kN/m³	20.00
γ_{sat}	kN/m³	20.50
Advanced		
Void ratio		
Dilatancy cut-off		No
e_{init}		0.5000
e_{min}		0.000
e_{max}		999.0
Damping		
Rayleigh α		0.000
Rayleigh β		0.000
Stiffness		
E	kN/m²	6000
ν (nu)		0.2500
Alternatives		
G	kN/m²	2400
E_{oed}	kN/m²	7200
Strength		
c_{ref}	kN/m²	5.000
φ (phi)	°	30.00
ψ (psi)	°	0.000
Velocities		
V_s	m/s	34.31
V_p	m/s	59.43

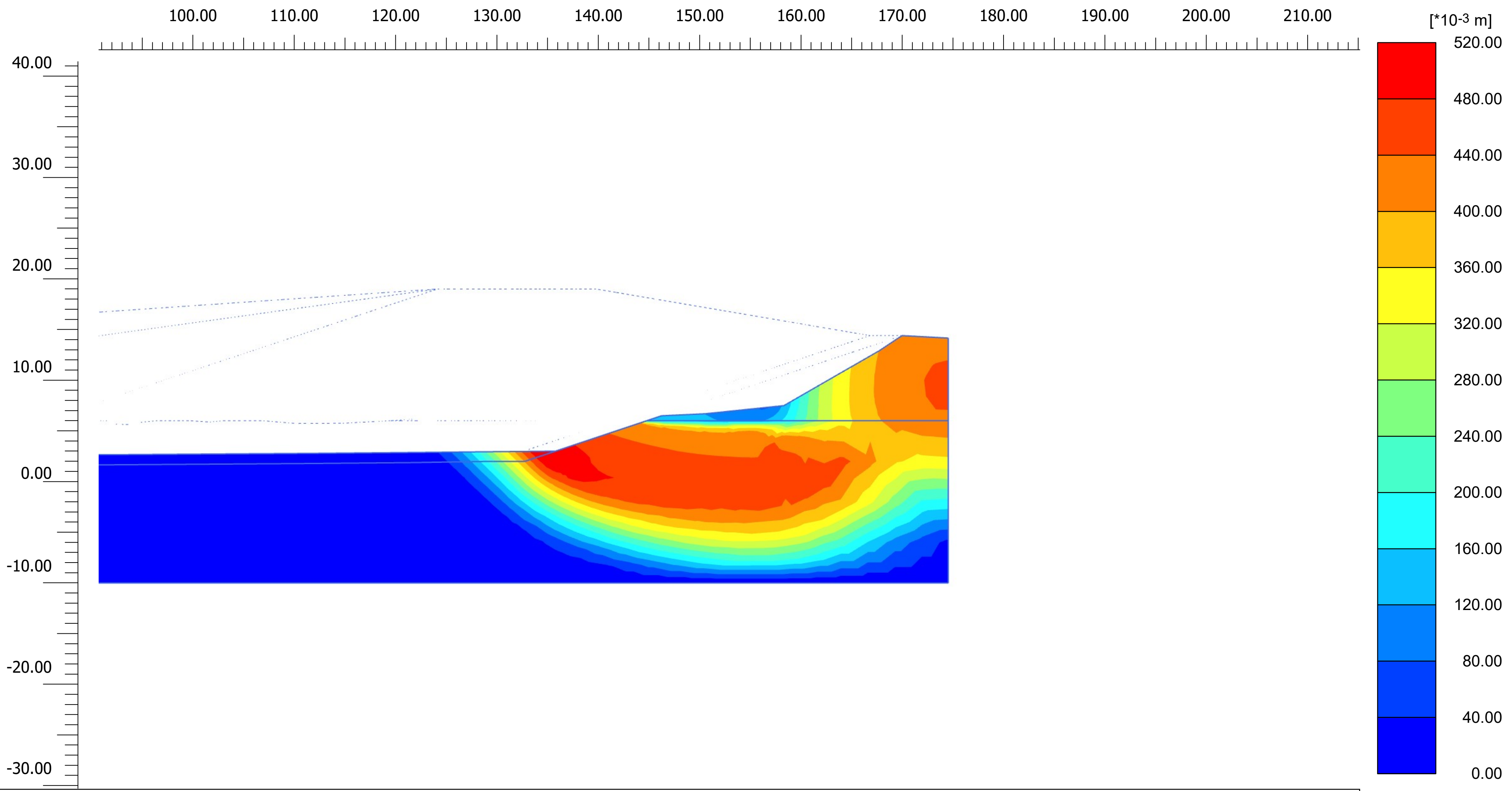
Identification		Engineered Clay Liner
Advanced		
Set to default values		Yes
Stiffness		
E_{inc}	kN/m²/m	0.000
y_{ref}	m	0.000
Strength		
c_{inc}	kN/m²/m	0.000
y_{ref}	m	0.000
Tension cut-off		Yes
Tensile strength	kN/m²	0.000
Undrained behaviour		
Undrained behaviour		Standard
Skempton-B		0.9833
ν_u		0.4950
$K_{w,ref}$ / n	kN/m²	235.2E3
Consolidation		
$C_{v,ref}$	m²/day	0.06221
Stiffness		
Stiffness		Standard
Strength		
Strength		Rigid
R_{inter}		1.000
Consider gap closure		Yes
Real interface thickness		
δ_{inter}		0.000
Groundwater		
Cross permeability		Impermeable
Drainage conductivity, dk	m³/day/m	0.000
Thermal		
R	m² K/kW	0.000

Identification		Engineered Clay Liner
K0 settings		
K_0 determination		Automatic
$K_{0,x} = K_{0,z}$		Yes
$K_{0,x}$		0.5000
$K_{0,z}$		0.5000
Model		
Data set		Standard
Soil		
Type		Coarse
< 2 μm	%	10.00
2 μm - 50 μm	%	13.00
50 μm - 2 mm	%	77.00
Flow parameters		
Use defaults		None
k_x	m/day	0.08640E-3
k_y	m/day	0.08640E-3
$-\psi_{unsat}$	m	10.00E3
e_{init}		0.5000
S_s	1/m	0.000
Change of permeability		
c_k		1000E12
Parameters		
c_s	kJ/t/K	0.000
λ_s	kW/m/K	0.000
ρ_s	t/m³	0.000
Solid thermal expansion		Volumetric
α_s	1/K	0.000
D_v	m²/day	0.000
f_{Tv}		0.000
Unfrozen water content		None

APPENDIX SRA3

PLAXIS STABILITY PRINTOUTS

Output Version 21.1.0.479



Incremental displacements |Δu| (scaled up 10.0 times)

Maximum value = 0.5149 m (Element 2656 at Node 22225)

Project description Whisby IBA Cells SRA			*Date* 06/03/2023
Project filename South-North Section 1-1' D3	*Step* 535	*Company* Sirius Environmental Ltd	

Step info				
Phase	Excavate Safety [Phase_6]			
Step	Initial			
Calulation mode	Classical mode			
Step type	Safety			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	1.000			
Relative stiffness	0.04290E-3			
Multipliers				
Soil weight			ΣM_{Weight}	1.000
Strength reduction factor	M_{sf}	0.01000	ΣM_{sf}	3.278
Time	Increment	0.000	End time	30.00
Staged construction				
Active proportion total area	M_{Area}	0.000	ΣM_{Area}	0.5872
Active proportion of stage	M_{Stage}	0.000	ΣM_{Stage}	0.000
Forces				
F_X	0.000 kN/m			
F_Y	0.000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	1363 kN/m^2			

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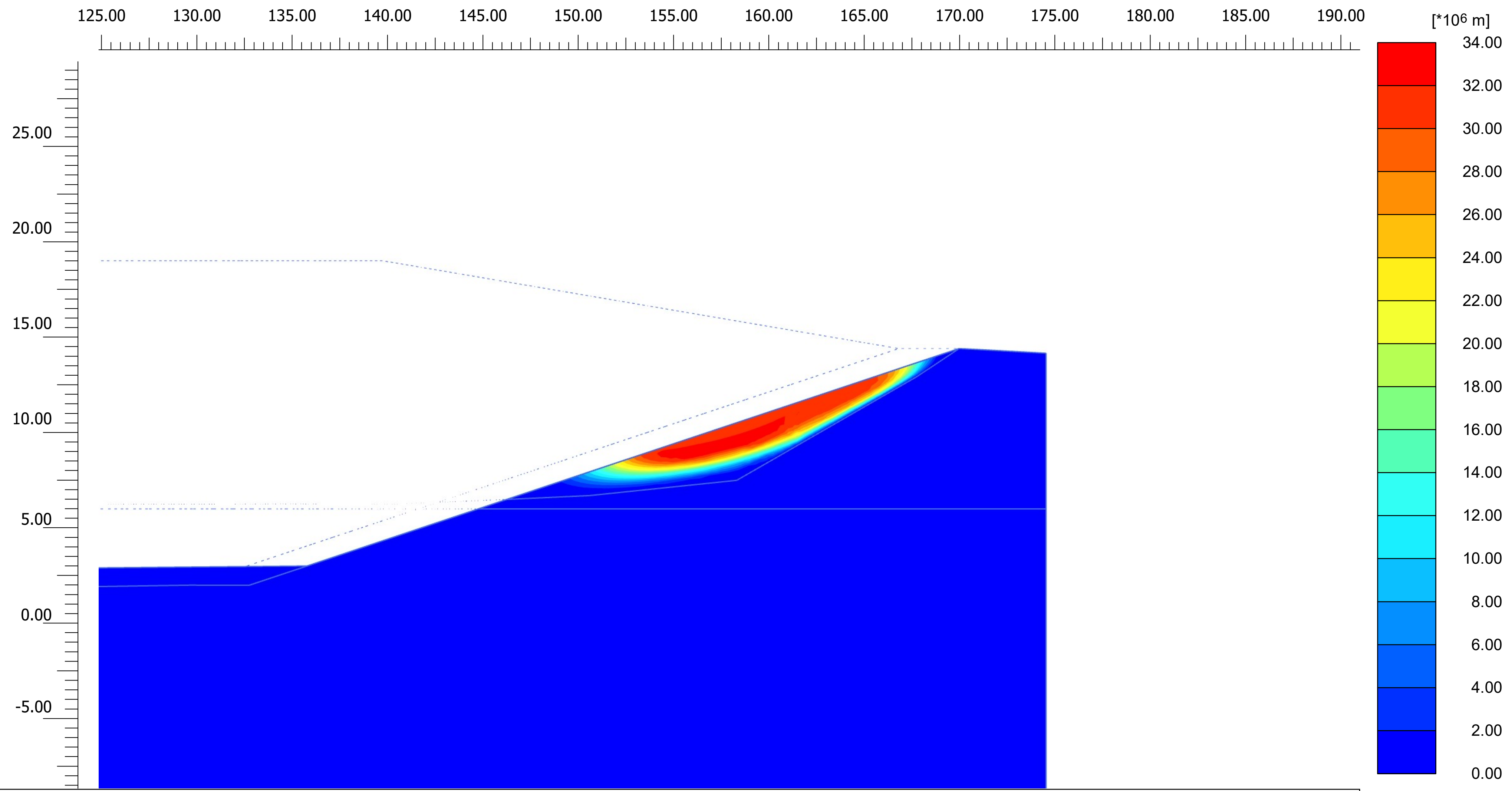


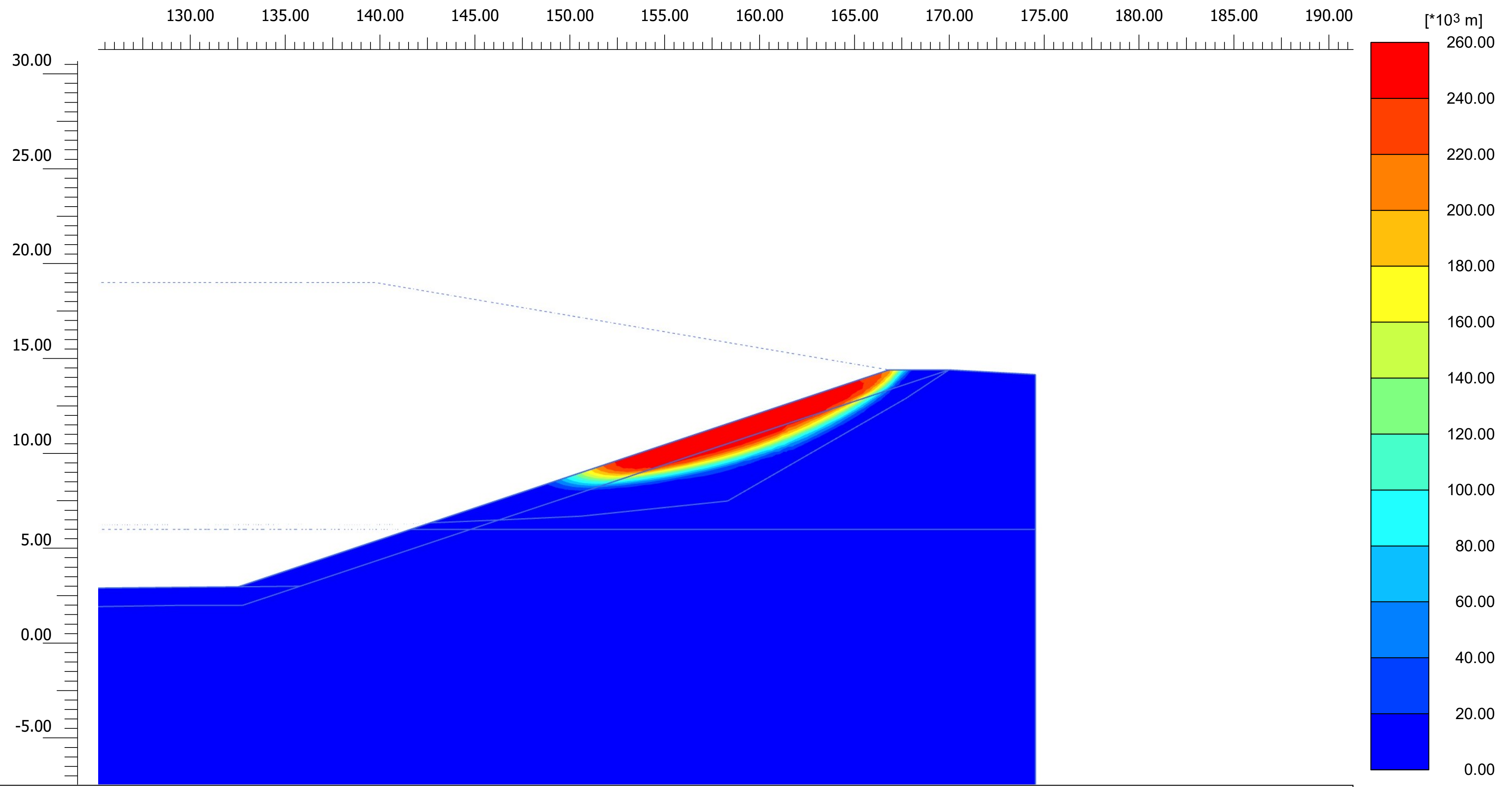
Incremental displacements |Δu| (scaled up 0.200×10^{-6} times)

Maximum value = 33.00×10^{6} m (Element 1559 at Node 24809)

Project description	Date
Whisby IBA Cells SRA	06/03/2023

Project filename	Step	Company
South-North Section 1-1' D3	435	Sirius Environmental Ltd

Step info				
Phase	Fill Safety [Phase_7]			
Step	Initial			
Calulation mode	Classical mode			
Step type	Safety			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	2.000			
Relative stiffness	0.01298E-15			
Multipliers				
Soil weight			ΣM_{Weight}	1.000
Strength reduction factor	M_{sf}	2.013E-3	ΣM_{sf}	1.908
Time	Increment	0.000	End time	51.00
Staged construction				
Active proportion total area	M_{Area}	0.000	ΣM_{Area}	0.6025
Active proportion of stage	M_{Stage}	0.000	ΣM_{Stage}	0.000
Forces				
F_X	0.000 kN/m			
F_Y	0.000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	144.2 kN/m^2			



Incremental displacements |Δu| (scaled up 0.0200*10^{-3} times)

Maximum value = 252.3*10^{3} m (Element 1516 at Node 25611)

Project description	Date
Whisby IBA Cells SRA	06/03/2023

Project filename	Step	Company
South-North Section 1-1' D3	335	Sirius Environmental Ltd

Step info				
Phase	ECL Safety [Phase_8]			
Step	Initial			
Calulation mode	Classical mode			
Step type	Safety			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	2.000			
Relative stiffness	-4.847E-15			
Multipliers				
Soil weight			ΣM_{Weight}	1.000
Strength reduction factor	M_{sf}	-1.164E-3	ΣM_{sf}	1.648
Time	Increment	0.000	End time	65.00
Staged construction				
Active proportion total area	M_{Area}	0.000	ΣM_{Area}	0.6179
Active proportion of stage	M_{Stage}	0.000	ΣM_{Stage}	0.000
Forces				
F_X	0.000 kN/m			
F_Y	0.000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	164.4 kN/m^2			

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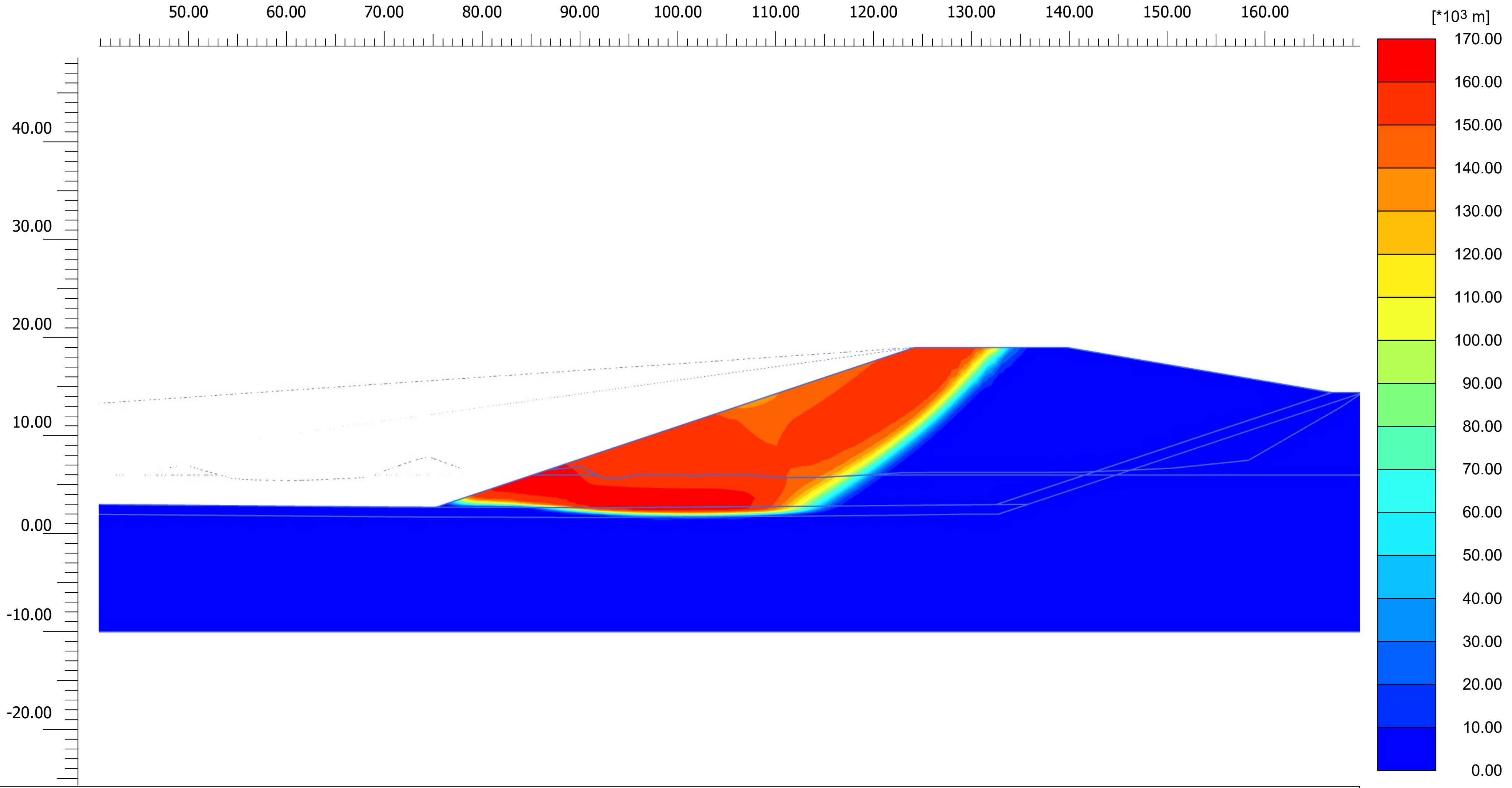


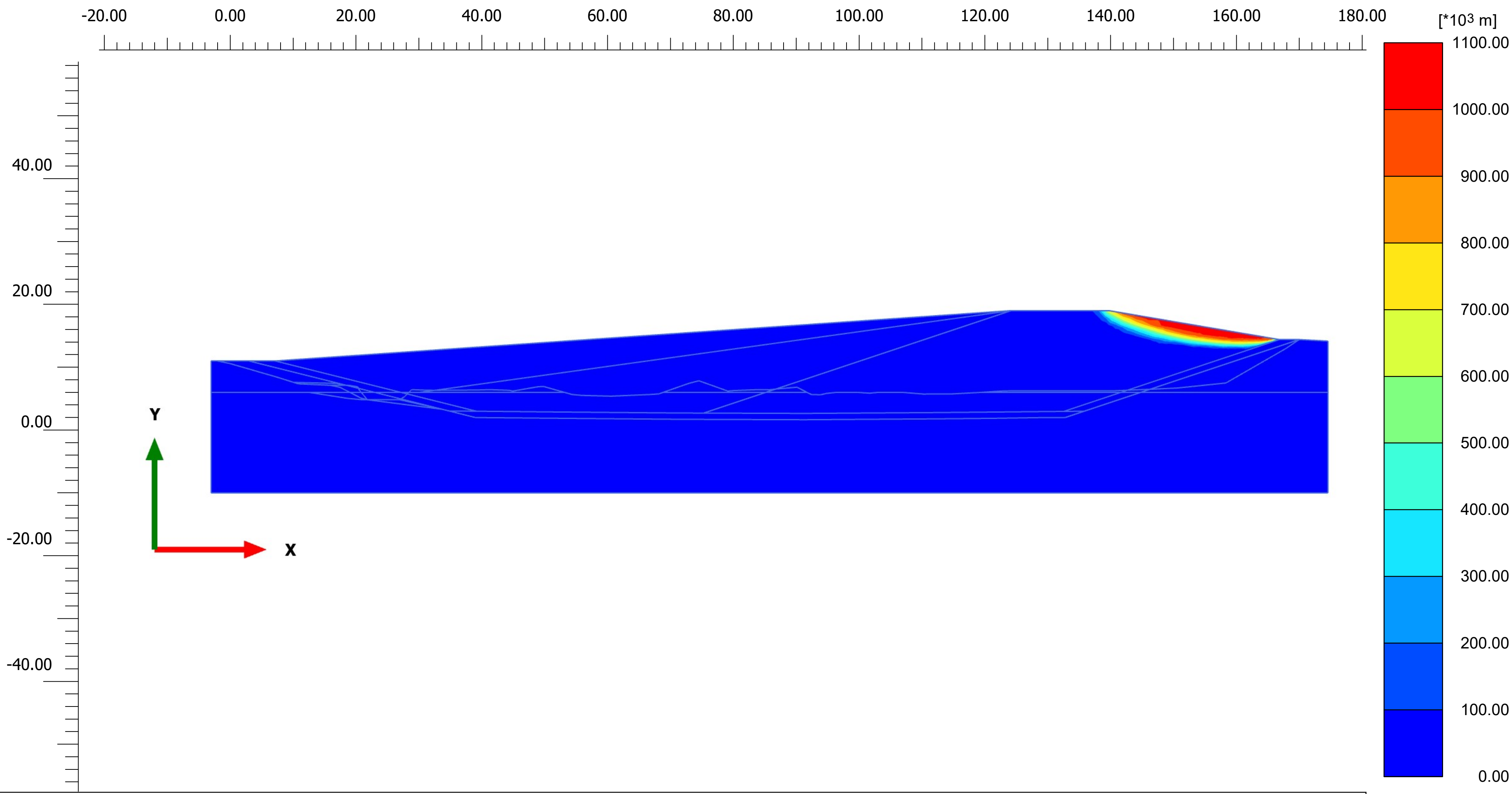
Incremental displacements |Δu| (scaled up 0.0500*10^{-3} times)

Maximum value = 165.0*10^{3} m (Element 1904 at Node 16151)

Project description		Date
Whisby IBA Cells SRA		06/03/2023

Project filename	Step	Company
South-North Section 1-1' D3	129	Sirius Environmental Ltd

Step info				
Phase	IBA Cell 1 Safety [Phase_9]			
Step	Initial			
Calulation mode	Classical mode			
Step type	Safety			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	2.000			
Relative stiffness	4.546E-15			
Multipliers				
Soil weight			ΣM_{Weight}	1.000
Strength reduction factor	M_{sf}	0.1788E-3	ΣM_{sf}	1.622
Time	Increment	0.000	End time	247.0
Staged construction				
Active proportion total area	M_{Area}	0.000	ΣM_{Area}	0.8006
Active proportion of stage	M_{Stage}	0.000	ΣM_{Stage}	0.000
Forces				
F_X	0.000 kN/m			
F_Y	0.000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	221.5 kN/m^2			



Incremental displacements |Δu| (scaled up $5.00*10^{-6}$ times)

Maximum value = $1.057*10^{6}$ m (Element 539 at Node 27452)

Project description	Whisby IBA Cells SRA		Date: 06/03/2023
Project filename	South-North Section 1-1' D3	Step: 231	Company: Sirius Environmental Ltd

sirius Environmental

Step info				
Phase	Final IBA Safety [Phase_12]			
Step	Initial			
Calulation mode	Classical mode			
Step type	Safety			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0.5000			
Relative stiffness	-0.02038E-15			
Multipliers				
Soil weight			ΣM_{Weight}	1.000
Strength reduction factor	M_{sf}	-0.4571E-3	ΣM_{sf}	3.370
Time	Increment	0.000	End time	794.0
Staged construction				
Active proportion total area	M_{Area}	0.000	ΣM_{Area}	1.000
Active proportion of stage	M_{Stage}	0.000	ΣM_{Stage}	0.000
Forces				
F_X	0.000 kN/m			
F_Y	0.000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	164.0 kN/m^2			

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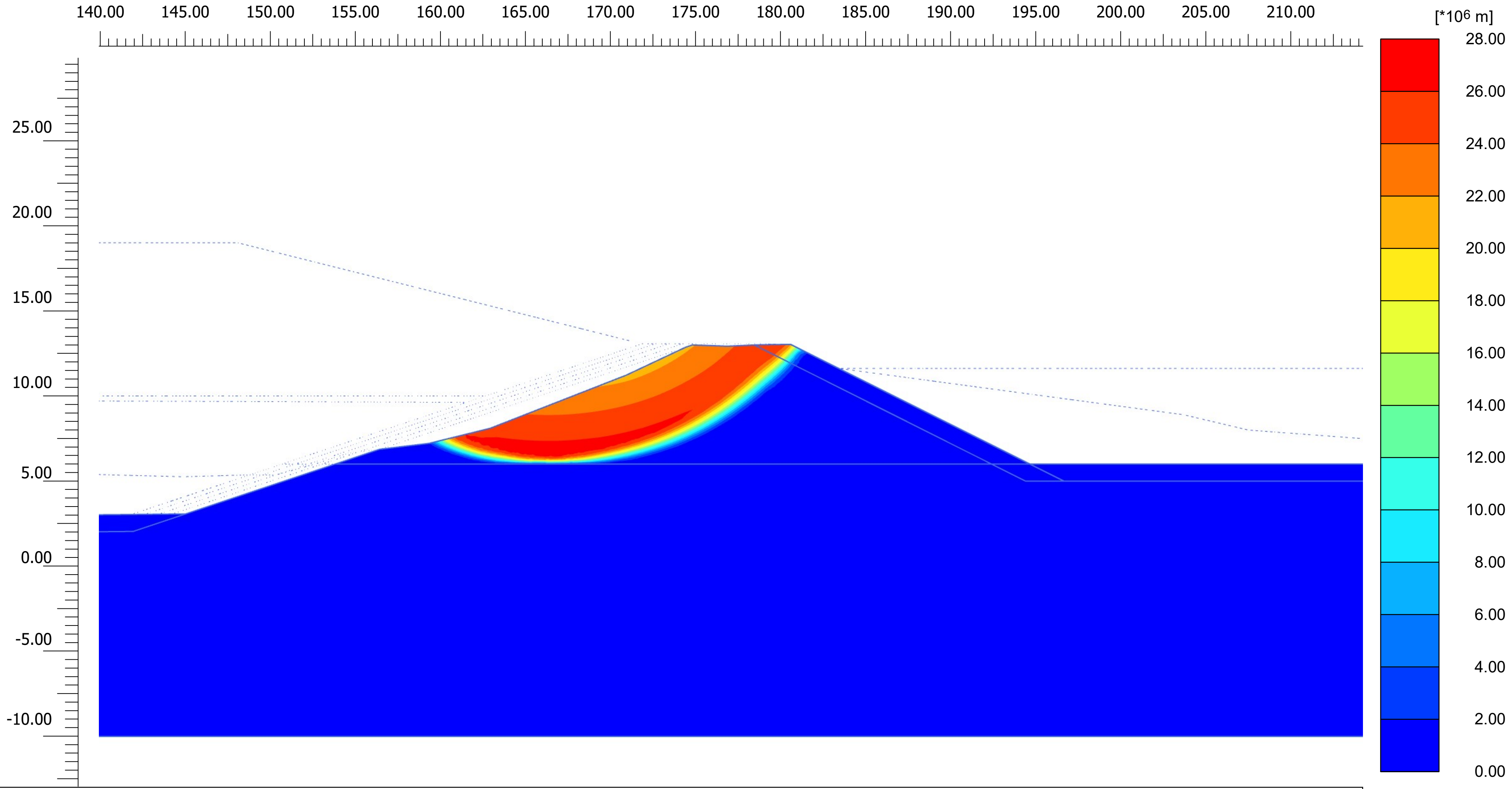

Incremental displacements |Δu| (scaled up 0.200*10^{-6} times)

Maximum value = 26.91*10^{6} m (Element 1150 at Node 20103)

Sirius Environmental	*Project description* Whisby IBA Cells SRA		*Date* 06/03/2023
	Project filename West-East Section 2-2' D3	*Step* 442	*Company* Sirius Environmental Ltd

Step info				
Phase	Excavate Safety [Phase_6]			
Step	Initial			
Calulation mode	Classical mode			
Step type	Safety			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	2.000			
Relative stiffness	0.7430E-15			
Multipliers				
Soil weight			ΣM_{Weight}	1.000
Strength reduction factor	M_{sf}	5.000E-3	ΣM_{sf}	1.603
Time	Increment	0.000	End time	30.00
Staged construction				
Active proportion total area	M_{Area}	0.000	ΣM_{Area}	0.5454
Active proportion of stage	M_{Stage}	0.000	ΣM_{Stage}	0.000
Forces				
F_X	0.000 kN/m			
F_Y	0.000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	141.6 kN/m^2			

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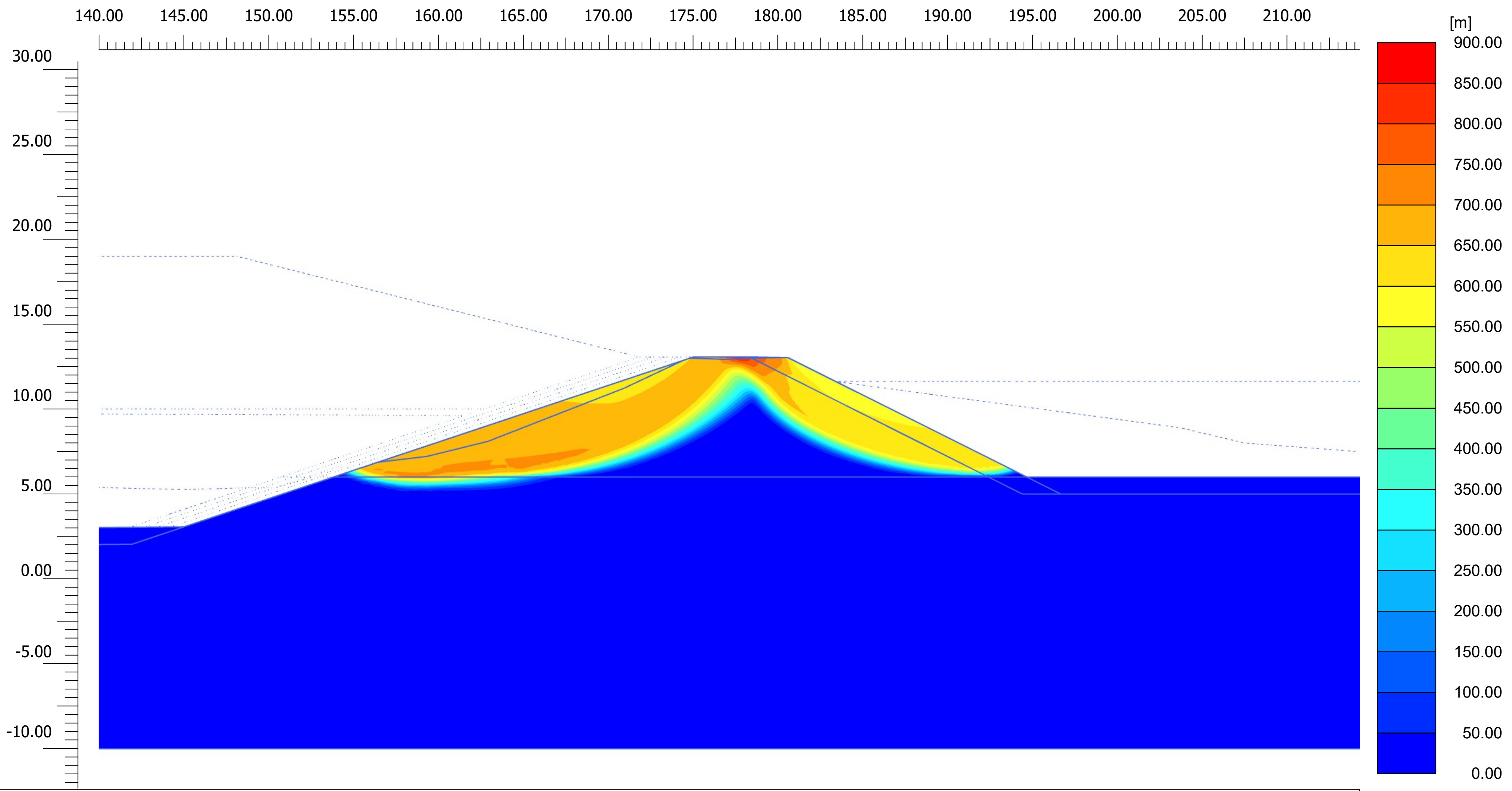


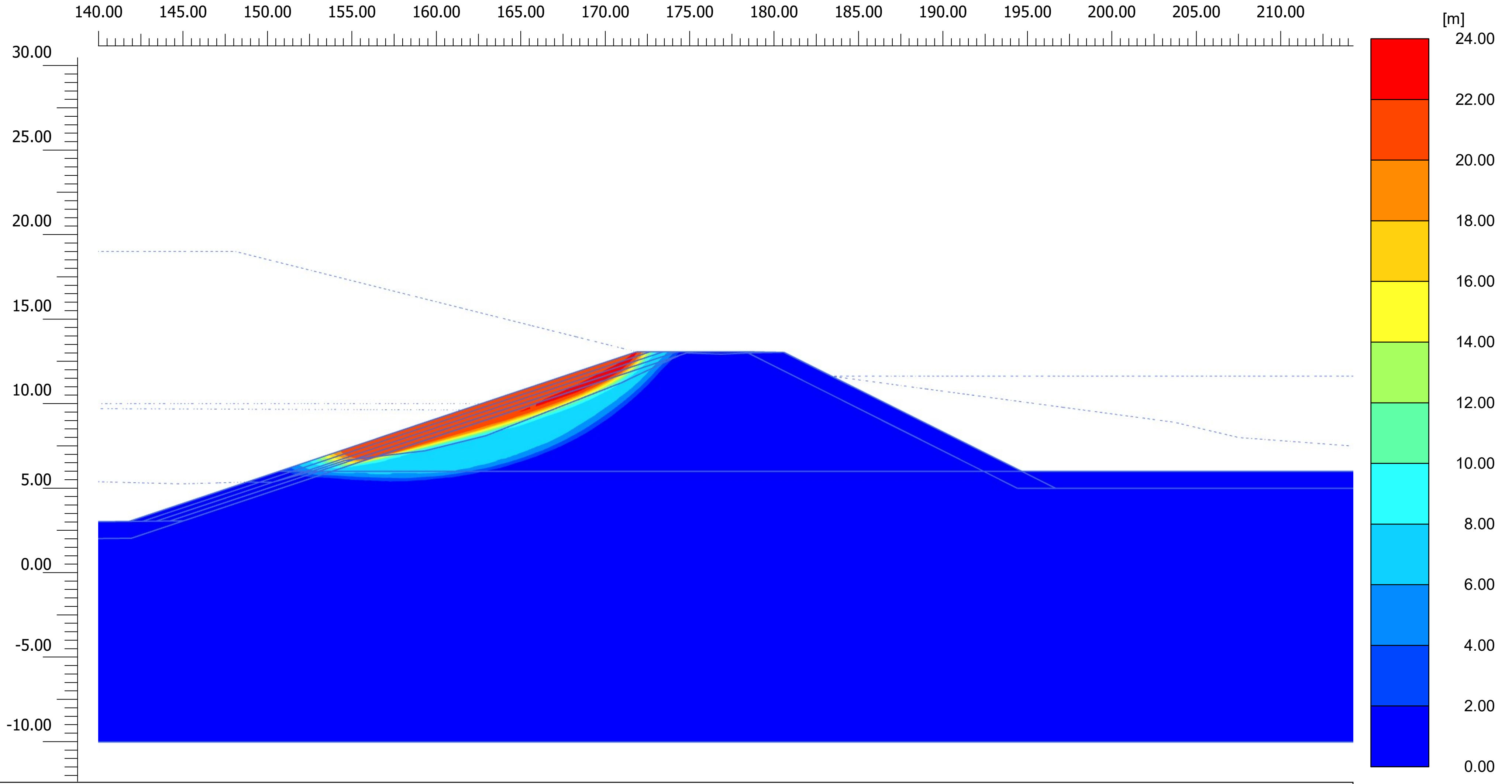
Incremental displacements |Δu| (scaled up $5.00*10^{-3}$ times)

Maximum value = 873.0 m (Element 391 at Node 26839)

sirius Environmental	*Project description* Whisby IBA Cells SRA		*Date* 06/03/2023
	Project filename West-East Section 2-2' D3	*Step* 338	*Company* Sirius Environmental Ltd

Step info				
Phase	Fill Safety [Phase_7]			
Step	Initial			
Calulation mode	Classical mode			
Step type	Safety			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0.5000			
Relative stiffness	0.1561E-9			
Multipliers				
Soil weight			ΣM_{Weight}	1.000
Strength reduction factor	M_{sf}	0.02566E-3	ΣM_{sf}	1.629
Time	Increment	0.000	End time	51.00
Staged construction				
Active proportion total area	M_{Area}	0.000	ΣM_{Area}	0.5470
Active proportion of stage	M_{Stage}	0.000	ΣM_{Stage}	0.000
Forces				
F_X	0.000 kN/m			
F_Y	0.000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	8305 kN/m^2			

Output Version 21.1.0.479



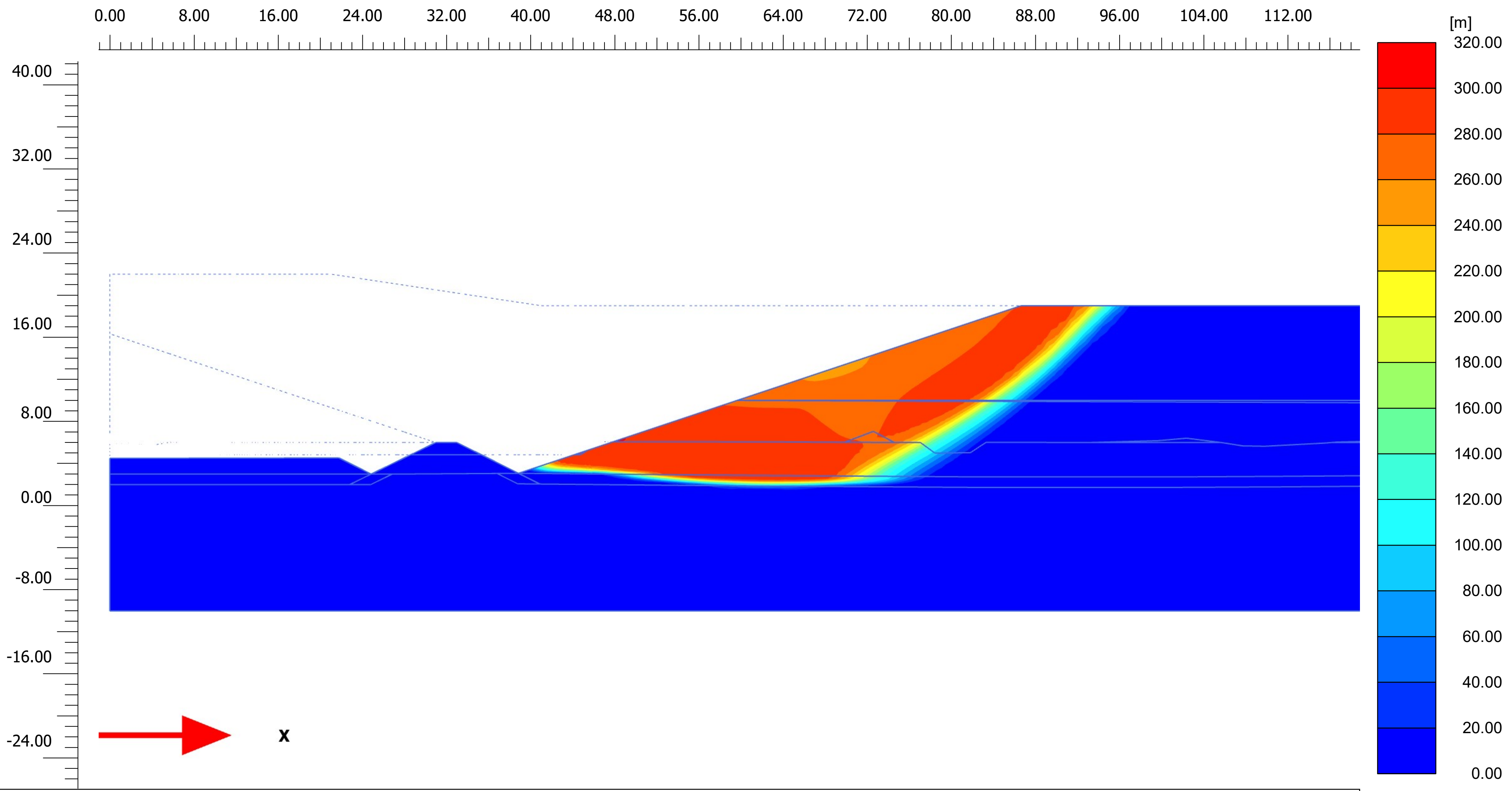
Incremental displacements |Δu| (scaled up 0.200 times)

Maximum value = 22.55 m (Element 420 at Node 21558)

Sirius Environmental	*Project description* Whisby IBA Cells SRA		*Date* 06/03/2023
	Project filename West-East Section 2-2' D3	*Step* 120	*Company* Sirius Environmental Ltd

Step info				
Phase	ECL Safety [Phase_8]			
Step	Initial			
Calulation mode	Classical mode			
Step type	Safety			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0.5000			
Relative stiffness	2.429E-9			
Multipliers				
Soil weight			ΣM_{Weight}	1.000
Strength reduction factor	M_{sf}	0.04024E-3	ΣM_{sf}	1.333
Time	Increment	0.000	End time	65.00
Staged construction				
Active proportion total area	M_{Area}	0.000	ΣM_{Area}	0.5557
Active proportion of stage	M_{Stage}	0.000	ΣM_{Stage}	0.000
Forces				
F_X	0.000 kN/m			
F_Y	0.000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	7958 kN/m^2			

Output Version 21.1.0.479



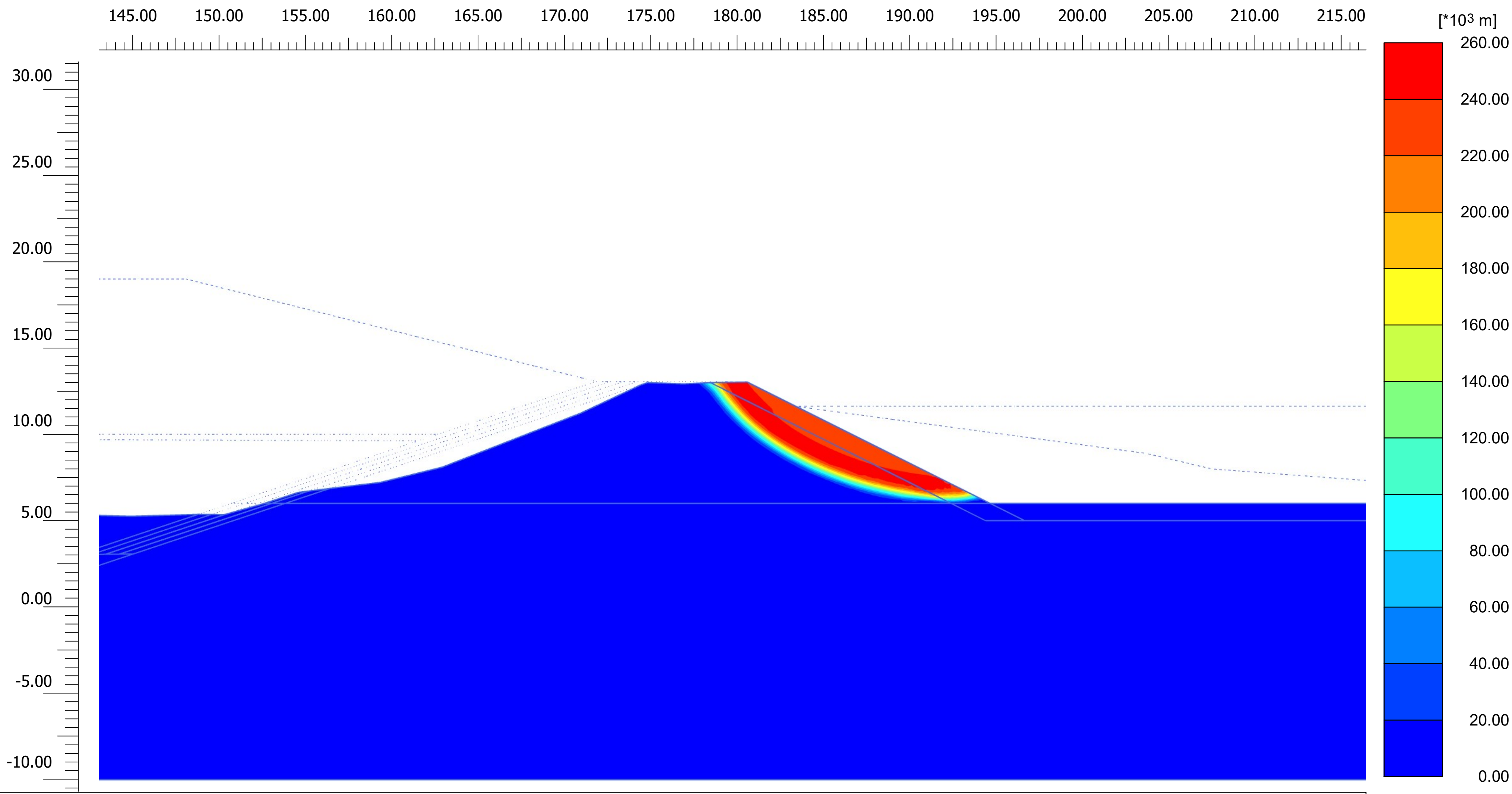
Incremental displacements |Δu| (scaled up 0.0200 times)

Maximum value = 300.5 m (Element 1494 at Node 2668)

sirius Environmental	*Project description* Whisby IBA Cells SRA			*Date* 06/03/2023
	Project filename West-East Section 2-2' D3	*Step* 238	*Company* Sirius Environmental Ltd	

Step info				
Phase	IBA Cell 1 Waste Safety [Phase_9]			
Step	Initial			
Calulation mode	Classical mode			
Step type	Safety			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	2.000			
Relative stiffness	0.08644E-9			
Multipliers				
Soil weight			ΣM_{Weight}	1.000
Strength reduction factor	M_{sf}	0.2481E-3	ΣM_{sf}	1.636
Time	Increment	0.000	End time	247.0
Staged construction				
Active proportion total area	M_{Area}	0.000	ΣM_{Area}	0.7975
Active proportion of stage	M_{Stage}	0.000	ΣM_{Stage}	0.000
Forces				
F_X	0.000 kN/m			
F_Y	0.000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	21.82E3 kN/m^2			

Output Version 21.1.0.479



Incremental displacements |Δu| (scaled up 0.0200*10^{-3} times)

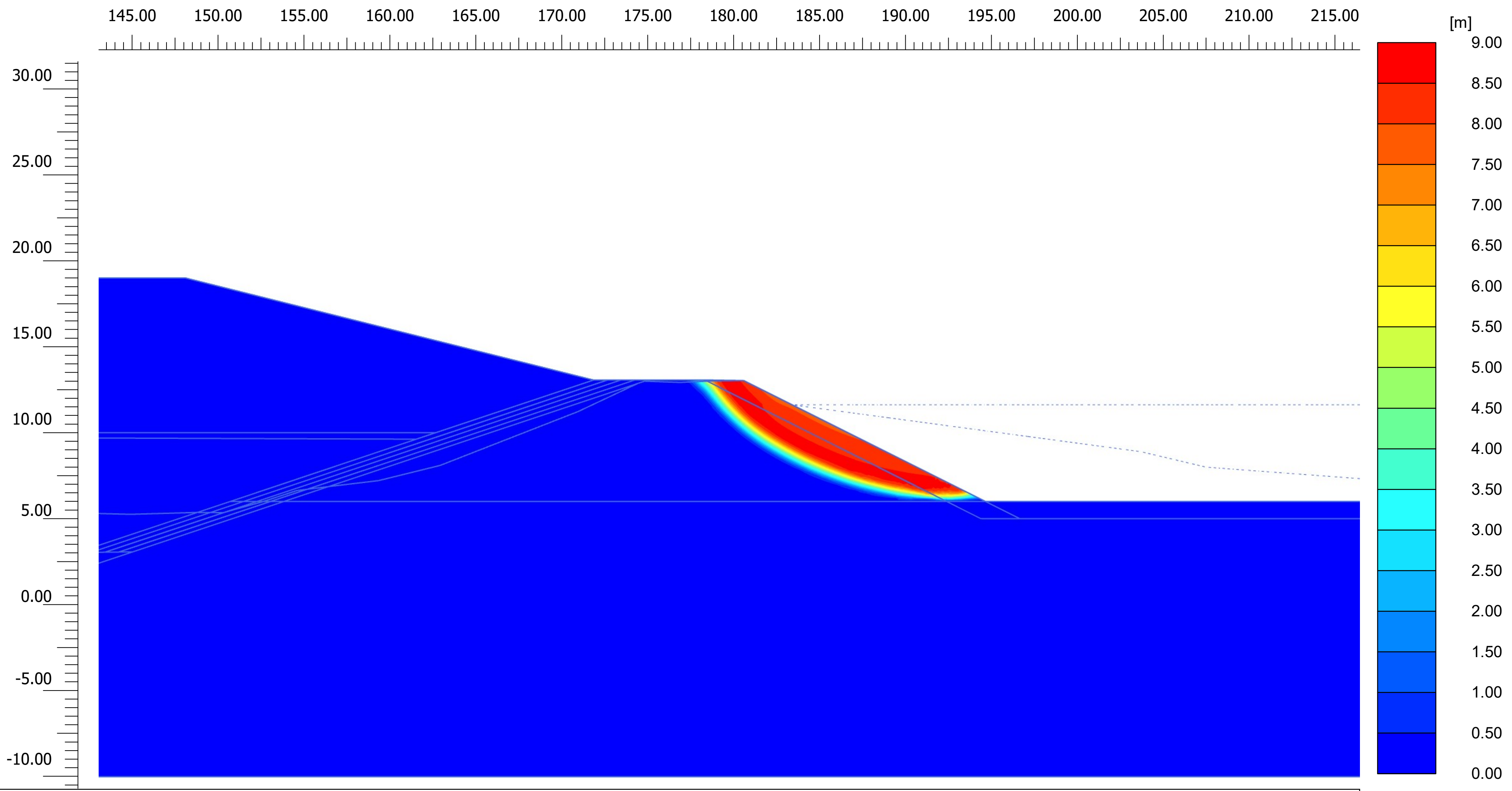
Maximum value = 251.2*10^{3} m (Element 902 at Node 26928)

Project description			Date
Whisby IBA Cells SRA			06/03/2023
Project filename	Step	Company	
West-East Section 2-2' D3	693	Sirius Environmental Ltd	

sirius Environmental

Step info				
Phase	Rapid Draw Down No Construction Safety [Phase_14]			
Step	Initial			
Calulation mode	Classical mode			
Step type	Safety			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	1.000			
Relative stiffness	0.01064E-12			
Multipliers				
Soil weight			ΣM_{Weight}	1.000
Strength reduction factor	M_{sf}	0.1497E-3	ΣM_{sf}	1.523
Time	Increment	0.000	End time	28.00
Staged construction				
Active proportion total area	M_{Area}	0.000	ΣM_{Area}	0.6041
Active proportion of stage	M_{Stage}	0.000	ΣM_{Stage}	0.000
Forces				
F_X	0.000 kN/m			
F_Y	0.000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	132.7 kN/m^2			

Output Version 21.1.0.479



Incremental displacements |Δu| (scaled up 0.500 times)

Maximum value = 8.743 m (Element 908 at Node 26914)

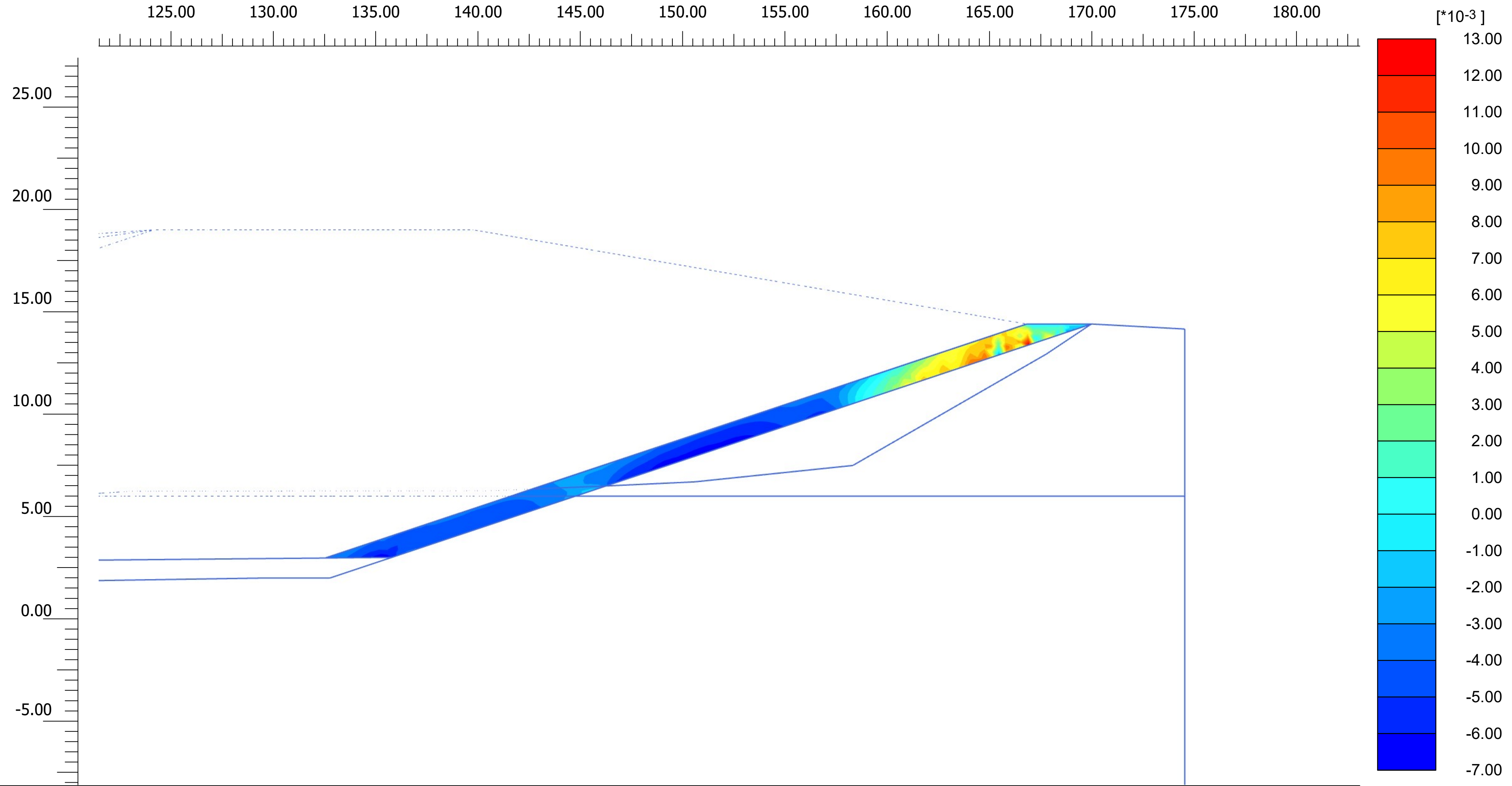
Sirius Environmental	*Project description* Whisby IBA Cells SRA			*Date* 06/03/2023
	Project filename West-East Section 2-2' D3	*Step* 542	*Company* Sirius Environmental Ltd	

Step info				
Phase	Rapid Draw Down Safety [Phase_10]			
Step	Initial			
Calulation mode	Classical mode			
Step type	Safety			
Updated mesh	False			
Solver type	Picos			
Kernel type	64 bit			
Extrapolation factor	0.5000			
Relative stiffness	0.3288E-9			
Multipliers				
Soil weight			ΣM_{Weight}	1.000
Strength reduction factor	M_{sf}	-0.5537E-3	ΣM_{sf}	1.561
Time	Increment	0.000	End time	275.0
Staged construction				
Active proportion total area	M_{Area}	0.000	ΣM_{Area}	0.7975
Active proportion of stage	M_{Stage}	0.000	ΣM_{Stage}	0.000
Forces				
F_X	0.000 kN/m			
F_Y	0.000 kN/m			
Consolidation				
Realised $P_{Excess,Max}$	2760 kN/m^2			

APPENDIX SRA4

PLAXIS INTEGRITY PRINTOUTS

Output Version 21.1.0.479



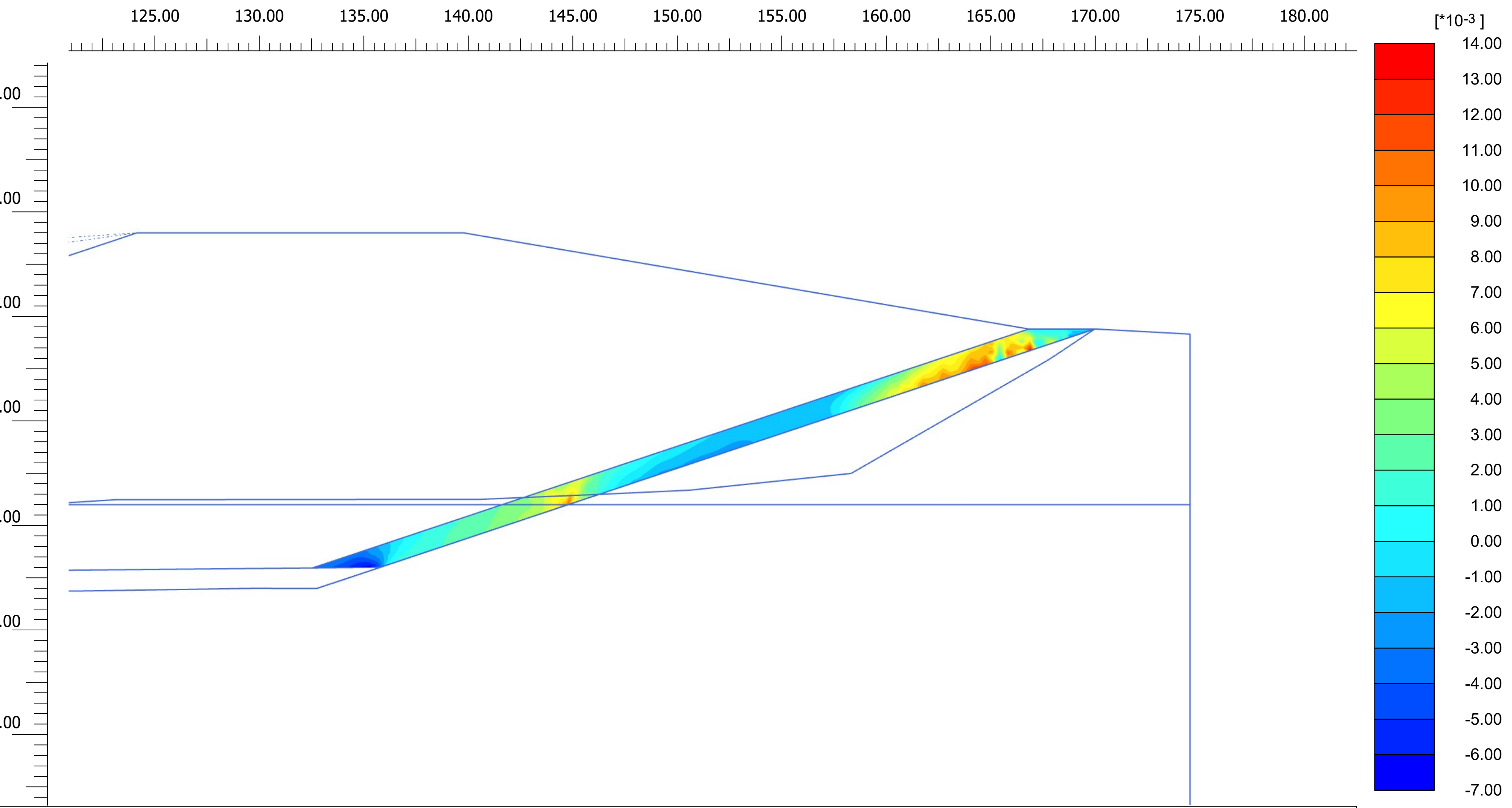
Total cartesian strain γ_{xy} (scaled up 200 times) (Time 65.00 day)

Maximum value = 0.01287 (Element 1496 at Node 24297)

Minimum value = $-6.845*10^{-3}$ (Element 2120 at Node 22139)

sirius Environmental	*Project description* Whisby IBA Cells SRA		*Date* 06/03/2023
	Project filename South-North Section 1-1' D3	*Step* 17	*Company* Sirius Environmental Ltd

Output Version 21.1.0.479



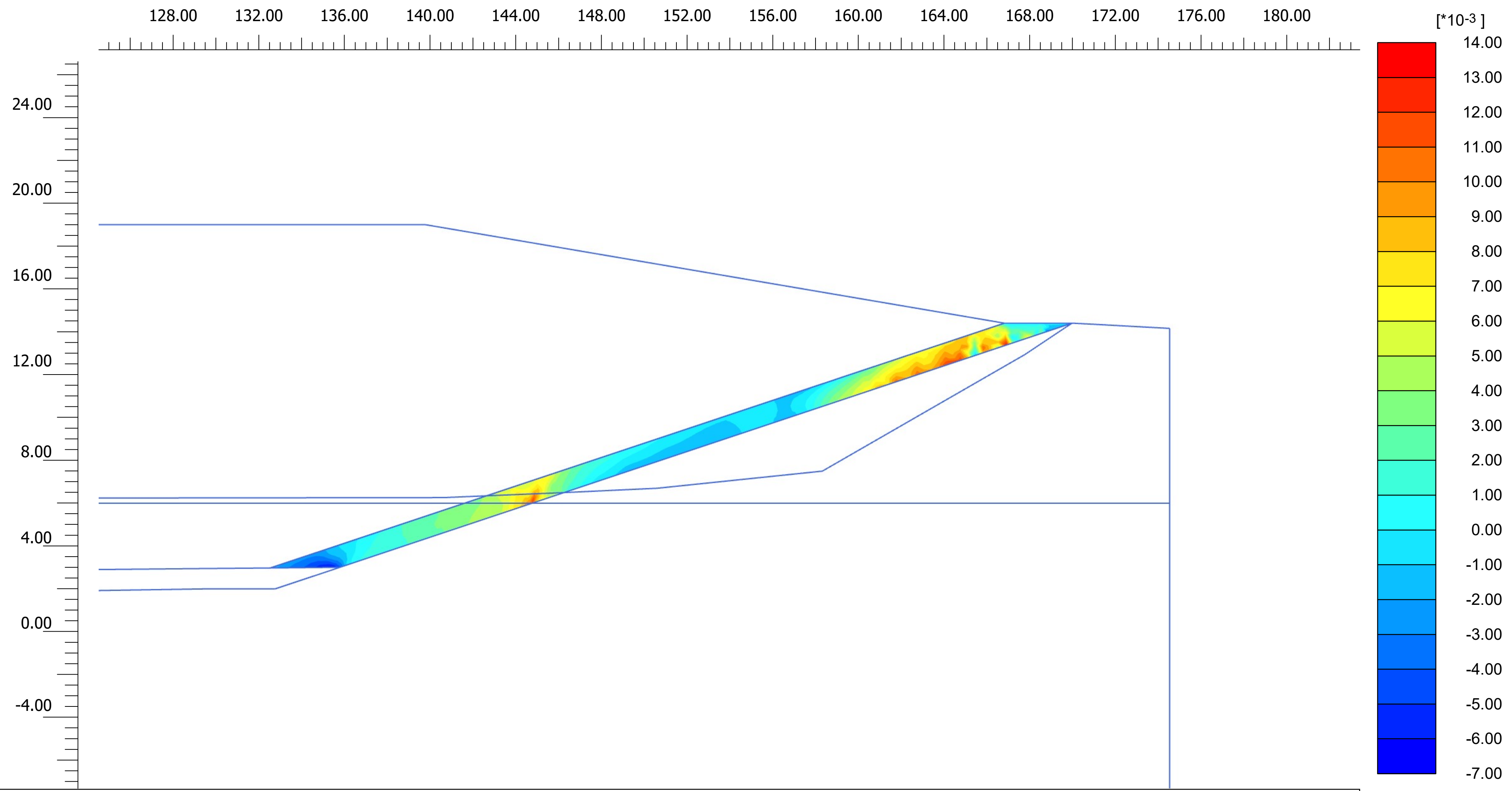
Total cartesian strain γ_{xy} (scaled up 200 times) (Time 247.0 day)

Maximum value = 0.01311 (Element 1496 at Node 24297)

Minimum value = $-6.516*10^{-3}$ (Element 2120 at Node 22139)

Sirius Environmental	*Project description* Whisby IBA Cells SRA		*Date* 06/03/2023
	Project filename South-North Section 1-1' D3	*Step* 29	*Company* Sirius Environmental Ltd

Output Version 21.1.0.479



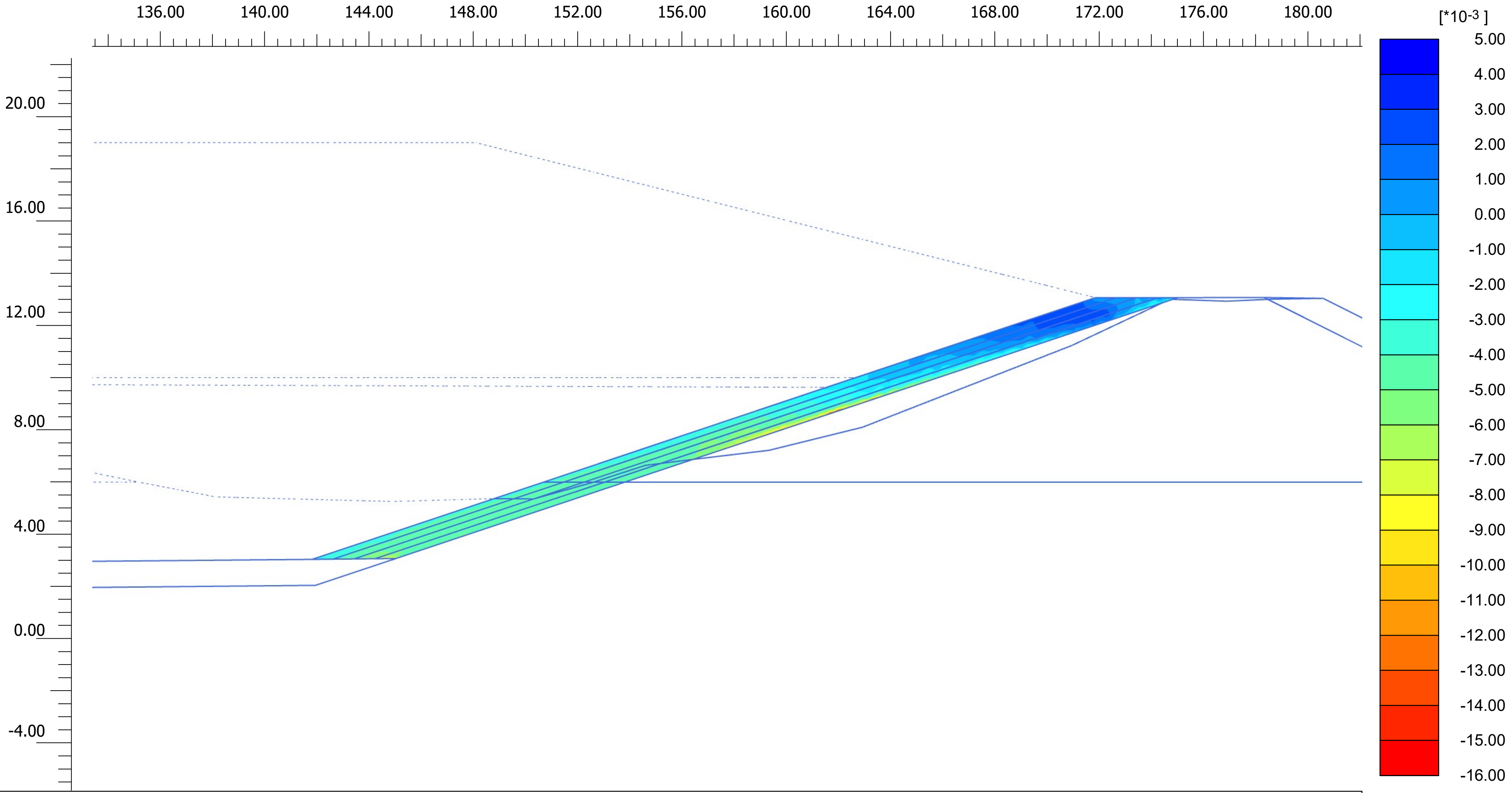
Total cartesian strain γ_{xy} (scaled up 200 times) (Time 794.0 day)

Maximum value = 0.01309 (Element 1496 at Node 24297)

Minimum value = $-6.325*10^{-3}$ (Element 2120 at Node 22139)

sirius Environmental	*Project description* Whisby IBA Cells SRA		*Date* 06/03/2023
	Project filename South-North Section 1-1' D3	*Step* 539	*Company* Sirius Environmental Ltd

Output Version 21.1.0.479



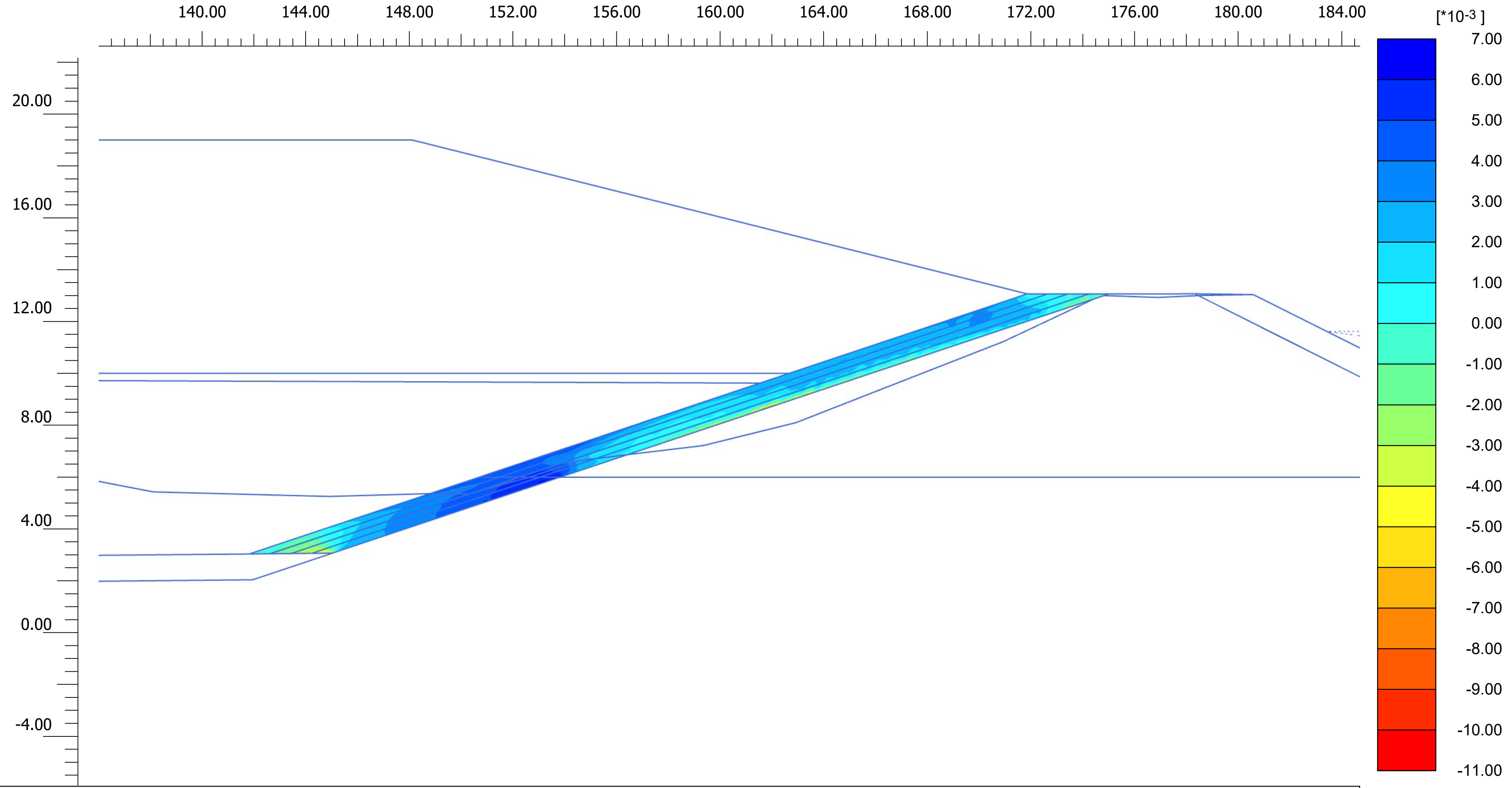
Total cartesian strain γ_{xy} (scaled up 500 times) (Time 65.00 day)

Maximum value = $4.422*10^{-3}$ (Element 2682 at Node 4643)

Minimum value = -0.01544 (Element 436 at Node 17549)

Sirius Environmental	*Project description* Whisby IBA Cells SRA		*Date* 06/03/2023
	Project filename West-East Section 2-2' D3	*Step* 20	*Company* Sirius Environmental Ltd

Output Version 21.1.0.479



Total cartesian strain γ_{xy} (scaled up 500 times) (Time 247.0 day)

Maximum value = 6.427×10^{-3} (Element 2229 at Node 18173)

Minimum value = -0.01043 (Element 436 at Node 17549)

Sirius Environmental	*Project description* Whisby IBA Cells SRA		*Date* 06/03/2023
	Project filename West-East Section 2-2' D3	*Step* 138	*Company* Sirius Environmental Ltd

APPENDIX 4

Cell 1 Engineering Specification Report

LINCWASTE LIMITED
(FCC ENVIRONMENT LIMITED)

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

Document Reference: WR7885_1 Rev1
April 2023

Project Quality Assurance

Report Reference	**:**	WR7885_1 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 Specification 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.

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1 GENERAL REQUIREMENTS

1.1 Introduction

FCC Environment (FCC) are seeking to construct IBA Cell 1 at Whisby Landfill Site, Lincolnshire. Whisby Landfill Site is located approximately 9km south-west of Lincoln City, at National Grid reference SK 897 669. The site address is:

Whisby Landfill Site
Thorpe Road
Whisby
Lincolnshire
LN6 9BT

Sirius Environmental Ltd has prepared a detailed Specification for the construction of IBA Cell 1. FCC will appoint a third party independent Construction Quality Assurance (CQA) consultant to provide supervision for the duration of the cell construction on FCC's behalf. A representative of the CQA Engineer, the CQA Inspector, will supervise the construction works and will advise the Contractor with regard to the onsite and offsite testing requirements.

The Construction Quality Assurance Method Statement and Engineering Specification for the cell construction works to be undertaken and has been prepared in accordance with the Environmental Permit.

This document, when read in conjunction with the CQA Plan ref: WR7885_2 details the requirements for the construction works undertaken by the Contractor and the quality control procedures that will be followed during the construction works by the CQA Inspector to demonstrate that the works have been undertaken in accordance with the Specification. This document also details requirements for each element of the construction, which should be read in conjunction with the construction drawings.

1.2 Project Team

The project team will comprise:

Waste Management Operator/Employer – FCC Environment (UK) Limited
Designer – Sirius Environmental Limited
Main Contractor – Jones Bros Ruthin
CQA – Sirius Environmental Limited
Principal Designer – Sirius Environmental Limited

1.3 Facilities

1.3.1 Contractor's Compound

The location and layout of the Contractor's compound shall be agreed with FCC prior to commencement of any works on site. The Contractor shall submit their proposals to FCC for mess facilities, plant standing, and maintenance areas. The Contractor shall site their plant standing, maintenance and refuelling areas so that no pollution will occur. 110% secondary containment bunding shall be used for fuel/oil storage tanks where appropriate. The Contractor shall also take into account the storage and mess requirements of their sub-contractors, if appropriate.

No lodgings or caravans will be allowed on site.

The Contractor shall ensure that adequate provision is made within the compound area for parking of all the plant, equipment and any private vehicles owned by operatives/subcontractors and visitors. Parking will not be permitted in any other areas of the landfill site.

The Contractor shall be responsible for the security of the works, all the Contractor's offices, plant, materials, services and machinery.

1.3.2 Contractor's Offices and Welfare Facilities

The Contractor shall be responsible for the provision and maintenance of welfare facilities for himself and any sub-contractors. These facilities shall be as prescribed in the Working Rule agreement published by the Civil Engineering Construction Conciliation Board for Great Britain. The sanitary accommodation and disposal arrangements shall comply with the requirements of the local Environmental Health Authority. The Contractor's personnel shall not be permitted access to FCC's mess, shower and toilet facilities.

1.3.3 Fuel and Oil Installations

The Contractor's fuel and oil installations within the site shall only be provided at locations approved by FCC, such approval not to be unreasonably withheld or delayed.

All fuel and oil installations provided by the Contractor shall be contained within an impermeable bund capable of containing 110% of the tank capacity in the event of a spillage; ‘self-bunded’ items will be permitted, subject to the Contractor being able to substantiate their efficacy.

The Contractor shall designate an area within his compound for carrying out plant maintenance and repairs. The Contractor shall ensure that all routine maintenance and repairs take place within this area. Any fuel or oil spillages will be remediated and a safe and controlled manner by the Contractor and at his expense.

1.3.4 Facilities for CQA Inspector (If required)

Where required, the Contractor shall provide, service and maintain one high-security steel ISO container, or as otherwise provided for, for the sole use of the CQA Inspector within the agreed location of his compound, subject to the approval of the CQA Inspector, which shall not be unreasonably delayed or withheld. The Contractor shall ensure that the container is provided with power supply, sufficient electricity power sockets, electric lighting and space heating, such that it will be ready for use by the CQA Inspector on the first day that CQA work is required. The Contractor shall be responsible for the maintenance of these facilities throughout the duration of the works.

All keys for the CQA Inspector's facilities shall be handed to the CQA Inspector.

1.4 Landfill Gas and Leachate Management Systems

FCC has installed landfill gas and leachate management systems across the Site, including areas within and adjacent to the works. FCC shall inform the Contractor which systems are to remain undisturbed during the period of the works, and which can be, or have been, decommissioned.

Should the Contractor subsequently damage or disturb any operational system, they shall immediately inform the CQA Inspector and FCC. Only if required by FCC, the Contractor shall carry out such reasonable remedial measures as are deemed necessary by FCC to reinstate any damaged or disturbed system to the same condition as immediately prior to commencement of the works, otherwise FCC shall provide for the remediation to be completed within a timescale to be agreed with the Contractor.

1.5 PPC Permit

The area of the works is encompassed by the existing Pollution Prevention and Control (PPC) Permit for the current landfill operations. The Contractor shall not directly or indirectly compromise FCC's ability to carry out its operations in accordance with the PPC Permit, a copy of which shall be provided by FCC on request.

2 CONSTRUCTION REQUIREMENTS

2.1 Regulations and Site Safety

The works come under the Construction (Design and Management) Regulations of 2015 and the Main Contractor will also be appointed as the Principal Contractor.

The Contractor shall comply with the safety requirements set out in the following documents:

- FCC - Health and Safety Policy;
- FCC - Site User Safety Instructions;
- FCC - General Policy Statement for Contractors Conditions of Contract and Safety Rules; and
- FCC - Health & Safety Site Plan.

A copy of these documents is available for inspection at the landfill site office.

The Contractor shall adhere to the site Health and Safety Rules and the DSEAR Regulations dated 2002. The Contractor's performance with respect to these rules will be reviewed at each progress meeting.

2.2 CDM Area

The extent and location of the CDM area shall be agreed with FCC prior to any works commencing on-site, and 'works' shall include the delivery of any plant, equipment, materials and/or accommodation.

The agreed area shall be demarcated on site and once demarcated, the Principal Contractor shall ensure that the requirements of the CDM Regulations 2015 are adhered to at all times within it.

2.3 Method Statements and Risk Assessments

The Sirius Design Risk Assessment is enclosed in Appendix 1.

The Contractor shall submit to FCC for approval, prior to commencement of the works, method statements and risk assessments detailing the proposals for all the works to be undertaken.

2.4 Substances Hazardous to Health

A substance hazardous to health shall only be used or generated in or about the works where specified in the Contract or with the consent of the CQA Inspector.

Where any substance hazardous to health is so used or generated during the works the Contractor shall provide the CQA Inspector with:

- A copy of the assessment of the risks created by the use of that substance; and
- Details of the measures to be taken to prevent or adequately control the exposure of the persons working with or those who may be affected by the substance.

The information required in the above shall be provided to FCC at least 14 days prior to the use of or incorporation into the works of substances hazardous to health or where appropriate at the commencement of the works where this is less than 14 days.

The Contractor shall advise FCC of the information, instruction, training and supervision to be provided for the Contractor's personnel and any other person likely to enter the area in which the hazard exists. The Contractor is to ensure that provision is made for monitoring health.

Where the measures referred to necessitate the use of protective clothing or other safety apparatus the Contractor shall:

- Provide FCC and their staff with sufficient and suitable items of protective clothing and safety apparatus if not previously supplied;
- Arrange for the proper storage, maintenance and regular testing and replacement of the items provided to the Employer and their staff; and
- Arrange for appropriate training or instruction for FCC and their staff in the use of such items.

2.5 Noise

The Contractor shall comply with any site specific noise limits and the following specific requirements:

- No work other than the operation of plant and equipment for the control of the groundwater shall take place outside the permitted hours except in case of emergency. FCC shall be informed of any such emergency immediately; and

- All mobile plant, equipment and vehicles under the control of the Contractor, their sub-contractors and suppliers, and in use or calling at the site, shall be fitted with appropriate silencing equipment and shall be maintained to manufacturers' standards.

2.6 Naked Flames and Smoking

Naked flames are prohibited within the working area on site at all times. Smoking will only be permitted in areas approved by FCC.

The Contractor shall obtain a permit to work from FCC for any 'hot works'. The works are to be carried out away from the landfill area and at a location agreed with FCC.

2.7 Mobile Plant

All Contractor’s and subcontractors’ vehicles (plant and operatives vehicles) shall be fitted with flashing amber beacons for vehicle awareness. Green flashing beacons to indicate that seat belts are in operation shall also be fitted to all construction plant. These beacons shall be located in a visually prominent position and shall be used whenever vehicles are on site. No Contractor’s or subcontractors’ vehicles will be allowed on site without the use of a flashing amber beacon.

All mobile plant shall be assessed for restricted rear view vision and action agreed, dependent upon the outcome of this assessment, which may result in suitable equipment being fitted in order to minimise the potential risk to within acceptable limits.

2.8 Dust Nuisance

The Contractor shall take all necessary steps to eliminate the generation of dust nuisance during the works.

Existing highways, site and access roads used by the vehicles and plant of the Contractor or of their sub-contractors or suppliers of materials, shall be kept clean and clear of all dust and mud dropped by the vehicles in any form. All dust and mud from the works spreading onto highways, site and access roads shall be immediately cleared by the Contractor by use of mechanical plant to the approval of FCC.

Compliance with this clause shall not relieve the Contractor of any responsibility for complying with the requirements of any Highway Authority in respect of keeping roads clean.

2.9 Communication Systems

The Contractor shall obtain the approval of FCC prior to the commissioning of any communication equipment and, following approval, shall ensure that it does not interfere with any existing systems on the site.

2.10 Access

The general arrangement of the site is shown on the respective site layout drawings. The only entrances to the works for the use of the Contractor are via the main site entrance, no other site entrances are to be used unless stated in the Specification. Areas for site offices, welfare facilities and plant standing areas will be arranged with FCC.

The main access road is to be kept clear at all times, as it will be used primarily by FCC's operations traffic. The Contractor will need to make provision for providing suitable access within the site, in particular between borrow areas, stockpile areas and the Contractor's compound.

The Contractor must not use the access roads used by FCC for access into active cells unless given prior permission of FCC. Alternative access roads must be used or constructed, the locations of which shall be agreed with FCC prior to work commencing.

The Contractor shall carry out jointly with FCC a condition survey of the access roads made available under the Contract prior to the commencement of any works. The Contractor shall repair and make good any damage to FCC's landfill access roads which occur as a result of the Contractor's activities.

The Contractor's vehicles must give way to landfill traffic and not impede the movement of the traffic involved in landfill operations.

The specified speed limits within the landfill site shall be observed at all times. Non-compliance may result in the exclusion of any offender from the site.

Appropriate signage must be displayed to warn traffic of slow moving plant, particularly if the haul road access crosses the main access road.

All vehicles leaving the site must be free from mud and debris. The Contractor will be responsible and will pay for the removal of debris and any damages arising from mud and debris that leaves the site as a consequence of the works.

2.11 Permitted Hours of Working

The permitted hours of working are to be agreed with FCC at the pre-start meeting for the works.

Working on Sundays and Bank Holidays will not be allowed unless approved beforehand by FCC.

2.12 Control of Surface Water

The Contractor shall carry out all necessary operations for the control of standing water, or surface water run-off, within the CDM area to enable the construction of the works, and by doing so shall prevent damage to the works, the site, or adjoining properties. Where these actions include measures to prevent the in-flow of water from the site, these works shall be approved by FCC before commencement.

Any water shall only be discharged outside the CDM area and/or off-site following the receipt of approval by FCC.

2.13 Control of Leachate

The Contractor shall carry out all necessary operations for the control of leachate, within the CDM area to enable the construction of the works, and by doing so shall prevent damage to the works, the site, or adjoining properties. Where these actions include measures to prevent the in-flow of leachate from the site, these works shall be approved by FCC before commencement.

Any leachate collected shall only be discharged outside the CDM area and/or off-site following the receipt of approval by FCC.

2.14 Disposal of Exhumed Waste

In the event that it is necessary to excavate waste in order to achieve any element or elements of this Specification, the excavated waste will be disposed of in the operational area of landfill, or as otherwise directed by FCC.

2.15 Protection of Boreholes

The Contractor shall locate and adequately protect existing deep ground water and landfill gas monitoring boreholes within the works area from damage during the works. The location of the boreholes are to be confirmed with FCC.

2.16 Inclement Weather

No materials shall be placed or compacted during inclement weather conditions, if in the opinion of the CQA Inspector, trafficking over compacted or uncompacted material would prove detrimental to the construction. Any such trafficking damage caused by the Contractor shall be repaired in accordance with the Contract at the Contractor's expense. Inclement weather conditions may include, rain, snow, freezing conditions or excessive heat as indicated by the CQA Inspector.

Following wet weather conditions, any standing water on the surface of the construction must be removed at the Contractor's expense. If instructed by the CQA Inspector, the Contractor shall remove any material rendered unsuitable by wetting at the Contractor's expense. Earthworks placement operations following inclement weather conditions shall not proceed without the prior approval of the CQA Inspector.

Any frozen material shall be allowed to thaw before use. Previously compacted material that has become frozen shall be removed from the works and stockpiled until suitable for reuse.

2.17 Tolerance limits

Tolerance limits for the work shall be as follows:

i) Positions in plan shall be within 50mm of the true positions shown on or calculated from the drawings;

ii) Levels shall be +50mm of the required elevation shown on or calculated from the drawings; and

iii) All other survey control and tolerance information is available in the FCC Good Practice Guide 6.0.

2.18 Confidentiality

The whole of the Tender Documents and all information provided by FCC for the purpose of or in connection with the Contract shall be dealt with by the Contractor as confidential to him and not be disclosed by him other than to his employees, sub-contractors or agents as appropriate for the sole purpose of the Contract.

The Contractor shall not, except with the prior consent in writing of FCC:

i) Publish or advertise or permit to be published or advertised any photograph, drawing or written matter concerning the Contract or the works;

ii) Use or permit the use of the name of FCC in any publication or advertisement; and

iii) Place any advertisement on any part of the works.

The Contractor shall refer all press representatives to FCC. Photographs for publication shall not be made of any part of the works without the prior written authorisation of FCC. Such authorisation if granted shall be in the form of itemised approvals for each exposure concerned.

3 SCOPE OF THE CONSTRUCTION WORKS

3.1 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.

3.2 Principal Quantities

The principal quantities for the works are given in Appendix 2.

3.3 Slope Stability

A Slope Stability report has been produced for the cell construction and lining system. This is a separate document but will be included in the works information.

3.4 Survey Information

The Contractor shall undertake an initial survey on a 10m grid spacing, or a 5m grid spacing on slopes and at breaks of slopes, of the site, this shall be compared to existing surveys, and once approved by FCC, the Contractor's survey will form the ‘original ground level survey’ (OGL) from which the measurement of the works will be undertaken. Further surveys will be required as follows:

- i) Base of excavation;
- ii) Formation levels;
- iii) Groundwater drainage pipework;
- iv) Drainage Geocomposite Panel Layout;
- v) Location of existing tie ins;
- vi) Top of Engineered Clay Liner levels;
- vii) Clay thickness isopachyte drawing;
- viii) Separation geotextile panel layout;
- ix) Leachate monitoring tower foundation pad and target pad, including pipe inverts;
- x) Top of leachate drainage stone (where placed); and
- xi) Final as Built of CDM Area included ditches installed.

As part of the CQA Process it is a requirement of the Environment Agency that check surveys are carried out to verify the accuracy of the main survey. This shall apply to the formation levels and top of engineered clay liner levels surveys stated above. Typically 10% of main survey points from both the formation surface and the top of clay surface shall be checked over at least two visits.

The check surveys shall be independent of the Main Contractor and shall be carried out be appropriately competent staff from FCC.

3.5 Daily Journal

The Contractor will be required to keep a detailed daily journal recording the information detailed below. The Contractor will give FCC reasonable access to the daily journal which will, if necessary, be made available to FCC, the Environment Agency (EA) or any other Authority during and after completion of the Works if required. The Contractor will forward copies of the daily journals on a weekly basis to the FCC.

This information shall be recorded in an acceptable form of daily journal which shall include the following:

- date of shift;
- names of personnel in attendance during the shift;
- weather conditions, including ambient temperature;
- type of plant used; plant breakdowns and hours;
- approximate totals of earthworks carried out including identification of source and destination;
- removal of foreign matter and oversize material;
- depth of layers under construction;
- approximate totals for amount of geosynthetic materials deployed, seamed, tested and repaired including width of each panel installed;
- summary of field and laboratory testing carried out;
- sample type and material taken for particular testing;
- delays;
- additional works, reasons and reference;
- deliveries;
- details of meetings and other correspondence;
- details of remedial works; and
- Any other relevant information.

4 EXCAVATION AND ENGINEERED FILL

4.1 General

This section outlines the requirements for excavation and placing the engineered fill materials to the required levels as shown on Drawing WR7885_01_02.

The compaction of all engineered fill materials shall be carried out in accordance with the Highways Agency "Manual of Contract Documents for Highway Works (MCDHW) – Volume 1 Specification for Highway Works" 1998 Series 600 Earthworks, published by HMSO except as amended hereunder. The Contractor shall employ only that plant and those working methods that are suited to the materials to be handled and traversed. He shall be responsible for maintaining the nature of the suitable material so that when it is placed and compacted it remains in accordance with the Contract. Suitability shall be determined in accordance with the definitions below.

The Contractor shall submit his proposals to the CQA Inspector regarding the extent and management of the excavations, stockpiling and filling of materials before starting works. Excavations shall not proceed without the prior approval of the CQA Inspector.

The Contractor shall not remove any materials from the site unless approved by FCC.

After completion of the works, the Contractor is required to re-grade any stockpiles and surrounding areas where deemed necessary. This shall be carried out to the satisfaction of FCC.

4.2 Definitions

The following definitions shall apply to the Specifications and CQA Plan wherever reference is made to the defined engineered fill material.

- "Suitable material" shall comprise all that is acceptable in accordance with the Contract for use in the works and deemed by the CQA Inspector to be suitable;
- "Unsuitable material" shall mean material other than suitable materials and shall include:
    - Peat, material from swamps marshes and bogs;
    - Logs, stumps and perishable material;
    - Material in a frozen condition;

- Material susceptible to spontaneous combustion; and
- Any commercial and domestic waste.

- "Rock" shall be deemed to mean hard material which, in the opinion of the Project Manager, necessitates for its loosening or removal the use of special machinery designed for rock cutting, but shall exclude any material that can be removed by normal excavating machinery and which, in any case, has a volume not exceeding 1 cubic metre or 0.25 cubic metres where the net width of the excavation is less than 2 metres.

4.3 General Excavation

The intended sub-grade formation profile shall be defined by the levels and lines as shown on Drawing WR7885_01_02.

The sub-grade formation profile shall be achieved by excavating *in situ* materials of varying consistency in accordance with this section.

The Contractor shall, unless otherwise agreed with FCC, carry out excavations in such a manner that the materials can be identified and placed in stockpiles for further use, without mixing of materials.

The sub-grade formation material shall not contain any unsuitable materials as defined in this section.

On the cell side-slopes, the sub-grade formation will be overlaid with a drainage geocomposite. In some areas the existing ground has water flowing through, or the subgrade material is granular, so the testing of the subgrade is not possible; only where any engineered fill is being placed shall testing be carried out.

The sub-grade formation shall be assessed by the CQA Inspector prior to the placement of engineered fill or drainage geocomposite. The assessment shall be based upon an inspection of the sub-grade for identification of unsuitable material. Where unsuitable material is encountered within the sub-grade it shall be removed and the resulting void shall then be filled in accordance with this section.

Where unsuitable material is encountered within the sub-grade to a depth below the excavation profiles provided, the CQA Inspector shall immediately inform the Designer to enable an assessment of the ground conditions to take place so that appropriate measure may be taken to investigate the presence and extent of unsuitable material and any impact this may have on the construction design.

In the event of ground water or leachate ingress into the formation material, appropriate remedial action shall be discussed with FCC, the Designer and the CQA Inspector, following which an agreed solution shall be established.

All remedial measures shall be completed and approved by the CQA Inspector prior to the placement of any fill material.

4.4 General Fill and Placement

Engineered fill material will comprise only suitable material as defined in this section and may be excavated on-site material, imported material or a combination of both.

The materials shall be classified, then placed and compacted in accordance with the method Specification contained within MCDHW, Clause 612, Compaction of Fills.

Haulage of materials to areas of placements shall only proceed when sufficient plant is available to compact the materials at the point of deposition.

Suitable engineered fill materials shall be placed and compacted in horizontal layers to a minimum Specification in terms of layer thickness and number of passes as defined by Table 6/4 of MCDHW appropriate to the compaction requirements as listed in Table 6/1 for the class of materials being compacted. The interface between individual layers shall be scarified to allow keying in between the layers of the structure and allow the structure to be formed as a homogeneous mass. Any clods present in the material should be broken down during compaction to ensure homogeneity of the fill material.

Once trimmed, the surface will be proof rolled using a smooth vibratory roller in dead weight mode with a mass per unit width of the roller between 2,000kg/m and 5,000kg/m to provide an even and unyielding surface. The surface will be sufficiently consolidated as to allow movement of vehicles without causing undue rutting or exhibiting other detrimental effects. Any soft spots or areas in which heave is observed during proof rolling will be removed and the subsequent void filled in accordance with the Specification.

Where engineered fill material is to be left exposed overnight the surface of the fill is to be sealed and smoothed to prevent water ingress. The sealed surface will be scarified prior to the placement of any future layers of fill material.

4.5 Engineered Fill Testing Requirements

The maximum particle size for cohesive engineered fill shall be 125mm except for isolated particles with a maximum size of 300mm in any dimension based upon a visual assessment at the point of placement in the Works and provided the isolated particles are dispersed within a finer matrix.

Testing shall be carried out on the engineered fill in accordance with Table 1.

The surface of the cell formation is only required to be hand shear vane (HSV) tested where engineered fill has been placed to achieve the formation levels.

Table 1: Engineered Fill Testing Requirements

Parameter	Test Method (BS 1377:1990:)	Acceptance Criteria	Testing Frequency
Cohesive Fill:			
Particle Size Density Grading Analysis	Part 2 Clause 9.2 -9.3		1 test per 1000m^3 of fill
In-situ Shear Strength (Hand Shear Vane)	Part 9 Clause 4.4	>50kPa	1 per 25m Grid Or at *least* one per layer

4.6 As-Built Drawings

A survey of the top of engineered fill / formation levels will be carried out. This drawing will be supplied to the CQA Inspector.

5 UNDER CELL DRAINAGE SYSTEM

5.1 General

A ground water drain will be installed along the interface of the Lower Lias Clay and the overburden / in-situ sand and gravel material, on the northern and southern side-slopes of IBA Cell 1, in accordance with the layout shown on Drawing WR7885_01_02. This is a known pathway for ground water ingress; once the excavation has been completed to show this interface, the true level and falls required on the pipework will be discussed with the Designer prior to installation, to ensure there is sufficient fall on any of the pipework to allow the water to egress from this area and enter the surface water control system.

Due to historic ingress issues on the northern and southern flank of the excavation, the northern and southern side-slopes of the cell will both have a groundwater drainage geocomposite installed as per the specification below.

Any other areas not identified in the design that show ingress of water shall be identified following the cell excavation works, and a solution shall be discussed with the Designer which will involve either additional drainage geocomposite or installation of additional French drains to ensure any ingress is directed away from the cell. An additional French drain has been shown on Drawing WR7885_01_02 on the eastern side-slope of the cell; this shall be installed if required following the cell excavation works.

Should any drainage be required in the in situ clay basal area, this shall be at such a depth that 1m of engineered clay liner can be reinstalled on the base in accordance with the specification in Section 6 of this document.

There are no proposed pumping systems for this cell, 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.

The proposed cuspated core geocomposite drainage layer (GDL) is to be laid against the prepared formation surface, or in-situ surface where fill is to be placed to achieve the formation level of the proposed sidewall. The GDL shall be comprised of a cuspated core with a geotextile on its upper and lower surface. The panels of GDL shall be laid with edges overlapping as per the manufacturer's Specification and recommendations (a copy of which shall be provided to the CQA Inspector for their information), and also laid cuspate down so that the smooth side is against the clay. The upper ends of each panel on the side slopes are to be restrained in an anchor trench formed within the formation. The GDL shall conform to the parameters shown in Table 2.

Table 2: Drainage Geocomposite Specification and Conformance Testing

Material Property	Test Method	Test Frequency	Requirement
Tensile strength of geocomposite	BS EN ISO 10319:1996	1 per 5,000m² and at least one per batch.	20 kN/m CD (-10%)
CBR puncture resistance of geocomposite	BS EN ISO 12236: 1996	1 per 5,000m² and at least one per batch.	4kN (-10%)
In plane water flow of (long and cross flow) geocomposite @ hydraulic gradient of 1.0 (Hard/Soft contacts) 200 kPa	EN ISO 12958:1997	1 per 5,000m² and at least one per batch.	1.0 l/s/m width (+/- 10%)

5.2 Delivery, Handling and Storage

The material will be delivered, handled and stored in accordance with the manufacturer's recommendations and should be delivered and stored in tight wrappings in order to offer protection from ultra violet degradation. Each roll of geocomposite delivered to site will be identified with:

- Manufacturer's name, address and telephone number;
- CE mark with accrediting body's number;
- Product identification and polymer type;
- Geocomposite batch and roll number;
- Roll length and width in metres;
- Roll weight in kilograms; and
- Polymer type.

Lifting and transportation of the geocomposite materials shall be by appropriate machinery with the use of slings and core bars. The material is not to be handled with the tines of a forklift machine, the bucket of an excavator, or any similar equipment under any circumstances.

The Contractor shall provide adequate and acceptable measures for protecting the material at all stages of the work, from all sources of potential damage such as sharp objects, boulders, cobbles etc, including weather conditions and will be located out of the way of the way of moving plant. The rolls of geocomposite will not be stacked more than 3 high with nothing stacked above them.

Any damaged material will be excluded from the works.

5.3 Manufacturers Quality Control

Quality control certificates will be supplied to cover each roll of material delivered to site. The certificates will be supplied prior to delivery of the material to site and will contain quality control data typically according to the requirements of Table 2.

Quality Control Certificates will be provided prior to installation and for inclusion in the CQA Validation Report as follows:

- A specification for the geocomposite which includes all properties contained in Table 2 measured using the appropriate test methods; and
- Written certification that minimum values given in Table 2 are guaranteed by the Manufacturer.

5.4 Drainage Geocomposite Conformance Sampling

As soon as practicable after the delivery of the geocomposite rolls to site, the Contractor shall cut and label samples 1 m long across the entire width of selected rolls for retention and/or conformance testing as directed by the CQA Inspector.

All testing to be carried out at an independent geosynthetic testing laboratory with UKAS accreditation for each test being carried out.

If testing shows that the geocomposite does not meet any one of the minimum requirements listed in Table 2, then this may be cause for rejection of the material from that roll. Any repairs, replacement or other works occasioned by the failure of the geotextile to meet the minimum requirements listed in Table 2 shall be carried out at the Contractor’s expense.

The CQA Inspector may at his discretion accept material from elsewhere on that roll if the Contractor can demonstrate through further laboratory testing (at his expense) at a geosynthetic laboratory approved by the CQA Engineer that this material does meet the acceptance criteria contained in Table 2.

5.5 Installation

The CQA Inspector will assign panel identification codes and maintain a record of panel/roll correspondence and the date and location of installation. Each panel will be observed for defects and a record will be kept to assure that all defects are properly repaired and tested.

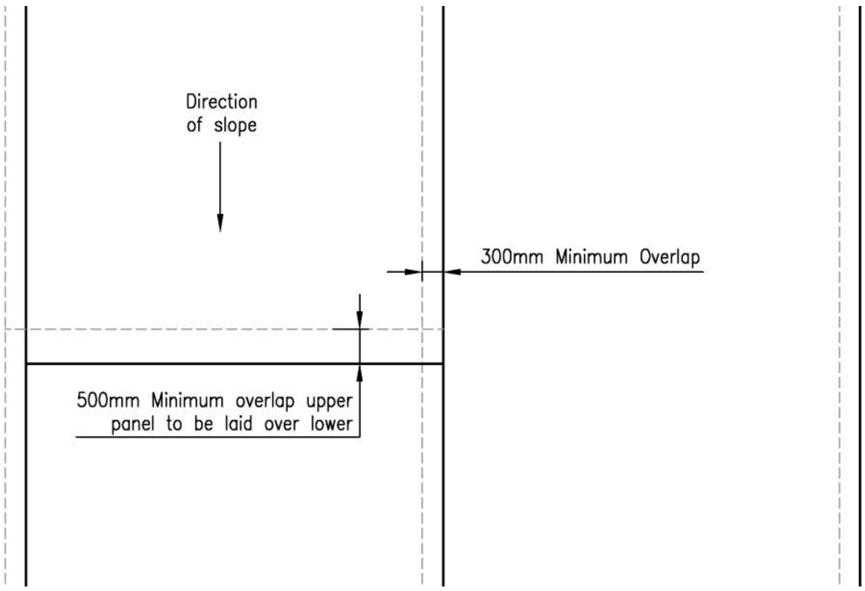
Geocomposite panels will be placed directly over and in intimate contact with the geomembrane. The minimum panel overlap on basal areas and across slopes shall be 300mm and down slopes the minimum panel overlap shall be 500mm (or in accordance with the manufacturers recommendations). This arrangement is shown on Figure 1 below.

Geocomposite panels shall be joined by either heat bonding or by sewing using methods to be approved in advance by the CQA Inspector.

The geocomposite shall be installed in an anchor trench at the crest of the slopes as shown on Drawing WR7885_01_03. The toe of the geocomposite shall be terminated in a French drain to allow the water to discharge into the existing lagoon for water control.

In windy conditions and at the end of the working day, all exposed edges of the geocomposite should be weighted down, the geocomposite should be held down using sandbags or similar weights that will not damage the material. The CQA Inspector shall visually check for such damage.

All geocomposite sheets will be visually inspected for damage and imperfections after deployment and any repairs required will be undertaken.



5.6 Repairs

Any faulted areas on the geocomposite shall be overlain with a single piece of compatible geocomposite. The patch shall have a minimum overlap of 500mm in all directions.

5.7 Collector Drains

The groundwater collection drains will be comprised of 250mm ID HDPE perforated pipework installed in 500mm x 500mm gravel filled trenches. The pipework shall be installed in a drainage trench located below the interface between the sands and gravels and the Lower Lias Clay, or at the base of the sidewalls if groundwater bearing limestone bands are found within the Lower Lias Clay. The exact locations and levels of the drains are to be confirmed following the cell excavation works. The drains are to fall to the west to allow free discharge of any water ingress. The trench is to be backfilled with non-calcareous 20/40mm clean drainage stone surround, in accordance with the construction details shown on Drawing WR7885_01_03.

The groundwater collection drain on the eastern side-slope of the cell will be required if significant groundwater ingress / limestone bands are found along this side-slope; this is to be confirmed following the cell excavation works.

The groundwater collection drains on the northern and southern side-slopes of the cell are to be tied-in to the existing pipework coming through the dam (north), and the known water egress point (south),

Northern and southern drains to be extended at the eastern ends to connect into existing pipework coming through the dam in the north, and the known ingress point to the south. This is shown in the layout on Drawing WR7885_01_02.

Junctions between sections of groundwater drain may be required, depending upon the final required drainage layout. The locations and nature of these junctions are to be agreed between the Contractor and FCC following the excavation works for the cell.

6 ENGINEERED CLAY LINER

6.1 General

The new sidewall liner will comprise a 1.0m thick (perpendicular to the sidewall) engineered clay liner (ECL) compacted to achieve a permeability of less than or equal to 1.0 x 10^{-9} m/s. The engineered clay liner is to be constructed over the sidewall as shown on Drawings WR7885_01_02, and 03. It is proposed that all of the clay will be sourced from site as per previous cell constructions for which a previous source evaluation report has been completed, any other source than this will have a source evaluation completed and submitted to the EA prior to its use.

The placement of the engineered clay liner shall also include the construction of the western perimeter bund, which shall be constructed in accordance with the relevant construction detail on Drawing WR7885_01_03.

6.2 Engineered Clay Liner Specification

The material shall conform to the requirements set out within Table 3.

Table 3: Engineered Clay Liner Specification

Parameter	Requirement
Clay Content	>10%
Moisture Content	TBC by compaction trial
Liquid Limit	<90%
Plasticity Index	>10 – <65%
Maximum Stone Size	125mm
Permeability	$\leq$1 x 10^{-10}m/s
Undrained Shear Strength	>50kPa
Air Voids	<5%
Thickness	$\geq$1.0m perpendicular to formation

Should the material used within the construction of the engineered clay liner alter significantly, then further source evaluation testing will be undertaken and additional acceptance criteria produced and agreed with the EA.

The Contractor will ensure that the clay material is handled such that it does not become unsuitable for inclusion in the works. At the end of each working day the stockpiles will be sealed to the satisfaction of the CQA Inspector in order to prevent any deterioration in the quality of the clay.

6.3 Compaction Trial

A compaction trial will be completed prior to the commencement of the engineering works to demonstrate that compliance with the Specifications can be achieved with the proposed plant and number of passes. The compaction trial will cover a minimum area of three construction machine widths and three to five construction machine lengths and in two lifts at the proposed layer thickness. The trial pad is to be located on an area of maximum side slope gradient. The Contractor is to arrange and carry out the following in situ and laboratory testing.

6.3.1 *In Situ* Testing

i) Moisture/density tests using a core cutter samples will be carried out by the Contractor at a minimum of 3 locations on each layer of the trial pad and;

ii) Undrained shear strength tests using a hand shear vane will be carried out at a minimum of 5 test locations on each layer of the trial pad. In addition, samples for the following laboratory testing shall be obtained and testing arranged by the Contractor.

6.3.2 Laboratory Testing

- 5 No. core cutter density and moisture content (BS 1377:1990: Part 2 Clauses 3.2)
- 2 No. liquid and plastic limits (BS 1377 1990: Part 2 Clauses 4.3, 5.3 and 5.4);
- 2 No. particle density (BS 1377:1990:Part 2 Clause 8.3 (gas jar method);
- 2 No. particle size distribution testing (BS 1377:1990: Part 2 Clauses 9.2 and 9.4);
- 2 No. moisture/dry density relationship 4.5 kg (BS 1377:1990:Part 2 Clause 3.5); and
- 2 No. constant head triaxial permeability testing (BS1377:1990: Part 6 Clause 6).

If site or material conditions change so that the CQA Inspector feels the construction of the clay liner may be compromised, then additional compaction trials may be undertaken at any time during the works.

6.3.3 Trial Excavation

A trial excavation shall be carried out along one side of the compaction trial area to allow a visual inspection to assess the bonding between layers of clay. Should there be insufficient bonding between layer, the area will be compacted using different placement and compaction techniques to ensure adequate bonding. If in the opinion of the CQA Inspector inadequate bonding has taken place then additional compaction shall be carried out to determine the required number of passes to achieve this.

6.4 Surface Preparation

All new areas of new engineered clay material will be keyed into the underlying formation levels to create a homogenous seal wherever the two materials meet, to prevent the formation of any potential preferential slip surfaces. This will be completed by the rolling of layers with a padfoot roller to leave an uneven surface.

6.5 ECL Placement and Layer Thickness

The ECL will be placed in discreet (loose) horizontal layers with a maximum thickness of 300mm (prior to compaction). The clay may be placed in inclined layers on any slopes provided that the requirements of this CQA Plan are achieved over the full layer thickness.

The ECL will be compacted using a padfoot roller or vibrating padfoot roller in accordance with the requirements determined during the compaction trial, or with further passes of the compactor, to achieve the compaction requirements of this Specification.

6.6 Sealing/Completion of ECL

Each lift will be sealed by smooth rolling before the end of each operating shift. Where previous lifts have been compacted smooth the surface will be scarified so that the subsequent lift is keyed in. The final lift will be rolled to provide a smooth, firm, unyielding surface. No earthmoving or other plant which could damage the compacted material will be allowed onto the surface of the clay liner following satisfactory compliance testing of that section.

6.7 Materials Deemed Unsuitable

If the materials used in the construction of the clay liner are at any point during construction works deemed unsuitable by the CQA Inspector, then the material will be removed and stockpiled at a designated stockpile away from the working area. The material may be utilised as engineered fill if it meets the Specification (requirements in Section 4).

6.8 ECL Conformance Testing

Throughout the construction of the clay liner the Contractor will, under the direction of the CQA Inspector, undertake quality control testing of the parameters and at the frequencies set out in Table 4. In situ testing of the basal clay liner will also conform with Table 4, based on the assumed volume if the base was to be fully engineered as opposed to being in-situ material. The Contractor will also carry out any additional testing required by the CQA Inspector.

Following compaction, each lift will be subjected to conformance testing as detailed in this section prior to placement of the subsequent lift. Placement of materials in a subsequent lift will not take place until satisfactory *in situ* test results have been obtained.

All samples for laboratory testing of the engineered clay material will be taken by the Contractor under supervision of the CQA Inspector. Laboratory testing will be arranged by the Contractor and carried out at a laboratory with UKAS accreditation for each test being carried out.

Table 4: Engineered Clay Liner Conformance / Testing

Parameter (as placed)	*Test Method*	*Frequency*	*Requirement*
Lift Thickness	-	-	250mm (Compacted)
In Situ Moisture and Density	BS1377 1990, Part 9	1/250m^3	mc – TBC from results of trial pad <5% Air Voids
In Situ Undrained Shear Strength (Calibrated HSV)	BS1377 1990 Part 9	1/250m^3	>50kPa
Laboratory Confirmation of *In Situ* Moisture/Density Testing	BS1377 1990 Part 2 Clauses 3.2 and 7.2	1 per 5 *in situ* tests or 1 per day whichever is the greater	mc - TBC <5% Air Voids
Plastic Limit and Plasticity Index	BS1377 1990 Part 2 Clauses 5.3 and 5.4	1/500m^3	PI >10% and <65%
Liquid Limit	BS1377 1990 Part 2 Clause 4.3	1/500m^3	< 90%
Particle Density	BS1377 1990 Part 2 Clause 8	1/500m^3	
Particle Size Distribution	BS1377 1990 Part 2 Clauses 9.2 and 9.4	1/500m^3	Fines content >20% Clay content >10%
Hydraulic Conductivity (Permeability)	BS1377 1990 Part 6 Clause 6 Cell Pressure 450kpa – 650kPa Hydraulic Gradient of 50kpa Mean Effective Stress of 100kPa	1/500m^3	< 1.0 x 10^{-9} m/s

Sampling and testing locations will be as directed by the CQA Inspector but are to be evenly distributed throughout the layers and will not be carried at the same location in successive layers.

The Contractor will make available to the CQA Inspector all quality control testing results as soon as they become available.

Should the *in situ* testing prove that the above acceptance criteria are not being achieved, the following can be undertaken:

- Undertake additional works on the layer as necessary such that subsequent testing of the layer meets the acceptance criteria. This may include such measures as wetting or drying placed materials, additional passes of the compacting plant or other measures as necessary; or

- Remove the part of the layer demonstrated to have not met the acceptance criteria and replace it such that subsequent conformance testing meets the specifications.

6.9 ECL Perforations

All perforations made in the clay liner for testing and measurement purposes will be backfilled with a thick bentonite putty or clay as appropriate. The mixture will be compacted in place with a tamping rod or compaction hammer according to the size of the perforation. This procedure will apply, but is not limited to:

- Core cutter;
- Permeability sample locations; and
- Undisturbed sample locations.

6.10 As-Built Drawings

A survey of the top of ECL levels will be carried out on slopes and batters using the point on point technique with the top of formation level points. From this an isopachyte drawing is be produced by the Contractor to verify the thickness of clay liner is in accordance with the Specification on areas of sidewall. Cross sections at 20m intervals along side-slopes shall be provided to demonstrate that the adequate thickness has been achieved requirement of thickness has been installed. Both these drawings will be supplied to the CQA Inspector and included within the CQA Validation Report.

7 SEPARATION GEOTEXTILE

7.1 General

A separation geotextile shall be placed on the surface of the approved clay liner; this will provide erosion protection on the side wall. The separation geotextile shall be installed in accordance with Drawing WR7885_01_03.

7.2 Material

The material installed shall be a non-woven separation geotextile conforming to the Specification set out in Table 5. Laboratory confirmation testing will be arranged by the Contractor and carried out at an independent laboratory with UKAS accreditation for each test being carried out.

Table 5: Separation Geotextile Specification and Conformance Testing

Parameter (as placed)	*Test Method*	*Frequency*	*Requirement*
Polymer			Polypropylene/Polyethylene
Construction			Non-woven
Wide Width Tensile Strength	BS EN ISO 10319	1/5,000 m^2	8 kN/m (min ave)
CBR Puncture Resistance	BS EN ISO 12236	1/5,000 m^2	3,000 N (min ave)
Cone Drop	BS EN ISO 13433	1/5,000 m^2	<25mm

7.3 Delivery, Handling and Storage

The material will be delivered, handled and stored in accordance with the manufacturer's recommendations and should be delivered and stored in tight wrappings in order to offer protection from ultra violet degradation. Each roll of geotextile delivered to site will be identified with:

- Manufacturer's name, address and telephone number;
- CE mark with accrediting body's number;
- Product identification and polymer type;

- Geotextile batch and roll number;
- Roll length and width in metres;
- Roll weight in kilograms; and
- Polymer type.

Lifting and transportation of the geotextile materials shall be by appropriate machinery with the use of slings and core bars. The material is not to be handled with the tines of a forklift machine, the bucket of an excavator, or any similar equipment under any circumstances.

The Contractor shall provide adequate and acceptable measures for protecting the material at all stages of the work, from all sources of potential damage such as sharp objects, boulders, cobbles etc, including weather conditions and will be located out of the way of the way of moving plant. The rolls of geotextile will not be stacked more than 3 high with nothing stacked above them.

Any damaged material will be excluded from the works.

7.4 Manufacturers Quality Control

Quality control certificates will be supplied to cover each roll of material delivered to site. The certificates will be supplied prior to delivery of the material to site and will contain quality control data typically according to the requirements above.

7.5 Conformance Testing

As soon as practicable after the delivery of the geotextile rolls to site, the Contractor shall select, cut and label samples 1m long across the entire width of selected rolls for retention and/or conformance testing as directed by the CQA Inspector. One set of samples per 5,000 m^2 shall be taken and tested as per the requirements of Table 5.

The Contractor shall submit the samples for conformance testing to an independent laboratory having UKAS accreditation for each test being carried out. A copy of the results of the testing are to be forwarded to the CQA Inspector.

If testing shows that the geotextile does not meet any one of the minimum requirements listed in Table 5, then this may be cause for rejection of the material from that roll. Any repairs, replacement or other works occasioned by the failure of the geotextile to meet the minimum requirements listed in Table 5 shall be carried out at the Contractor's expense.

The CQA Inspector may at his discretion accept material from elsewhere on that roll if the Contractor can demonstrate through further laboratory testing (at his expense) at a geosynthetic laboratory approved by the CQA Engineer that this material does meet the acceptance criteria contained in Table 5.

7.6 Installation

Geotextile panels shall be laid with a minimum overlap of 100mm and joined by either heat bonding or by sewing using methods to be approved in advance by the CQA Inspector. The geotextile will be secured either in anchor trenches along the upper perimeter of the works, or by the leachate drainage system on the cell base. All areas of geotextile on the sidewall shall have concrete filled sandbags along the all seams to prevent the geotextile being damaged by prevailing winds across the batters.

In windy conditions and at the end of the working day, all exposed edges of the geotextile should be weighted down, the geotextile should be held down using sandbags or similar weights that will not damage the material. The CQA Inspector shall visually check for such damage.

All geotextile sheets will be visually inspected for damage and imperfections after deployment and any repairs required will be undertaken.

Beneath the concrete slab for the leachate collection chamber, and beneath the target pad, a double layer of the separation geotextile shall be installed, in order to provide adequate protection for the basal lining system in these locations. Further geotextile shall also be placed above the target pad concrete slab, and above the leachate drainage gravel around the leachate collection point. These details are shown on Drawing WR7885_01_04 and Drawing WR7885_01_05.

Additional geotextile shall be also installed around the leachate collection drains (to act as a filtration geotextile), as shown in the construction detail on Drawing WR7885_01_04.

7.7 Repairs

Any faulted areas on the geotextile shall be overlain with a single piece of compatible geotextile. The patch shall have a minimum overlap of 500mm in all directions. Any patches required shall be heat bonded to the same standard as the original geotextile.

8 LEACHATE COLLECTION AND REMOVAL SYSTEM

8.1 General

The following works will be carried out to install the Leachate Collection and Removal System (LCRS):

- Installation of 4 collection pipework runs encased in leachate drainage gravel and geotextile, as per drawing WR7885_01_04;
- Installation of one leachate collection / monitoring chamber;
- Installation of one target pad; and
- Provide all material quality control certificates and other information described below.

8.2 Leachate Drainage Gravel

8.2.1 General

The leachate drainage system will comprise 1 leachate collection / extraction chamber and 4 pipe runs with gravel surrounds, fully wrapped in geotextile as per Drawing WR7885_01_04. The geotextile material shall be the same as that specified for the separation geotextile in Section 7 above.

8.2.2 Material

The granular material to be used in the leachate collection system will comprise 20/40mm natural gravel in accordance with Environment Agency Guidance and Table 6.

Details of the aggregate source to be used, including test data for the parameters detailed in Table 6, shall be submitted by the Contractor to the CQA Inspector prior to any placement being undertaken. This should be verified by the CQA Inspector.

Table 6: Leachate Drainage Gravel Specification and Conformance Testing: 20/40 Gravel

Parameter	Test Method	Test Frequency	20/40mm Gravel	
			Percentage Passing Sieve (%)	Sieve Size
Particle Size Distribution	BS EN 933-1	1 per 1,000 m^3	98 to 100 80 to 99 20 to 70 (+/-15) 0 to 20 0 to 5 	63 mm 40 mm 31.5 mm 20 mm 14 mm 10 mm 4 mm
Ten per cent Fines Value*	BS EN 1097-2	1 per source	>100 kN (soaked condition)	
Thickness	Survey Comparison	10 m intervals along pipework haunching	≥360 mm (Depth markers are acceptable)	

Notes:

1. Samples for conformance testing shall be taken from locations evenly distributed across the drainage layer.
2. The amount of fines may increase during handling on site, therefore an allowance of 2% shall be made for material passing the smallest sieve.
3. Where Ten per cent fines value is not available the aggregate shall have a Los Angeles Abrasion value (BS EN 1097-2) of ≤ 40.

8.3 Gravel Placement

The drainage gravel shall be transported within the cell on gravel haul roads with a minimum thickness of 1m above the geotextile. The gravel shall be placed in a careful and systematic manner so that machine shovels or blades are not in contact with the geotextile and to prevent the formation of wrinkles and creases in the liner.

The leachate drainage gravel is required to be placed along the leachate collection pipework runs, around the leachate collection point (battered down at a gradient of 1 in 1), and above the target pad (to 300mm thick), as shown in the construction details on Drawing WR7885_01_04 and Drawing WR7885_01_05.

Tracked vehicles that run directly on the stone above the geotextile shall operate from a haul road or above a minimum of 300mm of drainage gravel. No abrupt breaking or changes in direction that may otherwise damage the liner shall be permitted.

The CQA Inspector shall reserve the right to investigate any areas of potential damage to the underlying lining system. The Contractor shall submit a method statement detailing his proposed techniques and equipment prior to installation of the LCRS.

Should the Contractor damage the underlying geotextile in any way while placing the drainage gravel or excavating gravel trenches he shall acknowledge this immediately, replace and/or repair it according to the relevant sections of the CQA Plan, at their own expense.

Should the Contractor alter the gradients and cause local ponding and rutting due to plant or machinery on the drainage gravel, he shall undertake remedial measures at his own expense.

Thickness checks of the gravel placement above the leachate collection pipework will be carried out using mobile travel boards on-site and by comparing as-built survey information. Survey information is required for all elements of the gravel placement. Details of the thickness monitoring will be included in the CQA Validation Report.

8.3.1 Leachate Pipework

8.3.2 General

Leachate pipework will be constructed as the layout shown on drawing WR7885_01_04 to encourage the transmission of leachate to the extraction well. The pipework will comprise 160mm internal diameter pipes. The pipework will be bedded on a 100mm thick layer of leachate drainage gravel material. Pipework shall be either perforated or slotted.

The leachate collection pipework shall comprise material that meets the Specification set out in Table 7.

Table 7: Leachate Collection Pipework Specification

Parameter	Requirement
Pipe Material	HDPE
Pipe Internal Diameter	160mm
Deflection of the Pipe	< 5%
% Open Area	> 1% <5%
Perforation Location	Full circumference of pipe
Waste Density	10 kN/m^3
Depth of Waste	18m
Pipe Surround	Gravel
Pipe Joints	Butt or Electro Fusion welded

The size, spacing and orientation of perforations/slots made in the pipe must allow unhindered flow of leachate and prevent migration of drainage media into the pipe whilst maintaining pipe strength. The slots should have a minimum open area of 1% and a maximum of 5%. The perforations/slots shall be located around the pipe circumference. The Contractor shall submit deflection calculations to the CQA Inspector from the pipe manufacturer to demonstrate that the pipework and proposed fittings are suitable for this application

The Contractor shall provide the CQA Inspector with a copy of the quality control procedures taken by the pipe manufacturer and copies of any quality control certificates. All proposed pipework will be approved in writing by the CQA Inspector upon inspection of the above and sources of supply shall not be changed without their approval.

All leachate pipework shall be covered with leachate drainage gravel to a minimum level of twice the internal pipe diameter above the soffit of the pipe.

8.3.3 Pipework, Delivery, Handling and Storage

The pipework will be delivered, handled and stored in accordance with the manufacturer's recommendations and in such a way that damage will not occur to any material.

The pipes will be stored on an area flat enough to accommodate the entire length of the pipes and in such a way so that they are not deformed or damaged. The pipes will not be stacked higher than 1m.

8.3.4 Pipe Jointing

All pipework and fittings shall be joined using butt or electro fusion methods. The CQA Inspector will observe the connection of all lengths of leachate drainage pipework.

8.4 Vertical Leachate Extraction and Monitoring Well

8.4.1 Leachate Well Base

The base for the leachate collection/monitoring well shall comprise a 2,500mm x 2,500mm x 300mm reinforced concrete pad. The finished level of the concrete pad shall be the same as that of the top of clay.

Concrete to be used for the bases shall have a minimum strength of 40N/mm^2 and be sulphate resisting.

Reinforcement for all pads will comprise two layers of A393 square mesh with a minimum cover of 60mm.

Beneath all pads (leachate well base and target pad) the liner will be locally depressed, over this basal area the clay must be tested and trial pitted beneath the slab to ensure the 1m of in situ clay is still present to comply with the Specification; if this is not the case then the area must be re-engineered as per Section 6 of this Specification. The top of the pad will be flush with the liner. The geotextile lining shall pass beneath the pad as shown in the construction detail on WR7885_01_04.

8.4.2 Leachate Well Construction

An option for a Telescopic leachate well has been proposed, as well as the standard FCC leachate well construction. This option is shown in the construction detail on Drawing WR7885_01_05.

The well shall be constructed as shown on WR7885_01_04 or WR7885_01_05 (dependent upon which well design is chosen).

For the standard FCC well construction, the lower 1m of the HDPE pipework inside the well will be perforated, and the remainder of the pipework shall be un-perforated. The top of the chambers shall be completed with suitable temporary cover to allow the wells to be extended by FCC as waste placement progresses.

Additional leachate drainage gravel shall be placed to 2.0m above the top of the slab level as shown on WR7885_01_004.

8.4.3 Target Pad

A Target Pad shall be constructed as shown on drawing WR7885_01_04.

The target pad shall comprise a 5,000mm x 5,000mm x 300mm reinforced concrete pad. The finished level of the concrete pad shall be the same as that of the top of clay.

Concrete to be used for the target pad shall have a minimum strength of 40N/mm^2 and be sulphate resisting.

Reinforcement for will comprise two layers of A393 square mesh with a minimum cover of 60mm.

Upon completion, the target pad shall be covered with 300mm of leachate drainage gravel.

8.4.4 As-Built Drawings

A survey of the actual installed pipework routes and falls as well as the locations of all other fabrications will be produced.

The survey will include leachate drainage gravel levels, pipeline falls, and the locations and elevations of all wells and fabrications. The survey will be used to check that the falls and leachate drainage gravel thicknesses specified are achieved.

APPENDIX 1

DESIGNER'S RISK ASSESSMENT

FCC ENVIRONMENT LIMITED

DESIGNER RISK ASSESSMENT
INCINERATOR BOTTOM ASH CELL 1
AT WHISBY LANDFILL SITE

Document Reference: WR7885_3 Rev 0
March 2023

Project Quality Assurance

Report Reference	:	WR7885_3 Rev 0
Report Date	:	March 2023
Prepared for	:	FCC Environment Ltd
Issued by	:	Sirius Environmental Limited 4245 Park Approach Thorpe Park Leeds LS15 8GB

Rev	Date Issued	Amendment Details	Author	Reviewer
0	Feb 2023	Issued to FCC	ARK	ARK

Purpose

This document was prepared as a Designer Risk Assessment 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.

Contents

1. PROJECT DESCRIPTION

1.1.1 The proposed works and Construction Quality Assurance requirements are included with Documents Ref: WR7885_1 (Engineering Specification) and WR7885_2 (CQA Plan)

2. MAINTENANCE AND USAGE NOTES

2.1.1 The following notes are provided for the end-user, who should be aware of the following hazards when operating or maintaining the completed facility:

(i) Waste placement and compaction activities adjacent to the leachate collection and drainage system will need to be undertaken with care, to avoid damage and/or disturbance to the chamber structures.

(ii) Care will be required during placement of the first layer of waste, to avoid compaction plant coming into contact with the leachate drainage system and with the separation geotextile overlying the clay liner.

(iii) Ensure all drainage pipework is kept clear and open to allow discharge of the backwall drainage system to ensure the stability of the lining work.

(iv) Adjacent water bodies should always be kept below the level of the of the outlet from the backwall drainage system.

(v) The initial access road to be installed shall be carefully deposited in order to not damage the sidewall lining system

3. DESIGN RISKS

3.1.1 Design risks, mitigation measures and residual risks are identified on the following risk assessments. The Contractor's attention is drawn in particular to the specific construction hazards identified for which residual risks are considered to be moderate or high. The Contractor is expected to undertake an assessment of risk and to develop specific method statements in order to reduce the risks to an acceptable level.

Design Risk Assessment		**Sheet Number:**	1 of 4
		Job Number:	WR7885_3
		Date:	March 2023

Subject	Hazards	Persons at Risk	Initial			Mitigation Measures	Residual			Action
			Severity	Likelihood	Risk		Severity	Likelihood	Risk	
General excavations, deep excavations and excavations from stockpiles	Risk to personnel and plant from excavation collapse Risk to personnel and plant from stockpile collapse	Construction Personnel	H	M	H	Regularly inspect excavations as work proceeds to identify potential failure areas	M	L	M	Contractor to provide details of working methods in construction phase health and safety plan, including assessment of ground stabillity for earthworks plant, and details of all restrictions to be imposed
						Excavated slopes to be battered back at appropriate angle/gradient	M	L	M	
						Organise excavation work such that plant is located on stable ground	M	L	M	
						Restrict access to excavations (both above and below the working face)	M	L	M	
Excavations within landfill waste	Risk to personnel from contact with waste, leachate, etc	Construction personnel	M	L	H	Check extent and location of excavations (with regard to existing cell works). Remove leachate from excavations on regular basis. Monitor for presence of landfill gas. Implement strict hygiene rules	L	L	L	Contractor to provide details in construction phase health and safety plan. Movements on and around waste to be restricted to absolute minimum. Maintain good personal hygiene. Wear gloves.
	Risk to personnel from landfill gas	Construction and landfill personnel	H	H	H		M	L	M	Refer to landfill safe working practices. Requirement for 'hot works' permit. No smoking on site. H_2S issues to be highlighted. All H_2S wells and chambers to be clearly marked by Employer prior to mobilisation of Contractor. Evacuation strategy to be included in construction phase health and safety plan.
Exposure of buried asbestos during regrade of capping areas/construction of cell tie-in	Risk of inhalation of airborne fibres	Construction personnel	H	L	M	Stop works and isolate area. Request inspection of excavation by FCCstaff if any suspect materials are encountered. General restriction of access for non-essential personnel	H	L	M	Contractor to develop safe working methods to isolate any asbestos if encountered. If encountered, licensed specialist contractor to be appointed by contractor. ASB5 notification to be raised for HSE.
Working adjacent to excavations	Objects falling onto personnel and plant operating below	Construction personnel	H	M	M	Access to excavations, and edge of excavations, to be restricted	M	L	M	Contractor to provide details of restrictions
Water	Potential flooding of excavation due to intense rainfall combined with extensive catchment area	Construction personnel	L	M	M	Drainage ditches or sumps to be excavated to allow water to be diverted from, and removed from excavation	L	L	L	Weather reports to be monitored. Temporary drainage measures to be detailed in construction phase health and safety plan
	Surface water lagoon located to north of construction area.	Construction and site personnel	M	L	L	Lagoon is fenced. Contractor to liaise with FCCover pumping arrangements	L	L	L	Access within fenced area to be restricted to essential personnel; no lone working in this area.

Subject	Hazards	Persons at Risk	Initial			Mitigation Measures	Residual			Action
			Severity	Likelihood	Risk		Severity	Likelihood	Risk	
Groundwater	Instability/accumulation of groundwater/soft ground	Construction personnel	M	L	M	Pedestrian access to area to be restricted to essential personnel.	L	L	L	Ground water control system has been incorporated into the design.
Fire	caused by oxygen drawn into waste mass	Construction and site personnel	H	L	M	Close liaison with LFG contractor (Infinis) during construction works with regard to disconnection/reconnection of gas wells, and relocation of collection pipework, to prevent oxygen being drawn in to the waste mass during the capping works.	L	L	L	
Working on or adjacent to soft ground	Subsidence of plant and machinery	Construction personnel	M	M	M	Review existing soils data. Monitor condition of soils as work proceeds	M	L	M	Contractor to develop working methods to cater for working over and adjacent to soft ground
Loading of excavation materials	Risk to personnel in vicinity of vehicles	Construction personnel	M	M	M	Drivers to position vehicles in safe locations	L	L	L	Contractor to provide details of loading arrangements in construction phase health and safety plan
						Access to loading area to be restricted	L	M	L	Contractor to provide details of restriction arrangements in construction phase health and safety plan
Working at heights	Fall into excavations	Construction personnel	H	M	H	Excavation depths and gradients to be minimised	M	L	M	Contractor to provide details of measures to be imposed, including barriers to be erected around excavations and restricted access provisions.
	Objects falling onto personnel below	Construction personnel	H	M	H	Access to excavations to be restricted	M	L	M	
Transportation of materials on site	Risk of vehicle collisions	Construction personnel	M	L	M	Access/egress arrangements to each works rea to be self-explanatory	L	L	L	Contractor to provide details of access/egress arrangements, including signage, in construction phase health and safety plan
Working on steep slopes	Materials falling onto personnel and/or plant	Construction personnel	H	M	H	Existing slope angles to be capped up to maximum of 1:6, with excavated slopes for cell at 1:2½	H	M	M	Contractor to develop safe working method for materials handling
	Vehicles overturning	Construction personnel	H	M	H	Contractor to avoid vehicular access routes at crests of slopes where possible. Edge protection to be provided as necessary.	M	L	M	Materials to be placed from base of slopes where possible. If placed from top of slopes, stop boards or other protective measures must be used.
	Personnel falling down slope	Construction personnel	H	M	H	Access to be restricted to essential personnel	L	L	L	Contractor to provide suitable edge protection, instruction, and if appropriate, fall arrest systems

Subject	Hazards	Persons at Risk	Initial			Mitigation Measures	Residual			Action
			Severity	Likelihood	Risk		Severity	Likelihood	Risk	
Installation of geosynthetic materials	Risk to personnel from manual handling	Construction personnel	M	L	M	Use standard manual handling techniques. Consider wind conditions prior to placement	L	L	L	Contractor to provide manual handling details in construction phase health and safety plan. Use of mechanised handling in preference to manual handling.
	Risk to personnel during lifting operations	Construction personnel	M	L	M	Organise lifting operations to minimise conflict with groundworkers	L	L	L	Contractor to provide lifting details in construction phase health and safety plan
	Risk to personnel access over installed geosynthetic materials	Construction personnel	M	L	M	Provide safe means of access over geosynthetic	L	L	L	Contractor to provide safe access details in construction phase health and safety plan
	Risk of gas explosion/burns	Construction personnel	H	M	H	Installation contractor to demonstrate competence. Installation staff to be suitably qualified. No spark testing to be undertaken – vacuum box testing only of extrusion welds. DSEAR zooming to be applied. Gas monitors to be provided.	M	L	M	DSEAR zoning drawing to be obtained from Employer on mobilisation to site. Gas risk to be included in site induction [procedures.
	Cuts from knives used in installation	Construction personnel	M	M	M	Risk assessment and method statement to be provided. Use of retractable blades. Use of appropriate gloves.	L	L	L	Rotation of personnel to avoid fatigue. New blades to allow frequent replacement due to blunting
Site traffic/traffic management	Risk to personnel from moving plant and machinery	Construction and landfill personnel	M	L	M	Contractor to ensure that consideration has been given to vehicular and pedestrian traffic management	L	L	L	Separate pedestrian and vehicular access routes. Contractor to provide traffic management arrangements in construction phase health and safety plan. FCCsite rules to be included within induction process, and enforced.
Deliveries	Risk of injury during unloading and handling	Construction personnel, delivery drivers	M	L	M	Contractor to ensure that all suppliers and subcontractor material deliveries are properly coordinated and due regard is given to the restriction of routes, programming and sizing of delivery vehicles.	M	L	L	Contractor to provide details in construction phase health and safety plan
Existing services	Risk to personnel from landfill gas mains, leachate pipes, compressed air lines and associated power cables	Construction personnel	M	M	H	Banksman to be employed when operating in close proximity to leachate and has wells or pipes. Contractor to ensure that all persons affected by existing services are aware of those services and take all necessary	M	L	M	Contractor to identify services on site at commencement of construction works. Contractor to provide details of investigative procedures, e.g. CAT scanning Services drawing to be obtained from Employer on mobilisation to site.

Subject	Hazards	Persons at Risk	Initial			Mitigation Measures	Residual			Action
			Severity	Likelihood	Risk		Severity	Likelihood	Risk	
						precautions to protect themselves and the services.				
	Risk to personnel from hidden services	Construction personnel	M	L	M	Contractor to ensure that all persons undertaking works likely to affect any hidden services are aware of their possible presence and take all necessary precautions to protect themselves and the services	M	L	L	Contractor to identify KNOWN services on site at commencement of construction works. Details of 'safe dig' procedures to be provided in construction phase health and safety plan.
	Risk of damage to services	Construction personnel	M	L	M	Contractor to ensure adequate support is provided to services exposed during excavations Contractor to check adequacy of goal posts with regard to overhead power cables and routing of plant and vehicles	L	L	L	Contractor to provide details in construction phase health and safety plan, and in traffic management plan

APPENDIX 2

PRINCIPAL QUANTITIES

FCC ENVIRONMENT

PROJECT ACTIVITY SCHEDULE

ACTIVITY	LANDFILL
SUB-ACTIVITY	Cell Construction
CONTRACTOR	Jones Bros
SITE NAME	Whisby landfill
PROJECT NAME	Cell 1 and IBA Pad Construction
PROJECT CODE	
PROJECT AX CODE	
FCC NEC SUPERVISOR	
FCC NEC QUATITY SURVEYOR	
SITE START DATE	
SITE WORKS DURATION	
PROJECT STATUS	Draft / Full Design / Agreed
Void Delivered	80,000m3

Signed Agreement:

Date:	XX/XX/XXXX
Contractor	
FCC PS	
FCC QS	

Description of Works

General:-

Haul distances will be measured from the centre of the supply area to the centre of the final capped area.

Scope of Works:-

Cut and Fill to formation
Stockpile Unsuitable Materials
Installation of Drainage Geocomposite and toe drain
Installation of Engineered Clay Sidewall Liner
Installation of Western Perimeter bund
Installation of separator Geotextile
Installation of Leachate Drainage System
~~Instalaltion of Hardcore Road~~
~~Installation of Tempoarary 300mm Culvert Beneath Road with gravel surround~~

Extra-ordinary Works

0		
1. General Items		-
2. Bulk Earthworks		-
3. Ground Water Drainage System		-
4. Lining System		-
5. Leachate Drainage System		-
6. Protection Layer		-
7. Roads & Hardstandings		-
Project Total	£	-
Project Insuarance	£	-
Project Total less Discount	£	-

FCC ENVIRONMENT

LANDFILL Cell Construction

					JONES BROS Quants 1	Meas Unit 1	SIRIUS Quants 2	Meas Unit 2	Unit Rate	Total Cost £
1	**General Items**									
	1			**Site Establishment & General Attendance**	1	Sum				-
	2			**Weekly Site Running Costs**	15.0	Sum				-
	3			**Project Testing as per Testing schedule**	1	Sum				-
	4			**US Clerance outside of Cell area**	1					-
	5									-
									Total	-
2	**Bulk Earthworks**									
	1			**Excavate**						
		1		Rock (Mechanical Dig)						
			1	0 Haul		m3				-
			2	Not exceeding 250m Haul		m3				-
			3	More Than 250m Haul ne 500m haul		m3				-
			4	More Than 500m Haul ne 1000m haul		m3				-
			5	More than 1000m haul (per 500m)		m3				-
		2		Rock (Hard Material)						
			1	0 Haul		m3				-
			2	Not exceeding 250m Haul		m3				-
			3	More Than 250m Haul ne 500m haul		m3				-
			4	More Than 500m Haul ne 1000m haul		m3				-
			5	More than 1000m haul (per 500m)		m3				-
		3		US Material						
			1	0 Haul		m3				-
			2	Not exceeding 250m Haul	4329	m3	4329			-
			2a	Not exceeding 250m Haul	11084	m3	11084			-
			3	More Than 250m Haul ne 500m haul (Cap)	3339	m3	3339			-
			4	More Than 500m Haul ne 1000m haul		m3				-
			5	More than 1000m haul (per 500m)		m3				-
		4		General						
			1	0 Haul		m3				-
			2	Not exceeding 250m Haul	21445	m3	21445			-
			3	More Than 250m Haul ne 500m haul		m3				-
			4	More Than 500m Haul ne 1000m haul		m3				-
			5	More than 1000m haul (per 500m)		m3				-
		5		Topsoil Strip						
			1	0 Haul		m3				-
			2	Not exceeding 250m Haul		m3				-
			3	More Than 250m Haul ne 500m haul		m3				-
			4	More Than 500m Haul ne 1000m haul		m3				-
			5	More than 1000m haul (per 500m)		m3				-
		6		Peat						
			1	0 Haul		m3				-
			2	Not exceeding 250m Haul		m3				-
			3	More Than 250m Haul ne 500m haul		m3				-
			4	More Than 500m Haul ne 1000m haul		m3				-
			5	More than 1000m haul (per 500m)		m3				-
	2			**Fill**						
		1		Excavate From on site / Imported.		m3				-
			1	0 Haul		m3				-
			2	Not exceeding 250m Haul	11084	m3	11084			-
			3	More Than 250m Haul ne 500m haul		m3				-
			4	More Than 500m Haul ne 1000m haul		m3				-
			5	More than 1000m haul (per 500m)		m3				-
		2		Spread level & compact cell footprint	11084	m3	11084			-
		3		Trim surface to level Cell Footprint	13246	m2	13246			-
		4		Spread Level Compact US Materials on cap	3339	m3	3339			-
		5		Trim surface US materials (0.5m depth) on cap	6678	m2	6678			-
		5		Form stockpile onsite inc sealing surface	25774	m3	25774			-
									Total	-
3	**Groundwater / Backwall Management**									
	1			**Drainage system**						
		1		Pipework Backwall / Bench		m				-
		1		Pipework Toe Drain						-
			1	100mm ID		m				-
			2	160mm ID		m				-
			3	250mm ID Backwall drain	370	m	370			-
			4	250mm ID Floor (Provisional)	260	m	260			-
			5	250mm ID Stocking Area Drain	73	m	73			-
			6	Bends	3		3			-
		2		Geocomposite						
			1	3kn 300g/m +/-10% Tolerance		m2				-
			2	4kn 400g/m +/-10% Tolerance	9594	m2	9594			-
			3	5kn 500g/m +/-10% Tolerance		m2				-
	2			**Sidewall Riser**						
		1		450mm ID SDR 11		m				-
		2		600mm ID SDR 11		m				-
	3			**Gravel Surround**						
		1		10mm - 20mm		m3				-
		2		20mm - 40mm	175	m3	175			-
	4			**Road Crossing with Cover Stone**						
		1		350mm ID SDR 11		m				-
		2		450mm ID SDR 11		m				-
		3		600mm ID SDR 11		m				-
	5			**Manhole in OverConstruct**		Sum				-
									Total	-

FCC ENVIRONMENT

LANDFILL Cell Construction

				JONES BROS Quants 1	Meas Unit 1	SIRIUS Quants 2	Meas Unit 2	Unit Rate	Total Cost £
4	**Lining Systems**								
	1		**Mineral Layer**						
		1	Base						
			1 Import		m3				-
			2 Excavate From on site / Imported.						
			1 0 Haul		m3				-
			2 Not exceeding 250m Haul		m3				-
			3 More Than 250m Haul ne 500m haul		m3				-
			4 More Than 500m Haul ne 1000m haul		m3				-
			5 More than 1000m haul (per 500m)		m3				-
			3 Spread level & compact		m3				-
			4 Trim surface	9483	m2	9483			-
		2	Bunds						
			1 Import		m3				-
			2 Excavate From on site / Imported.						-
			1 0 Haul		m3				-
			2 Not exceeding 250m Haul	2647	m3	2647			-
			3 More Than 250m Haul ne 500m haul		m3				-
			4 More Than 500m Haul ne 1000m haul		m3				-
			5 More than 1000m haul (per 500m)		m3				-
			3 Spread level & compact	2647	m3	2647			-
			4 Trim surface	1595	m2	1595			-
		3	Sidewalls						
			1 Import		m3				-
			2 Excavate From on site / Imported.						-
			1 0 Haul		m3				-
			2 Not exceeding 250m Haul	12174	m3	12174			-
			3 More Than 250m Haul ne 500m haul		m3				-
			4 More Than 500m Haul ne 1000m haul		m3				-
			5 More than 1000m haul (per 500m)		m3				-
			3 Spread level & compact	12174	m3	12174			-
			4 Trim surface	12174	m2	12174			-
		4	E.O for watering clay to achieve moisture levels (for non-	14821	m3	14821			-
	2		**Geosynthetic Layers**						
		1	Base & Intermediate Bunds						
			1 2mm HDPE Double rough		m2				-
			2 GCL		m2				-
			3 Geotextile		m2				-
			1 3kn 300g/m +/-10% Tolerance	9843	m2	9483			-
			2 4kn 400g/m +/-10% Tolerance		m2				-
			3 5kn 500g/m +/-10% Tolerance		m2				-
			4 Anticpated Cylinder Test HPS		m2				
		2	Sideslopes						
			1 2mm HDPE Double rough		m2				-
			2 GCL		m2				-
			3 Geotextile		m2				-
			1 3kn 300g/m +/-10% Tolerance	15029	m2	15029			-
			2 4kn 400g/m +/-10% Tolerance		m2				-
			3 5kn 500g/m +/-10% Tolerance		m2				-
			4 Sand Bags	24872		24872			-
		3	Anchor Trenches	874	m	874			-
		4	Leak Detection		m2				-
		5	Connect to exisitng						-
			1 Connect to existing 2 Layers		m				-
			2 Connect to existing 3 Layers		m				-
			3 Connect to existing 4 Layers		m				-
								Total	**-**

FCC ENVIRONMENT

LANDFILL Cell Construction

				JONES BROS Quants 1	Meas Unit 1	SIRIUS Quants 2	Meas Unit 2	Unit Rate	Total Cost £
5	**Leachate Drainage Systems**								
	1		Piped work (all SDR 11 pipework, additional gravel over pipework)						
			160mm dia	272	m	272			-
			225mm ditto		m				-
		1	Fittings						
			1 bends		no				-
			2 Junctions		no				-
			3 Others		no				-
	2		**Drainage Blanket**						
		1	Stone 10/20mm		m3				-
		2	Stone 20/40mm	141	m3	141			-
		3	Geocomposite		m2				-
	3		**LCPs**						
		1	Concrete	1	no.	1			-
		2	HDPE		no.				-
		3	Gabions		no.				-
	4		**LMPs**						
		1	Concrete		no.				-
		2	HDPE		no.				-
		3	Gabions		no.				-
	5		**Target Pad**						
		1	5m x 5m x 300mm thick concrete	1	no.	1			-
		2	5m x 5m x 600mm thick gravel		no.				-
								Total	**-**
6	**Lining System Protection Layer**								
	1		protection layer						
		1	Protection Soils						
			1 Import						-
			2 Excavate From on site / Imported.						-
			1 0 Haul		m3				-
			2 Not exceeding 250m Haul		m3				-
			3 More Than 250m Haul ne 500m haul		m3				-
			4 More Than 500m Haul ne 1000m haul		m3				-
			5 More than 1000m haul (per 500m)		m3				-
			3 Spread level & compact		m3				-
			4 Trim surface		m2				-
		1	Protection Materials						-
			1 1mm LLDPE / HDPE		m2				-
			2 Geotextile						-
			1 3kn 300g/m +/-10% Tolerance		m2				-
			2 4kn 400g/m +/-10% Tolerance		m2				-
								Total	**-**
7	**Roads & Hardstandings**								
	1		Site roads						
		2	Hardcore						
			1 Road construction inc geogrid or similar.						-
			1 300mm thick		m2				-
			2 450mm thick		m2				-
			3 600mm thick		m2				-
			2 Bump Bank (size & dimensions)		m				-
			ne 1m (H) * 2m (W)						-
			1 0m - 25m						-
			2 25m - 75m						-
			3 75m - 100m		m				-
			Ditches	200	m				-
									-
								Total	**-**

Material	Test	Rate (£)	Quantity	Cost
Clay	Plasticity Index			£ -
	Particle Density			£ -
	Core Cutter Density			£ -
	Moisture Content			£ -
	Triaxial Permeability (fixed rate)			£ -
	PSD by Hydrometer			£ -
	Wet Sieve PSD			£ -
	Dry Density / Moisture Content (2.5kg)			£ -
	Dry Density / Moisture Content (4.5kg)			£ -
				£ -
Leachate Drainage Blanke	10% Fines			£ -
	Wet Sieve Analysis			£ -
	Dry Sieve Analysis			£ -
	Permeability			£ -
GCL	Swell Index / Free Swell			£ -
	Montmorillonite Content			£ -
	Bentonite Mass/Unit Area			£ -
	Mass per Unit Area of GCL			£ -
	Moisture Content of Clay			£ -
	Peel Strength			£ -
	CBR Puncture Resistance			£ -
	GCL Grab Strength			£ -
Geomembrane	Carbon Black Content			£ -
	Carbon Black Dispersion			£ -
	Density			£ -
	Dimensional Stability			£ -
	Melt Flow Index			£ -
	Thickness			£ -
	Puncture Resistance			£ -
	Tear Resistance			£ -
	Textured Asperity Height			£ -
	Notched Constant Load Test - limited to 500hrs			£ -
	Oxidative Induction Time			£ -
	UV Resistance			£ -
	Destructive Weld/ Seam Testing			£ -
Geotextile	Tensile Properties			£ -
	Thickness			£ -
	Puncture Resistance			£ -
	Tear Resistance			£ -
	Apparent Opening Size			£ -
	Drop Cone Test			£ -
	Grab Breaking Strength			£ -
	Mass/Unit Area			£ -
	Cylinder Load Test			£ -
Interface Testing	Capping interface testing			£ -
Engineered Fill testing	PSD			£ -
	Materials Classification			£ -
	Core Cutter Density			£ -
	Particle Density			£ -
Added By Jones Bros				£ -
GDL **(Not covered under Geotextile)**	In Plane Water Flow (long and cross direction			£ -

£	-
£	-

Contract Risk Register

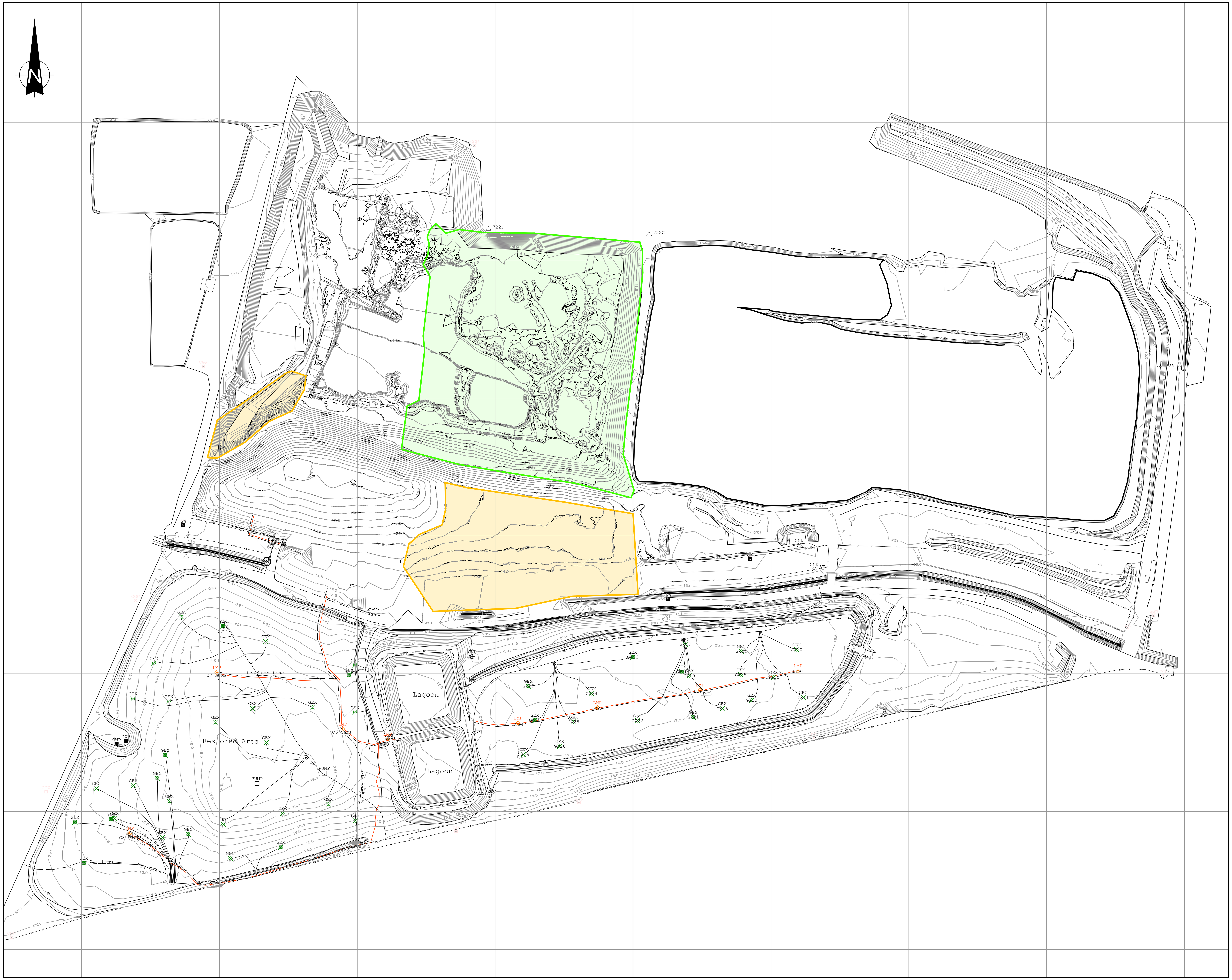
Site	**Whisby landfill**
Project Title	**Cell 1 and IBA Pad Construction**
Project Number	**0**
Contractor	**Jones Bros**

Risk Number	Risk Detail	Risk Owner	Likelihood	Severity	Provisional sum
1	SRA based on information supplied by Tarmac being correct -FCC need to clarify undoubtably that JB are safe to proceed with cell construction	FCC			
2	Soils Balance based on assumptions volumes could increase significantly	FCC			
3	Price & Programme based on Preliminary works being undertaken before cell works	FCC			
4	Provisional item for undecell at the base of the cell included in AS- No allowance for additional duration for these works	FCC			
5	FCC responsibility to maintain pump chamber outside of cell, significant risk to construction of cell should the pump fail	FCC			
6	All Undercell & Ditches are based on 500x500mm	FCC			
7	Valley fill based on placing pipe and stone in current ditch- no allowance for any other works in that area	FCC			
8	No allowance for ecology	FCC			
9	No stockpile design- all prices based on drawings provided showing approx. area for stockpiling	FCC			
10	GDL priced on installation with the use of the long reach excavator- This is due to access from the top is not possible and the flank being 1:15 gradient	FCC			
11					
12					
13					
14					
15					

Signed for and on behalf FCC & Contractor

Contractor		**Date**	
FCC NEC Project Manager		**Date**	

DRAWINGS



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LEGEND

- 18.5 — SITE SURVEY
- EXTENTS OF PROPOSED IBA CELL 1 WORKING AREA
- STOCKPILE AREA FOR UNSUITABLE / EXCESS MATERIALS FROM CELL EXCAVATION

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

General Arrangement

DRAWN	DATE	APPROVED	DATE
ARK	02/03/2023	ARK	02/03/2023

SCALE	SHEET	DRAWING NUMBER	REVISION
1:1250	A1L	WR7855 01 01	0

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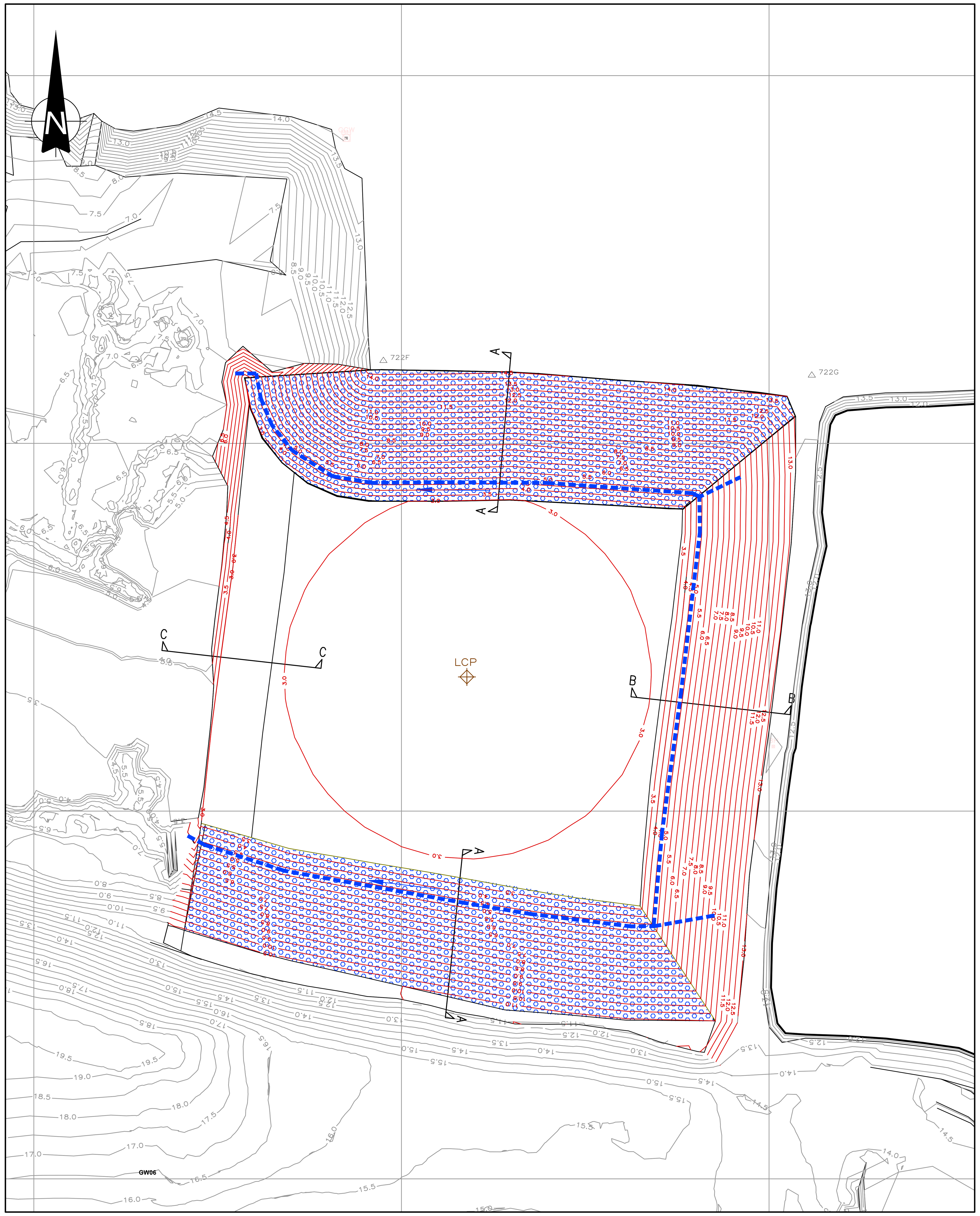
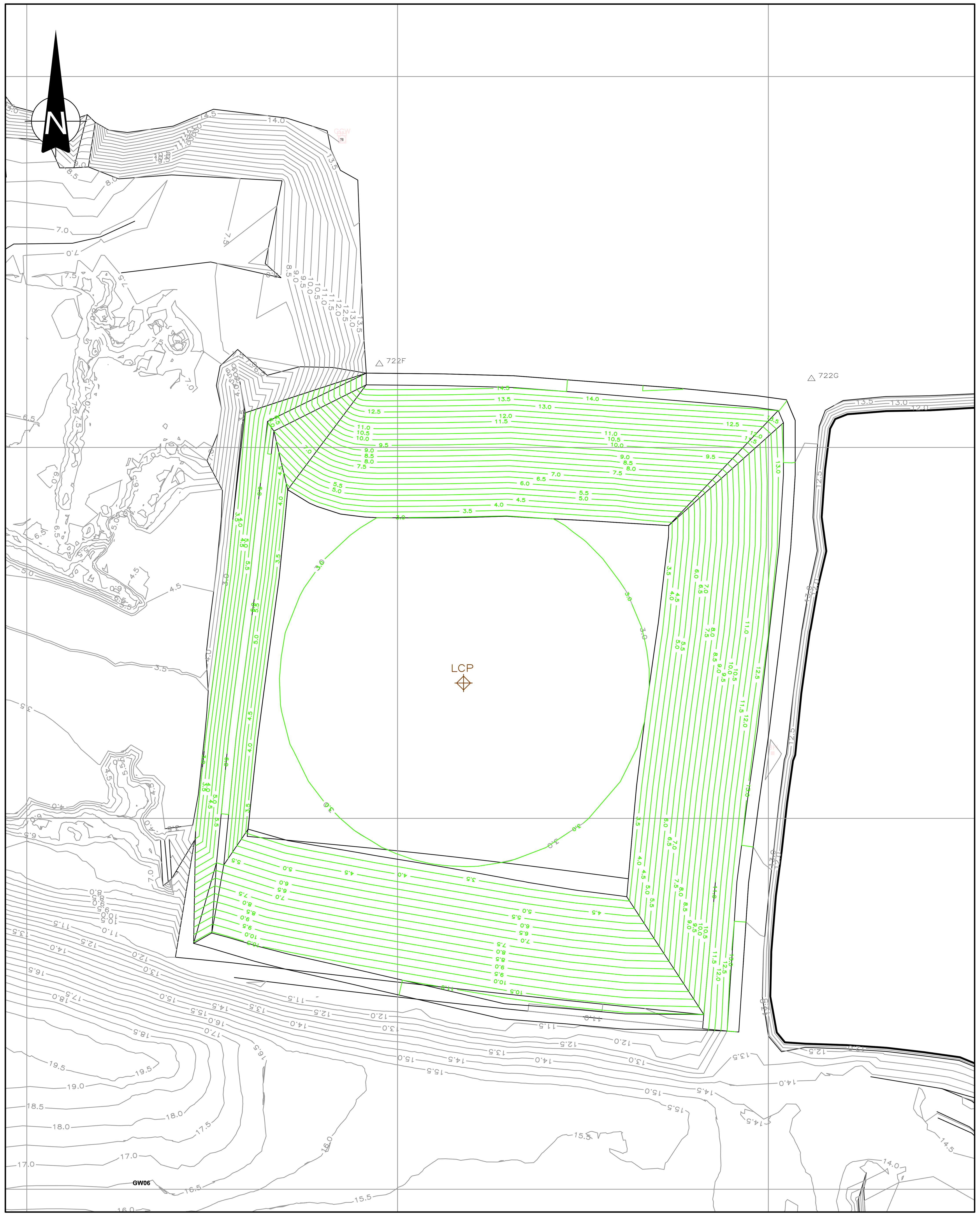


LAYOUT SHOWING PROPOSED FORMATION LAYOUT

SCALE 1:750



LAYOUT SHOWING PROPOSED TOP OF LINER

SCALE 1:750

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

REV	DESCRIPTION	DATE	BY
1	SOUTHERN BATTER AMENDED	04.04.2023	ARK

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

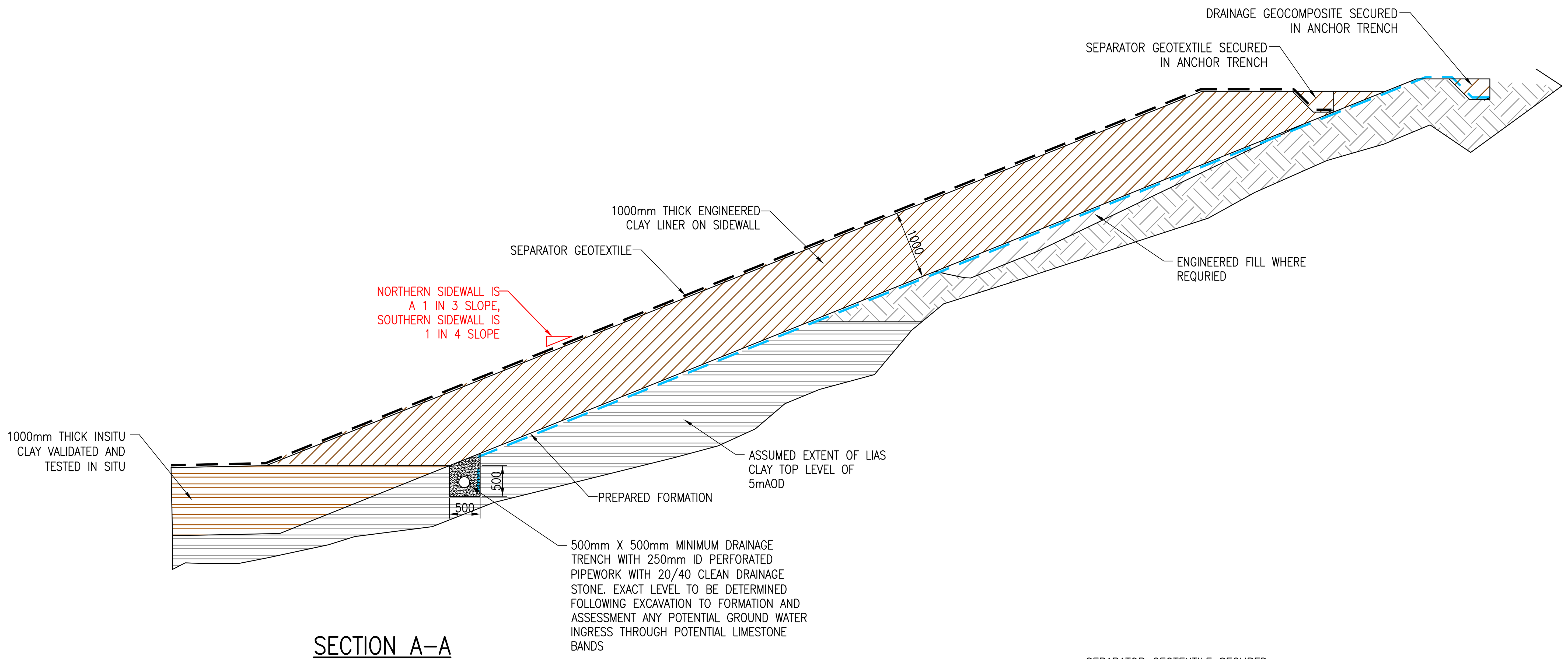
WHISBY LANDFILL SITE
IBA CELL 1 CONSTRUCTION

DRAWING TITLE

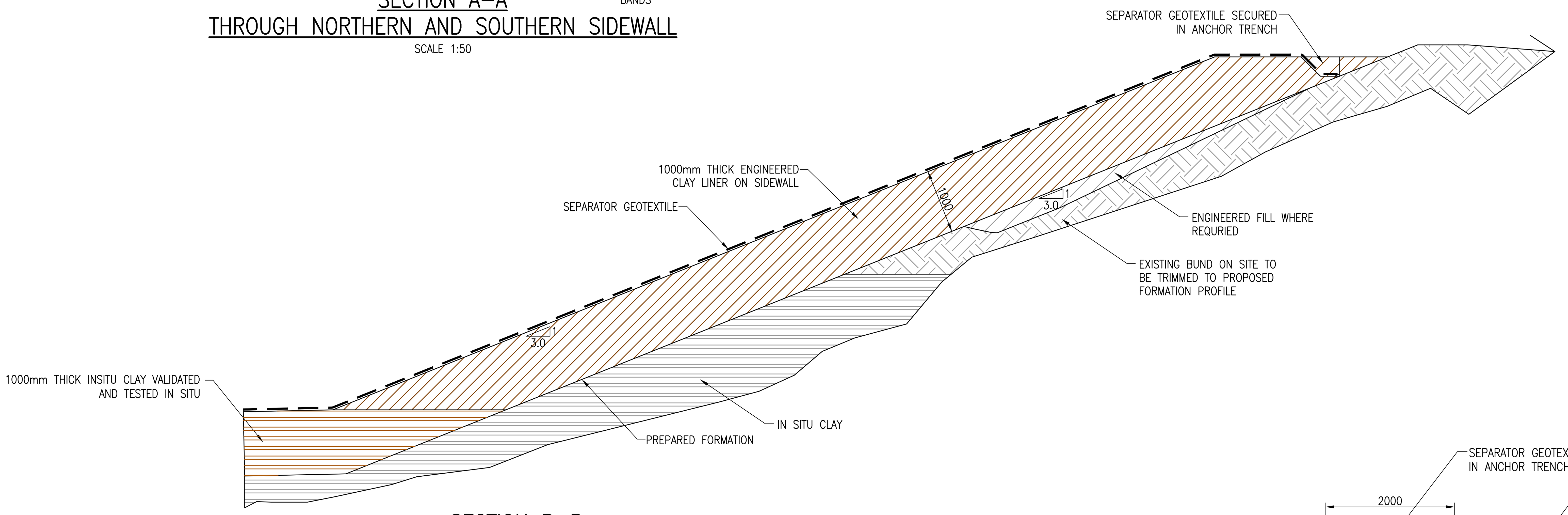
FORMATION AND TOP OF LINER LAYOUT

DRAWN	DATE	APPROVED	DATE
ARK	02/03/2023	A.K	02/03/2023

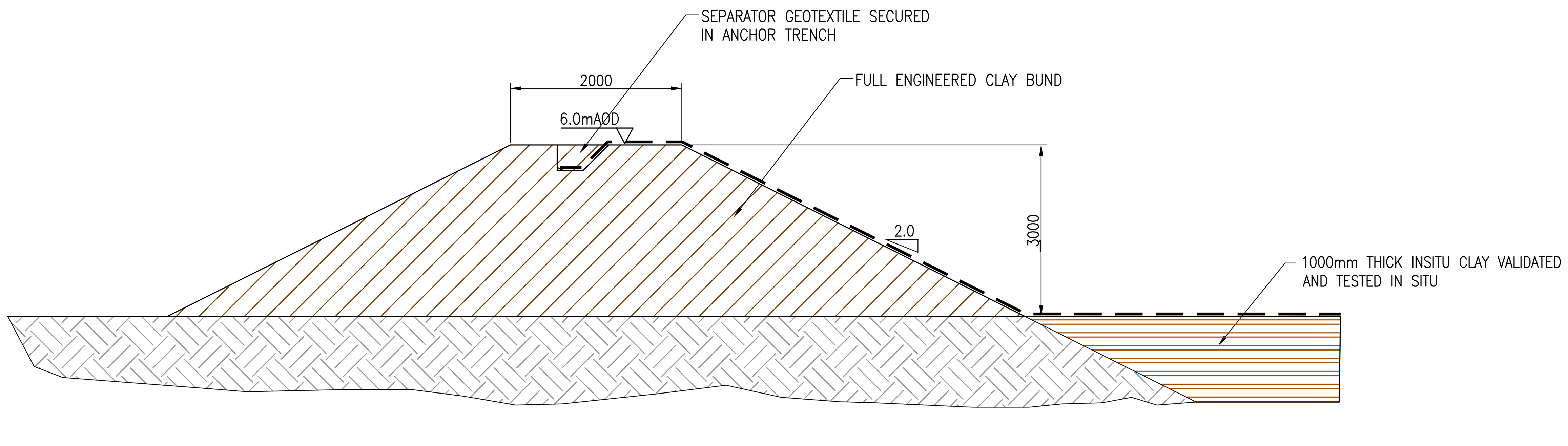
SCALE	SHEET	DRAWING NUMBER	REVISION
As Shown	A1L	WR7855 01 02	1



SECTION A–A
THROUGH NORTHERN AND SOUTHERN SIDEWALL
SCALE 1:50



SECTION B–B
THROUGH EASTERN SIDEWALL
SCALE 1:50



SECTION C–C
THROUGH WESTERN PERIMETER BUND
SCALE 1:50

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REV	DESCRIPTION	DATE	BY
1	GROUND WATER TRENCH DETAIL AMENDED	04.04.2023	ARK

CLIENT

FCC Environment

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

sirius Environmental

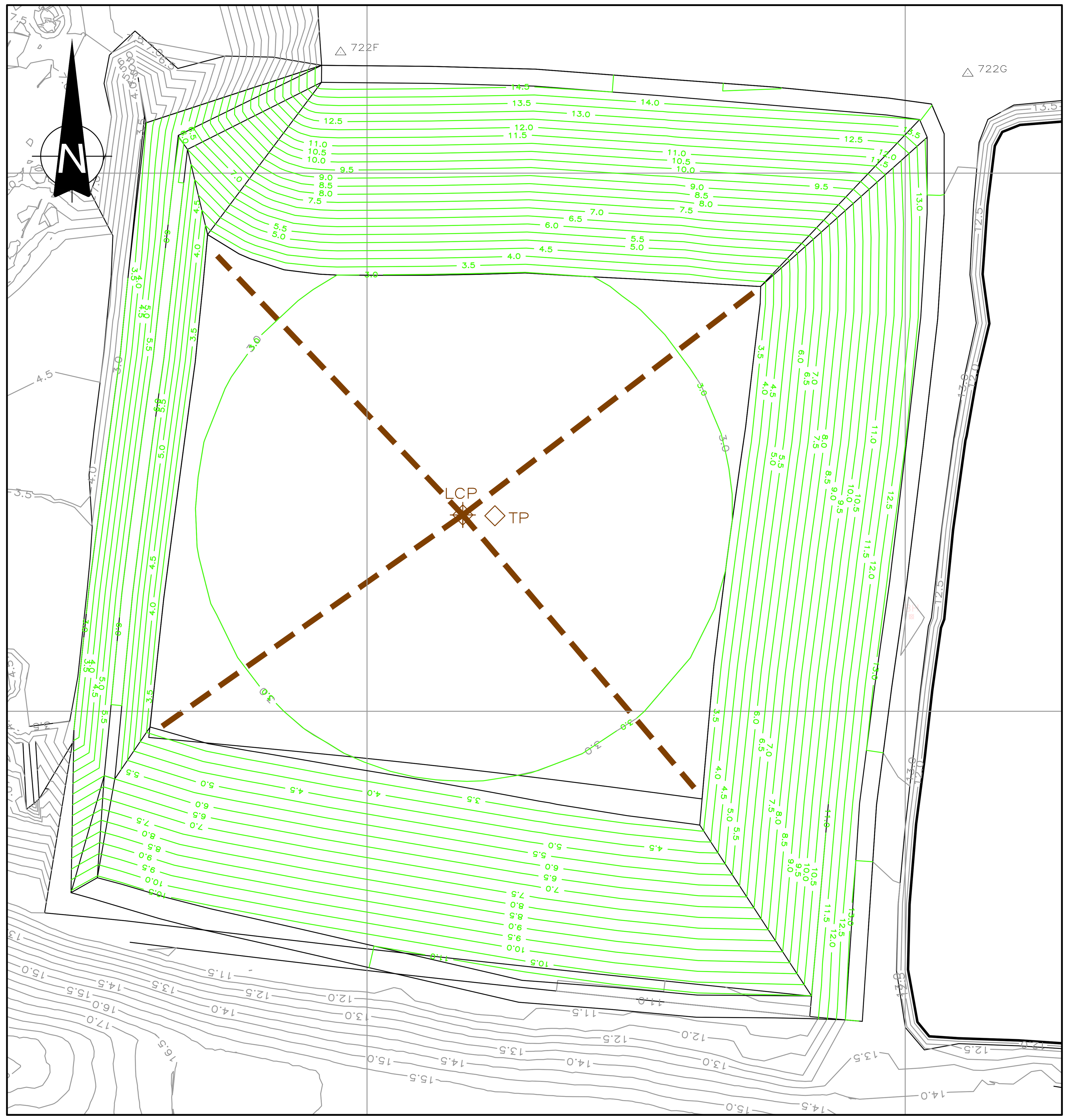
4245 Park Approach, Thorpe Park, Leeds. LS15 8GB. 0113 264 9960

JOB TITLE
WHISBY LANDFILL SITE
IBA CELL 1 CONSTRUCTION

DRAWING TITLE
Construction Details

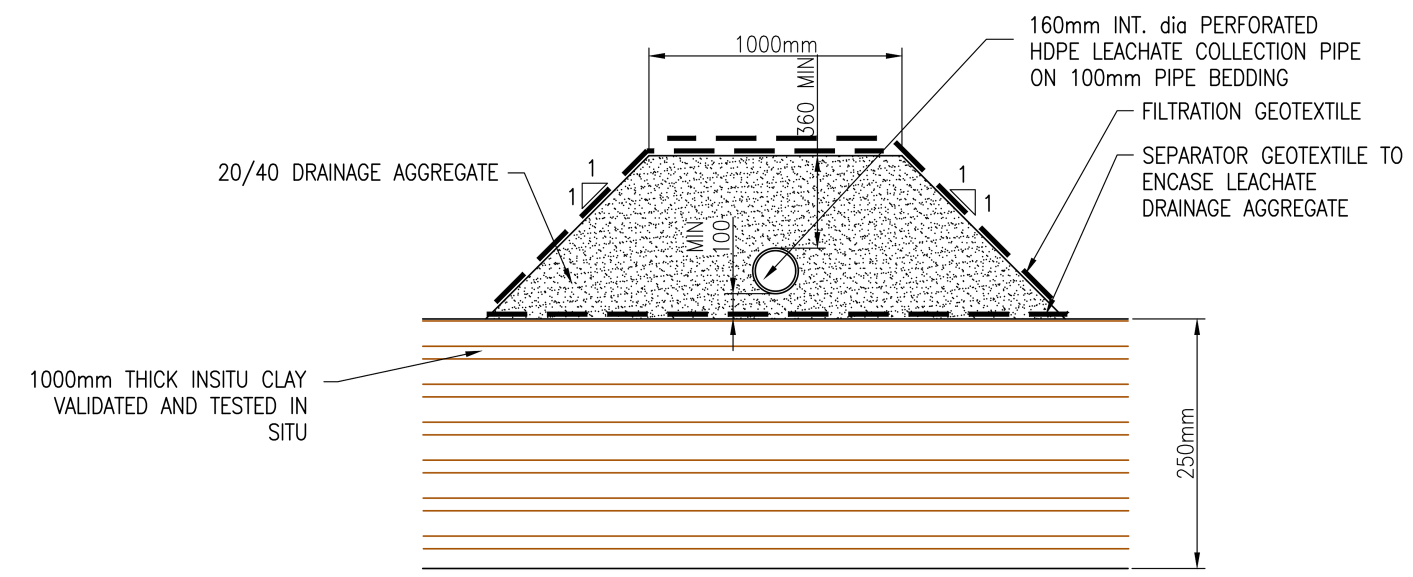
DRAWN	DATE	APPROVED	DATE
ARK	02/03/2023	A.K	02/03/2023

SCALE	SHEET	DRAWING NUMBER	REVISION
As Shown	A1L	WR7855 01 03	1



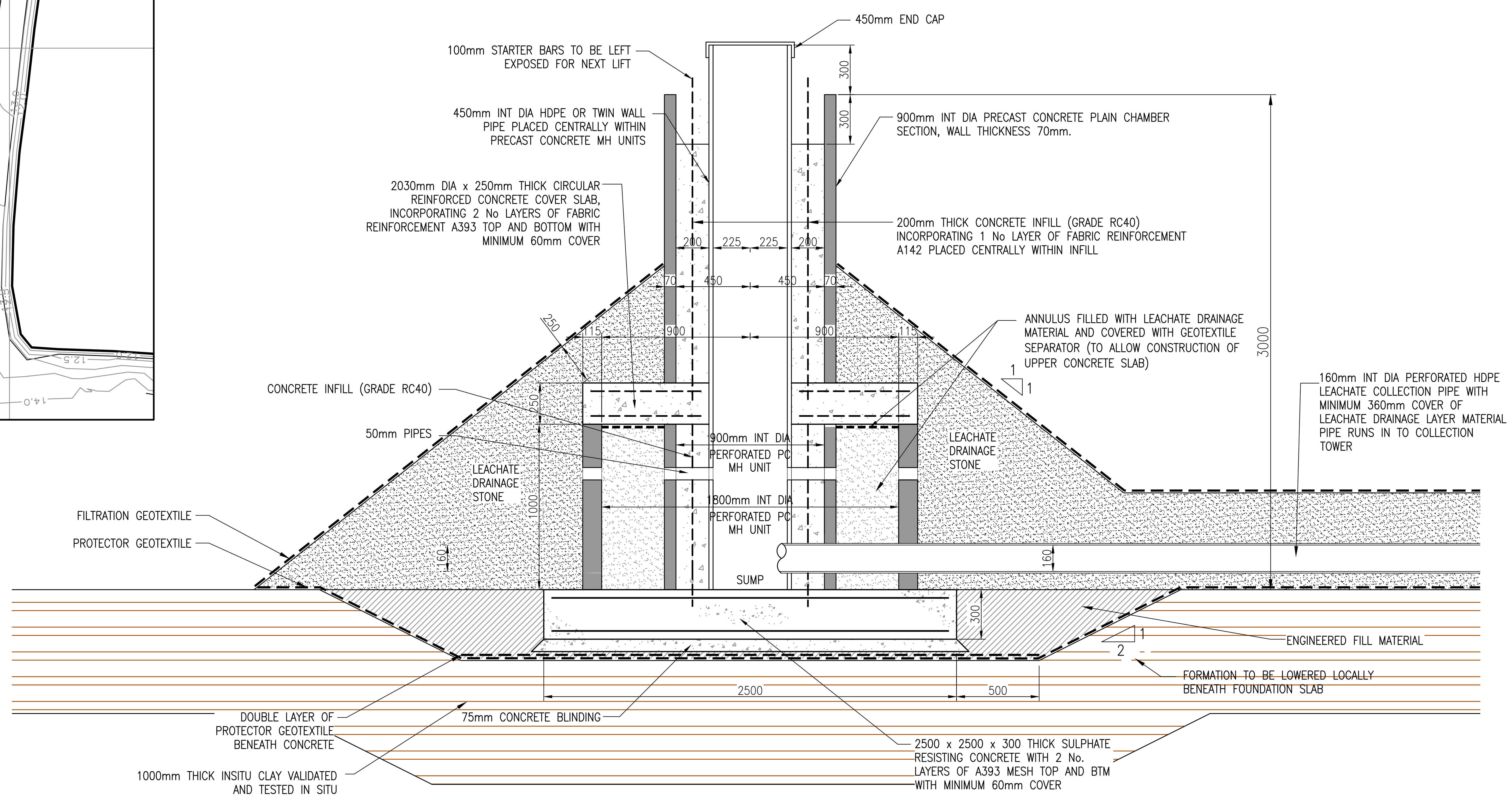
LAYOUT SHOWING PROPOSED TOP OF LINER

SCALE NTS



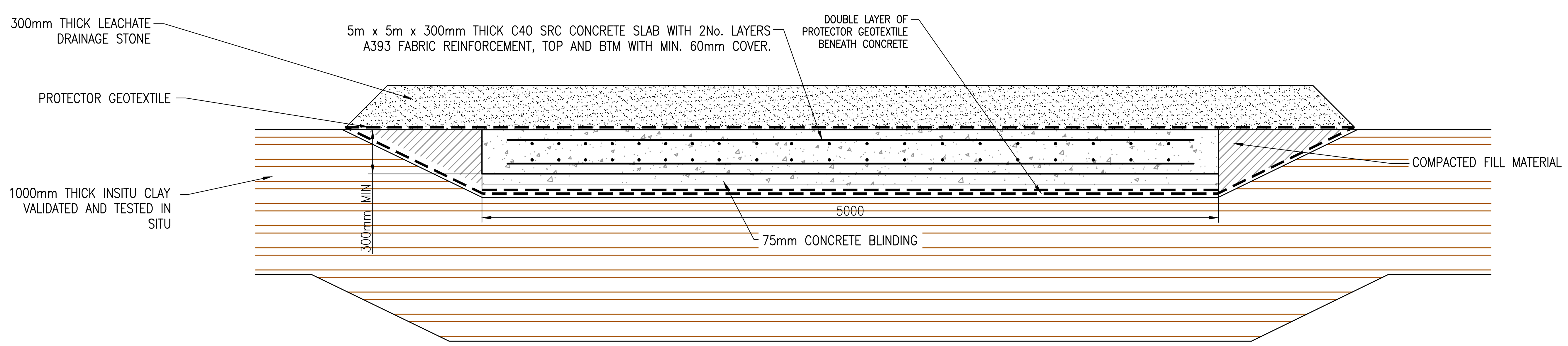
LEACHATE COLLECTION PIPE

1:25



LEACHATE COLLECTION POINT CONSTRUCTION DETAIL

SCALE 1:20



TARGET PAD CONSTRUCTION DETAIL

SCALE: 1:25

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4. FOR SECTION DETAILS SEE DRAWING WR7885 01 03

LEGEND

- SITE SURVEY
- PROPOSED TOP OF LINER
- LCP — PROPOSED LEACHATE COLLECTION / MONITORING POINT
- 160mm OD SDR PERFORATED HDPE LEACHATE COLLECTION PIPE
- TP — PROPOSED TARGET PAD

REV	DESCRIPTION	DATE	BY
1	SOUTHERN BATTER AMENDED	04.04.2023	ARK

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

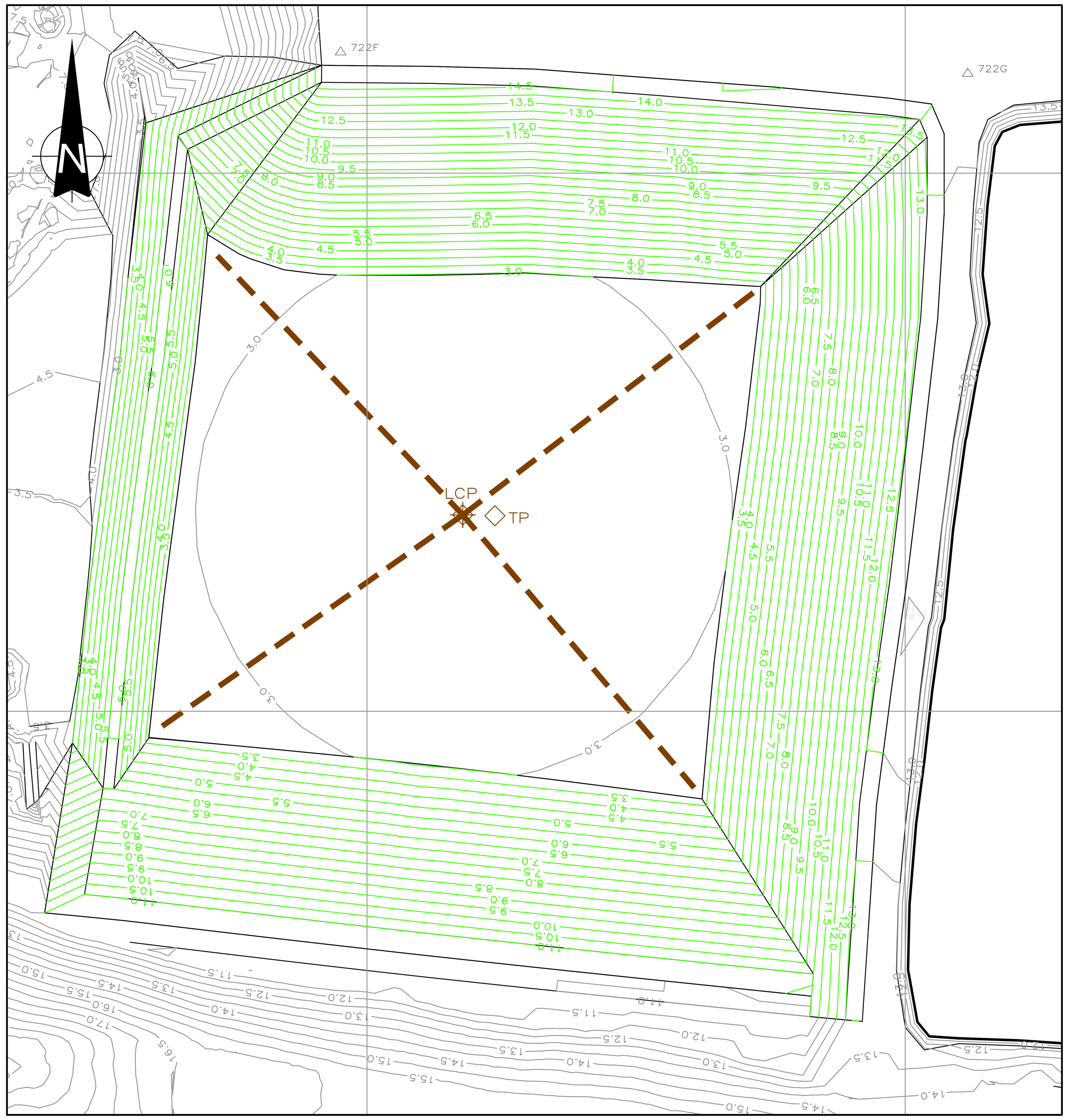
WHISBY LANDFILL SITE
IBA CELL 1 CONSTRUCTION

DRAWING TITLE

PROPOSED LEACHATE DRAINAGE LAYOUT

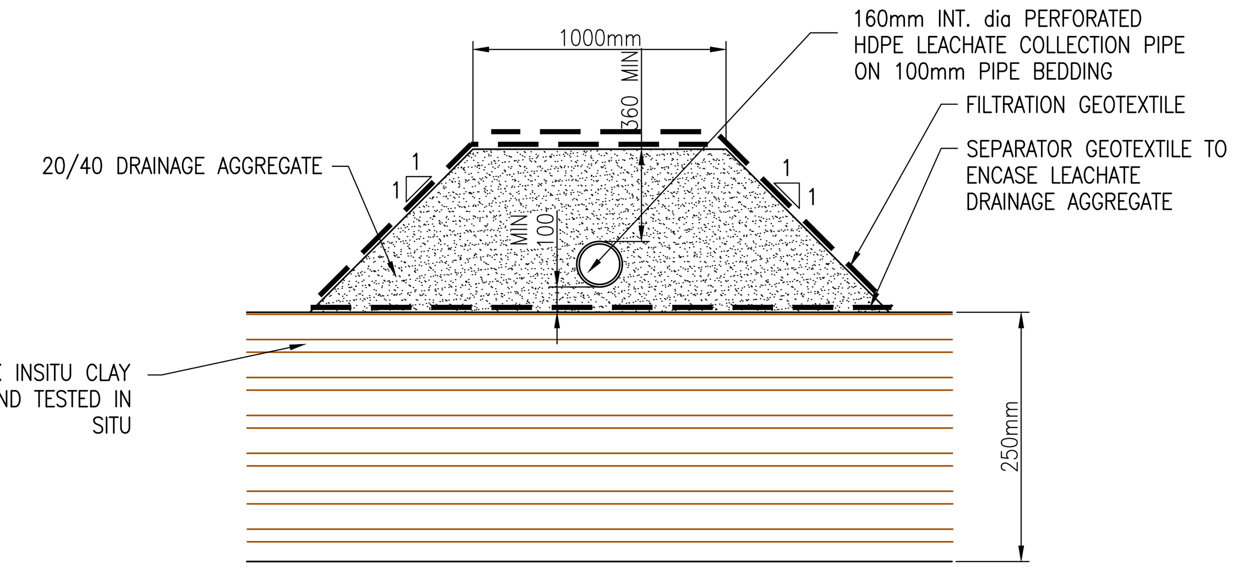
DRAWN	DATE	APPROVED	DATE
ARK	02/03/2023	A.K	02/03/2023

SCALE	SHEET	DRAWING NUMBER	REVISION
As Shown	A1L	WR7855 01 04	1



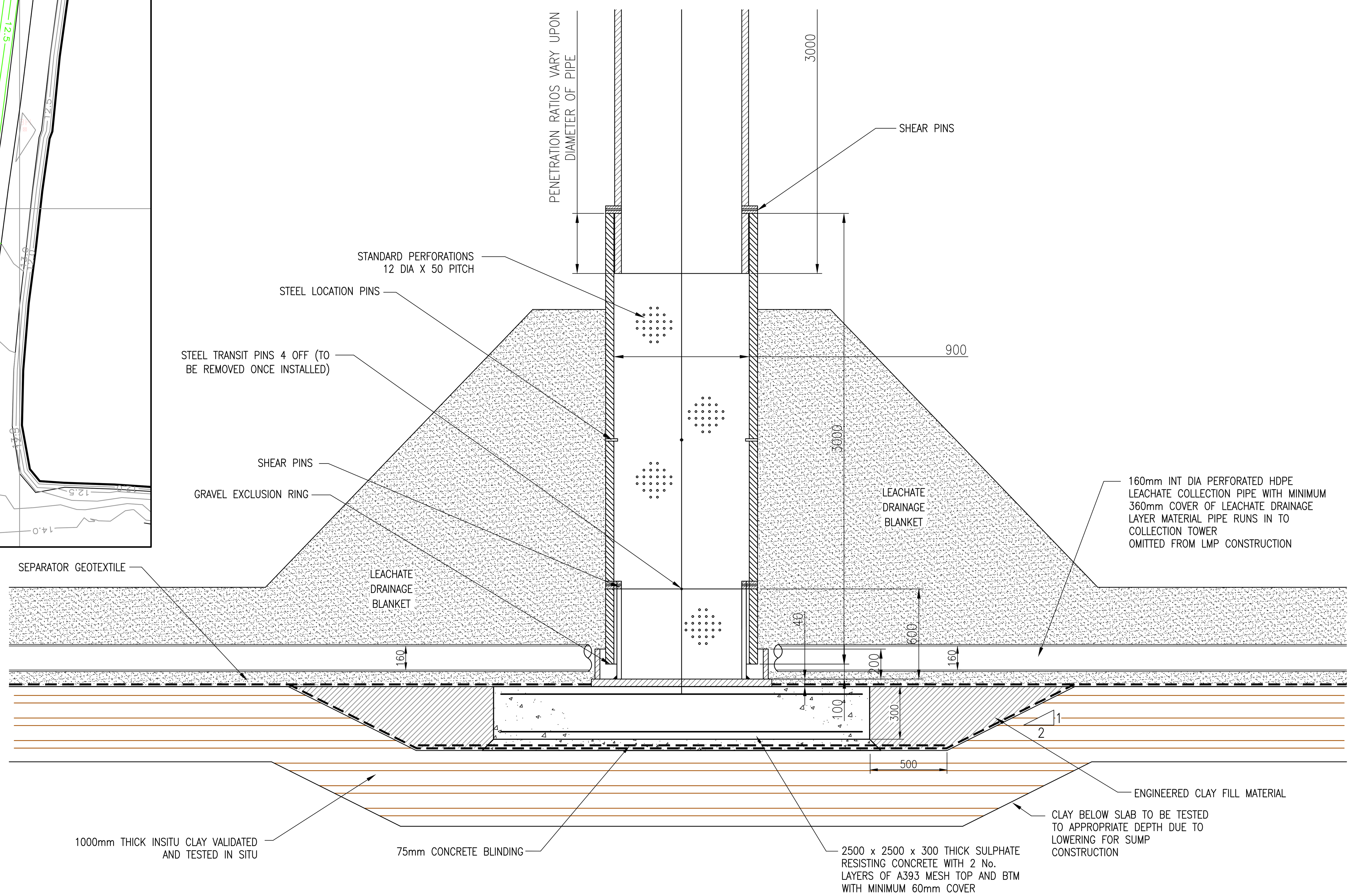
LAYOUT SHOWING PROPOSED TOP OF LINER

SCALE NTS



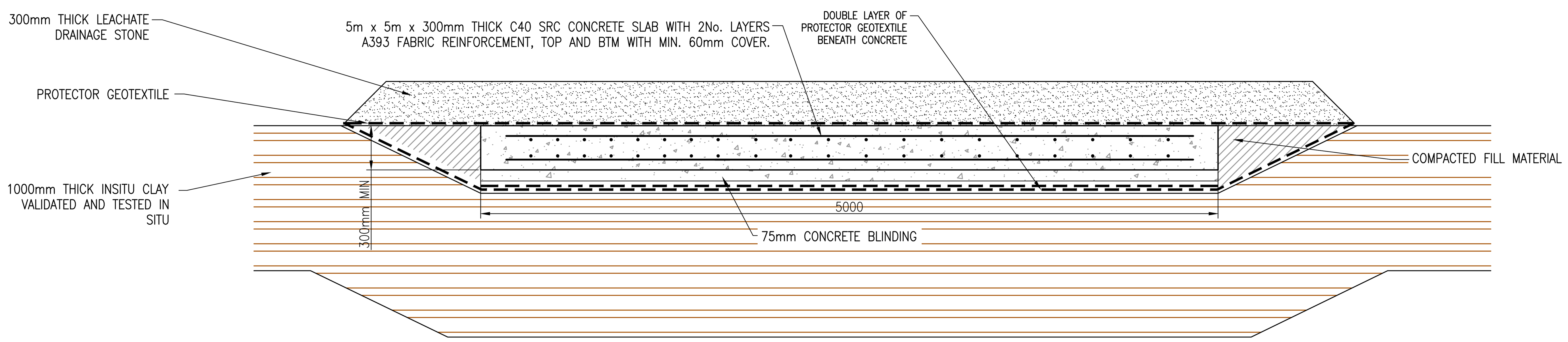
LEACHATE COLLECTION PIPE

1:25



TELESCOPIC LEACHATE COLLECTION POINT AND LEACHATE MONITORING POINT CONSTRUCTION DETAIL

SCALE 1:20



TARGET PAD CONSTRUCTION DETAIL

SCALE: 1:25

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4. FOR SECTION DETAILS SEE DRAWING WR7885 01 03

LEGEND

- 18.5 — SITE SURVEY
- 19.5 — PROPOSED TOP OF LINER
- LCP — PROPOSED LEACHATE COLLECTION / MONITORING POINT
- 160mm OD SDR PERFORATED HDPE LEACHATE COLLECTION PIPE
- TP — PROPOSED TARGET PAD

REV	DESCRIPTION	DATE	BY
1	CHANGED GRAVEL IN TARGET PAD DETAIL	17/04/23	JC

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

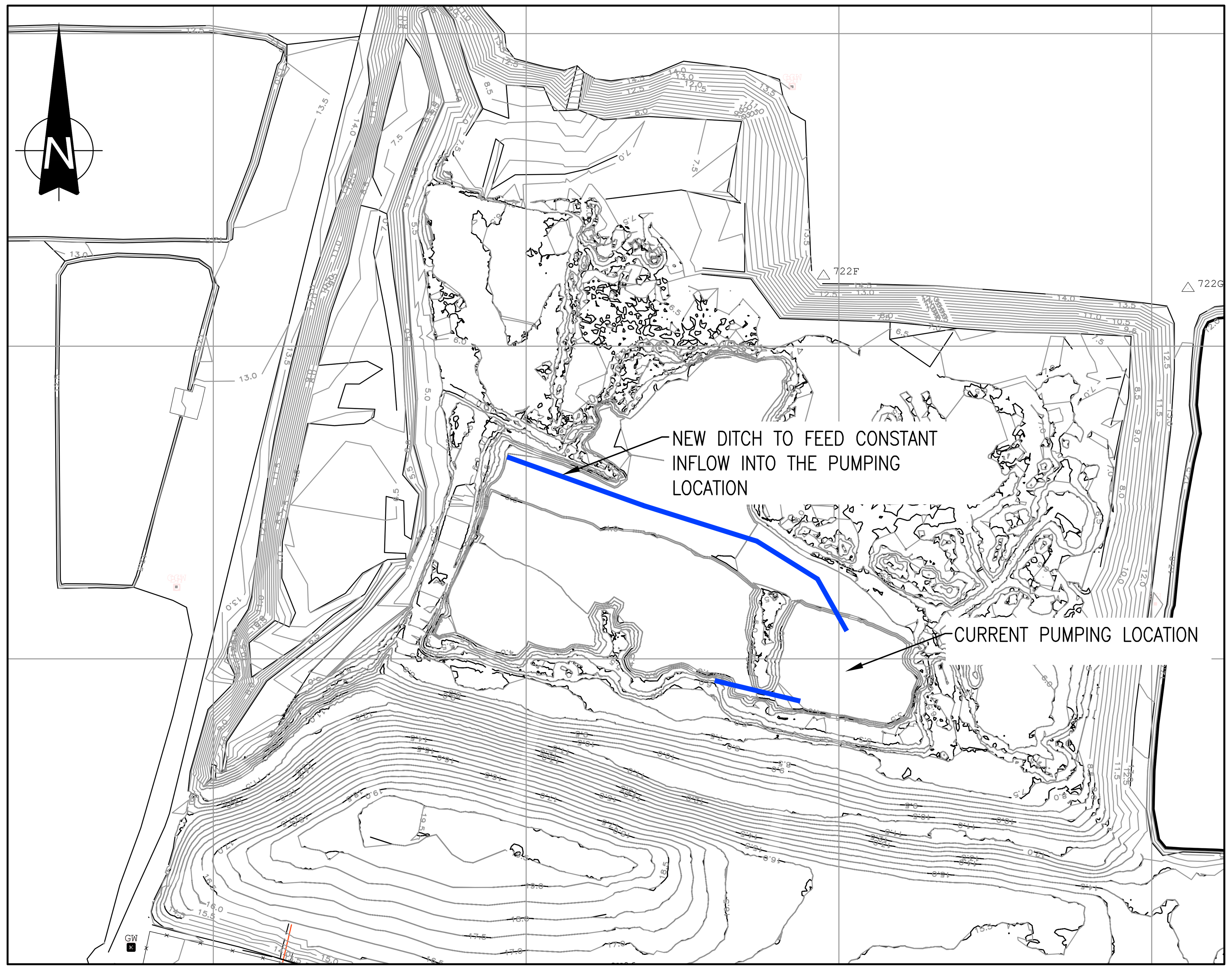
WHISBY LANDFILL SITE
IBA CELL 1 CONSTRUCTION

DRAWING TITLE

PROPOSED LEACHATE DRAINAGE LAYOUT OPTIONAL WELL DETAIL

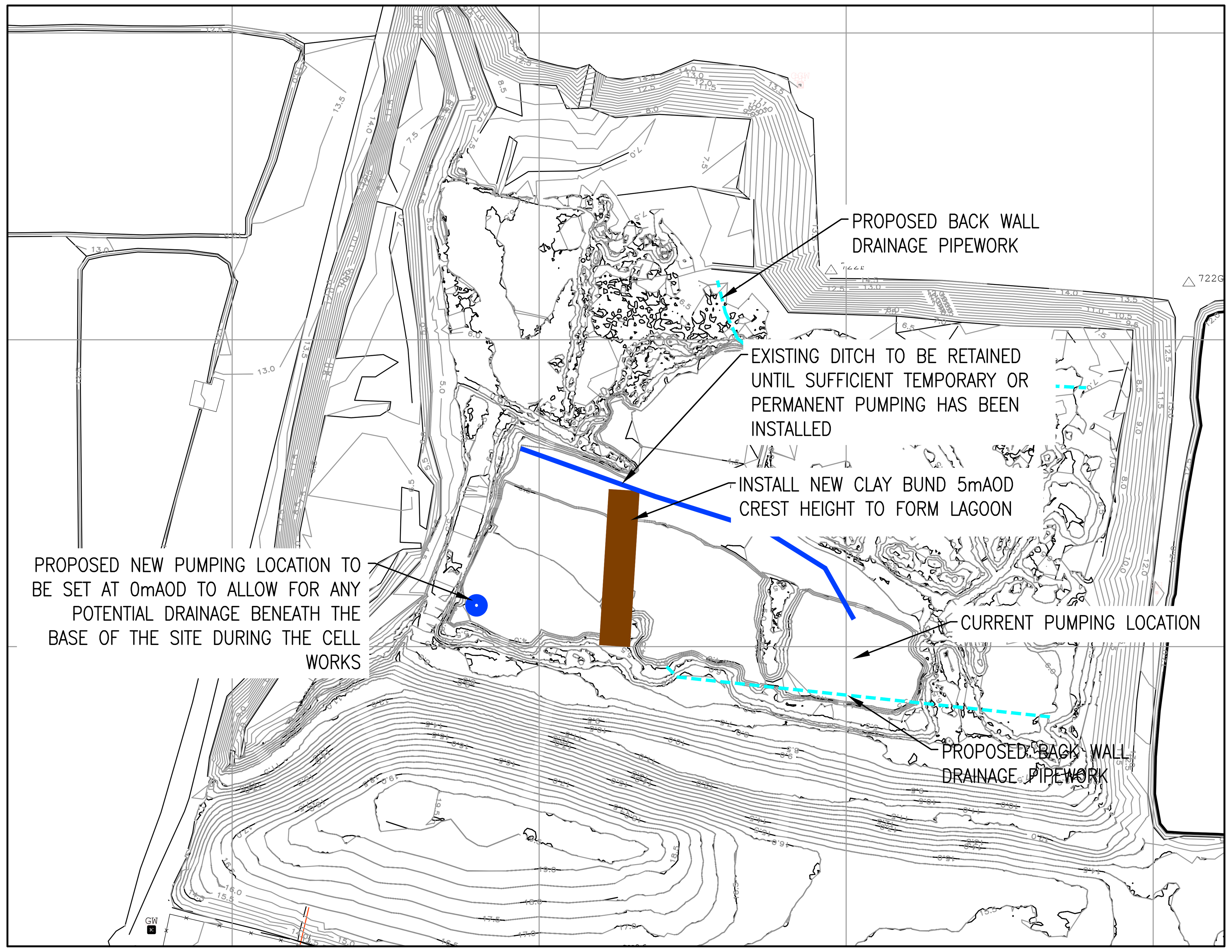
DRAWN	DATE	APPROVED	DATE
ARK	02/03/2023	A.K	02/03/2023

SCALE	SHEET	DRAWING NUMBER	REVISION
As Shown	A1L	WR7855 01 05	1



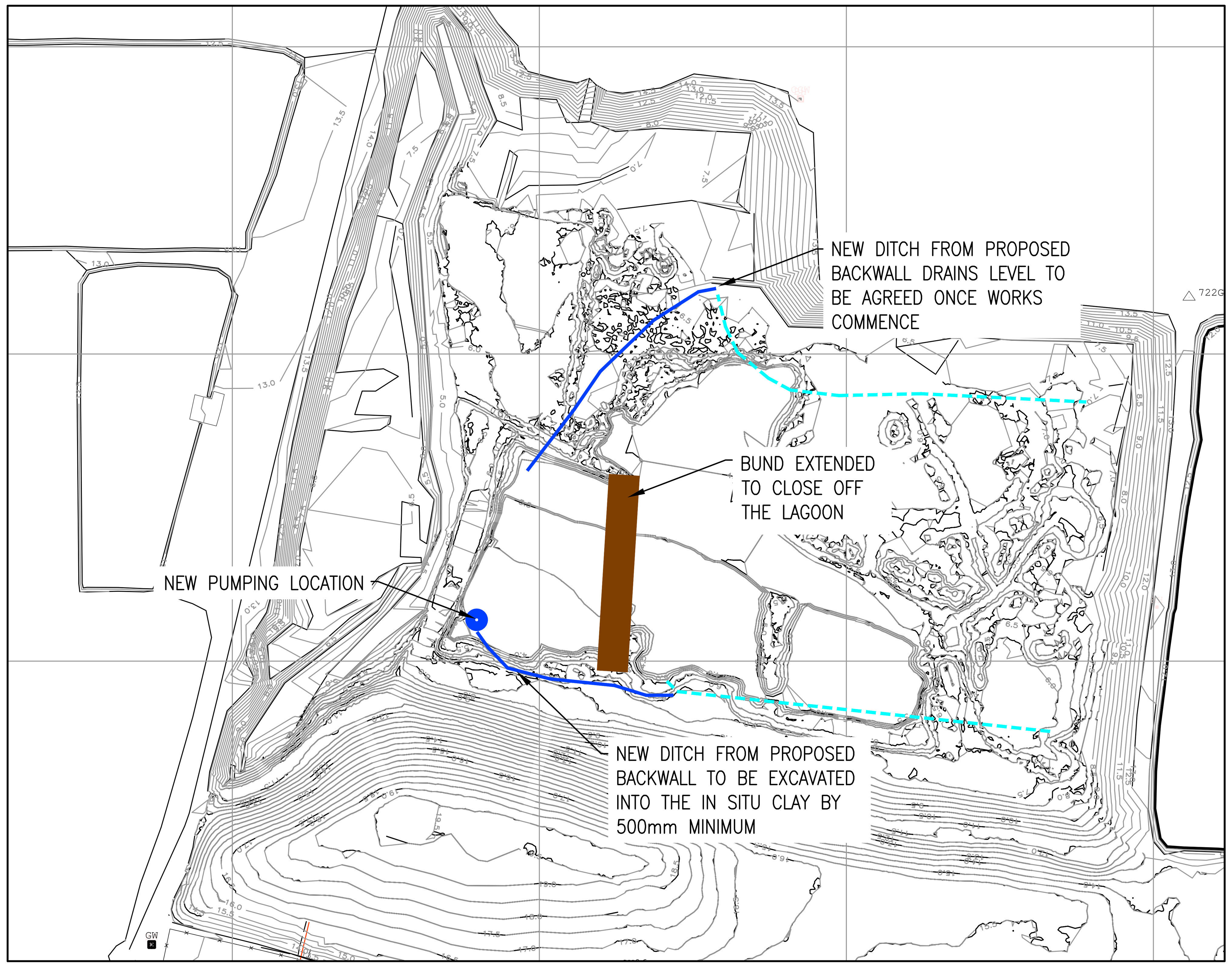
STAGE 1

UTILISE CURRENT PUMPING LOCATION AND REMOVE ANY BUNDS / EXCAVATE GRIPS TO FEED WATER TO CURRENT PUMPING SYSTEM



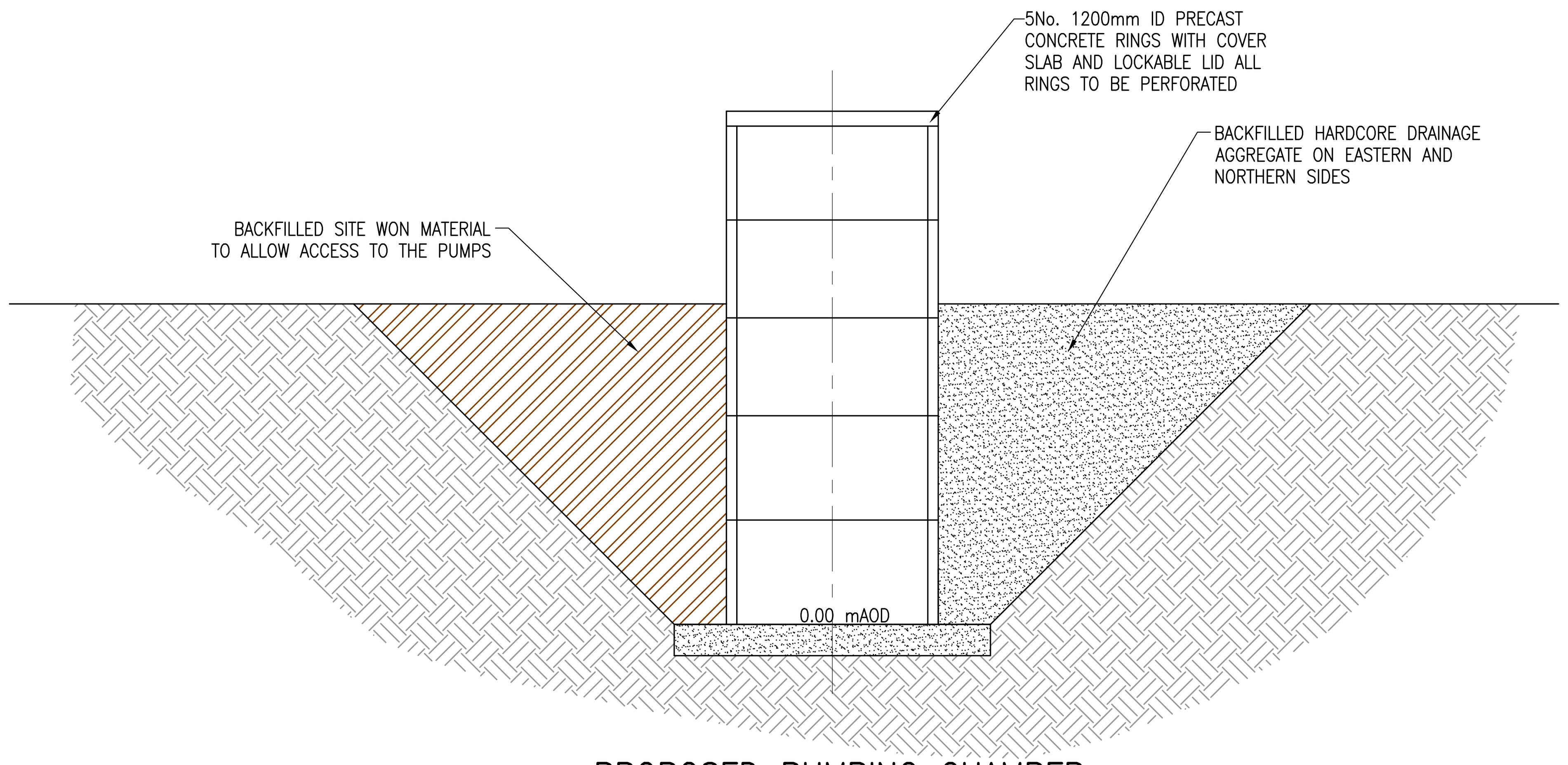
STAGE 2

ONCE WATER LEVEL TO THE WEST IS REDUCED INSTALL SEPARATION BUND AND NEW PUMPING SUMP LOCATION. FCC TO INSTALL NEW DUAL PUMPING SYSTEM IN NEW LOCATION



STAGE 3

NEW PUMPING SYSTEM INSTALLED, BUND COMPLETED TO CONTAIN THE WATER, NEW DITCHES CUT INTO THE SOUTHER AND NORTHERN AREAS TO ALLOW FORM FROM THE BACKWALL DRAINAGE SYSTEM AND WATER FROM BENEATH THE LANDFILL TO BE DIRECTED TOT HE NEW PUMPING LOCATION.



PROPOSED PUMPING CHAMBER

SCALE 1:50

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LEGEND

- SITE SURVEY
- EXTENTS OF PROPOSED IBA CELL 1 WORKING AREA
- STOCKPILE AREA FOR UNSUITABLE / EXCESS MATERIALS FROM CELL EXCAVATION

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

Proposed Water Management

DRAWN	DATE	APPROVED	DATE
ARK	14/03/2023	ARK	14/03/2023

SCALE	SHEET	DRAWING NUMBER	REVISION
1:1250	A1L	WR7855 01 06	0

APPENDIX 5

Noise Impact Assessment

WWW.CAULMERT.COM

Caulmert

engineering environmental planning

Registered Office: InTec, Parc Menai, Bangor, Gwynedd, LL57 4FG
Tel: 01248 672666
Email: contact@caulmert.com
Web: www.caulmert.com