RPS

Comhairle Contae Chill Mhantáin

Fassaroe Historic Landfills

Remediation Strategy Report

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Fassaroe Historic Landfills

Remediation Strategy

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1 INTRODUCTION

RPS has been engaged by Wicklow County Council to prepare a remediation strategy for five historic landfills known as Site 1, Site 2, Site 3A Site 3B and Site 3C located in Fassaroe, Bray, Co. Wicklow (as shown on **Figure 1 MGE1206FG0001F01**). Each site is summarised in the following sections.

1.1 SITE 1

The existing ground profile for Site 1 is shown on **Drawing No. DG0008-01**. Site 1 covers an area of approximately 0.59 Ha. The cross-section shows the profile of the landfill to be relatively flat (1V:35H) with a maximum height of 96mOD and a gradual increase in slope towards the northern section of the site at the top of the river valley. The site is currently vegetated.

1.2 SITE 2

The ground profile for Site 2 is shown on **Drawing No. DG0008-02**. Site 2 covers an area of approximately 4.72 Ha. The western and central portions of the site are currently grassed. The cross-section shows the profile of Site 2 to be relatively flat in the western portion of the site with a maximum height of 85mOD. From the centre of the site however, the slope increases in an eastward direction to approximately 1V:8H. The eastern portion of the site, which is densely vegetated with mature trees and bushes, extends down a very steep section of the valley for approximately 50m at a slope of between 1V:2.5H to 1V:3H, dropping from 63mOD to 43mOD. At two locations on this section of the valley, slope failure has occurred, which has exposed waste material.

1.3 SITE 3A

The ground profile for Site 3A is shown on **Drawing No. DG0008-03**. Site 3A covers an area of approximately 1.9 Ha. The cross-section shows that the profile of Site 3A is relatively level along the centre with the site falling 5m from 106mOD in the west to 101mOD in the east. The northeast tip of Site 3A has a steeper slope at approximately 1V:2.5H falling from 102mOD to 90mOD in a south to north direction. Similarly, the northwest tip has a 1V:6H slope, dropping from 105mOD to 100mOD over 30m in a south to north direction. A shallow slope is located at the southeast corner, with an approximate slope of 1V:10H.

1.4 SITE 3B

The ground profile for Site 3B is shown on **Drawing No. DG0008-04**. Site 3B covers an area of approximately 0.49 Ha. The cross-section shows the profile of the landfill to be relatively flat with a gradual slope of 1V:30H occurring in a south to north direction from 101mOD to 99mOD.

1.5 SITE 3C

The ground profile of Site 3C is shown on **Drawing No. DG0008-05.** Site 3C covers an area of approximately 0.9 Ha. The cross section shows that the site slopes downwards from south to north, dropping 11 metres from 95mOD to 84mOD. The northern portion of the site has a steeper slope of 1V:2H.

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General Notes

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(ii) All Levels refer to Ordnance Survey Datum, Malin Head.

(iii) DO NOT SCALE, use figured dimensions only, if in doubt ask.

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FASSAROE HISTORIC LANDFILL

Title
PLAN SHOWING HISTORIC LANDFILL LOCATIONS, EXISTING SERVICES, WAYLEAVES & SAC's

File Ref. MDR1206FG0001F02.dwg | Drg. No. Figure 1 | Rev. F02

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1.6 PLANNING CONTEXT

The Fassaroe Historic Landfill sites lie within the area of Fassaroe, Bray, Co. Wicklow which is zoned for major new development under the Draft Bray Municipal District Local Area Plan 2018. The lands are zoned for residential high density (R-HD) new development with existing residential (RE), open space (OS1 and OS2), active open space (AOS), and neighbourhood centre (NC)[1].

1.7 OBJECTIVE AND SCOPE OF REMEDIATION STRATEGY

The objective of this report is to identify the preferred remediation strategy for the five historic landfills based on the results and recommendations of the Environmental Risk Assessment (ERA) undertaken by RPS (MDR1206Rp004F01) in accordance with Chapter 6 of the *Code of Practice - Environmental Risk Assessment for Unregulated Waste Disposal Sites (EPA, 2007).*

This remediation strategy will form part of Wicklow County Council's application to the Environmental Protection Agency for Certificates of Authorisation for the five landfill sites in accordance with the Waste Management (Certification of Historic Unlicensed Waste Disposal and Recovery Activity) Regulations, 2008. This strategy has been prepared by RPS in accordance with Chapter 7 of the *Code of Practice - Environmental Risk Assessment for Unregulated Waste Disposal Sites (EPA, 2007)*. The scope of this report is as follows:

- Review of the findings of the ERA (MDR1206Rp004F01) remediation options appraisal;
- Proposed Landfill Capping System considerations and design; and
- Proposals for aftercare management and monitoring of the three landfill sites.

1.8 PREVIOUS RELEVANT INVESTIGATIONS AND STUDIES

The following reports have previously been undertaken for the subject sites:

- Fassaroe Historic Landfill Environmental Risk Assessment – RPS, June 2016;
- Tier 2-3 Environmental Risk Assessment Landfills No. 3A and 3C - Wicklow County Council, December 2012 (amended April 2013);
- Disused Wicklow County Council Landfill Sites 3A, 3B and 3C at Fassaroe, County Wicklow Appropriate Assessment Screening Report – Altemar in association with Environmental Management Services, April 2013;
- Fassaroe Business Park Geotechnical Interpretative Report – Atkins McCarthy, July 2001;
- Fassaroe Historic Landfill Environmental Risk Assessment – Atkins, June 2010;
- Fassaroe AGS and Excel ground investigation data (IGSL and Glovers logs) October 2015;
- Environmental Ground and Geotechnical Site Evaluation Report for Site at Fassaroe, Bray – Muir Associates, January 1998.

[1] Bray Municipal District Local Area Plan 2017 Land Use Zoning Map, Map No. 2 DRAFT.

2 FINDINGS OF ENVIRONMENTAL RISK ASSESSMENT

A summary of the landfill site areas, depth of waste, estimated tonnages and types of waste present is provided in **Table 2.1**.

Table 2.1 Estimated Landfilled Waste at Each Site

Site	Site area (Ha)	Estimate of waste tonnage present (tonnes)	Depth of waste (mbgl)	General waste description	Waste types recorded
1	0.59	110,000	14	Predominantly comprised of construction and demolition waste with pockets of municipal waste. One fragment of asbestos cement encountered within the waste mass	Plastic, glass, metal, concrete blocks, tyres, brick, wood, plastic piping, reinforced concrete, glass, ceramics.
2	4.72	340,000	19	Predominantly comprised of municipal waste.	Plastic bags, bottles, concrete, fabric, timber, waving piping, wood, newspaper, metal, glass, brick, concrete blocks, textiles, rubble, tins,
3a	1.90	120,000	16	Predominantly comprised of municipal waste.	Household waste, rubber, glass, paper, metal, textiles, footwear, car tyre, plastics, perspex, metals, wire, paper, timber,
3b	0.49	8,500	4.9	Predominantly comprised of municipal waste.	Household waste, plastics, glass, timber, textiles and footwear, plastics, household refuse, paper, metals, timber and textiles
3c	0.90	47,000	13	Predominantly comprised of municipal waste.	Household waste, plastics, rope, mattress, glass, paper, timber, textiles including rugs, pipes, shoes, coins, metals, rubber tyres, bones
Total	**8.6**	**625,500**			

2.1 CONCEPTUAL SITE MODEL

As part of the ERA a conceptual site model (CSM) was prepared for each site. The refined CSMs were based on the initial regional geological and hydrogeological data from the GSI and site investigation data from trial pits, boreholes, geophysical surveys, quality data and groundwater levels. The CSMs for each of the sites are shown in **Appendix A (ERA-Figures 19 to 23)**. The models show the source, pathways and receptors for each of the sites.

2.2 RECOMMENDED REMEDIAL MEASURES FROM ERA

The capping of the five landfills with a low permeability barrier is considered the preferred remedial option as set out in the Environmental Risk Assessment (document ref. MDR01206Rp0007F01)

Landfill capping is an accepted method for reducing leachate generation on landfill sites. A capping option is considered viable on the historical landfill sites, would be cost effective and would be a low impact approach that will mitigate human health risks associated with asbestos and PAHs in soils and will result in a net betterment to the water environment by improving water quality without significant reducing groundwater flow to the Ballyman Glen SAC. Furthermore an engineered cap low permeability cap would also enable landfill gas management measures for any future development of the site.

3 REMEDIATION STRATEGY

3.1 SCOPE

The proposed landfill capping remedial measures, as set out in the following sections of this report, shall be designed specifically to:

- Minimise infiltration of water and maximise clean run off from the landfill areas;
- Promote surface drainage and maximise clean run off from the landfill areas;
- Control landfill gas migration; and
- Provide a physical separation between waste and human and environmental receptors.

While the five sites are currently used as agricultural land they are located within an area which is designated for major new development under the Draft Bray Municipal District Local Area Plan, 2018. Therefore, the remedial measures must also consider the potential for the appropriate future development of the zoned land. The proposed landfill capping measures shall comprise mitigation and management proposals to minimise potential adverse impacts from the landfills on future development in the area, and in particular any potential to impact on human health or the uses proposed which include residential and amenity uses.

3.2 PROPOSED CAPPING SYSTEM DESIGN

3.2.1 Landfill Capping Design

The proposed capping works will be carried out in accordance with the Environmental Protection Agency *Landfill Manual: Landfill Site Design* (EPA 2000). Based on the investigations carried out to date at each of the five sites, the sites can be classed as non-hazardous biodegradable landfills for the purposes of capping. The EPA manual recommends the following capping system for a non-hazardous biodegradable landfill:

- *'Topsoil (150-300m) and subsoil of at least 1m total thickness;*
- *Drainage layer of 0.5m thickness having a minimum hydraulic conductivity of $1x10^{-4}$m/s;*
- *Compacted mineral layer of a minimum 0.6m thickness having a hydraulic conductivity of less than or equal to $1x10^{-9}$m/s or a geosynthetic material (e.g. GCL) or similar that provides equivalent protection; and*
- *A gas collection layer of natural material (minimum 0.3m) or a geosynthetic layer. ''*

3.2.2 Proposed Capping System Details

In all landfill areas to be capped the following minimum capping system will be installed (in order of placement):

- Regulation layer, where required;
- Gas collection geocomposite (approximately 4-6mm thickness);

- 1mm thick low permeability geomembrane, e.g. LLDPE liner having a hydraulic conductivity of less than or equal to $1x10^{-9}$m/s;
- Surface water drainage geocomposite (approximately 4-6mm thickness);
- 850mm Subsoil layer; and
- 150mm Topsoil layer.

The proposed capping system is presented graphically in **Figure 4.1**. As shown, the finished ground level shall be 1m above the capping surface water geocomposite and liner and up to 1.3m above the existing ground.

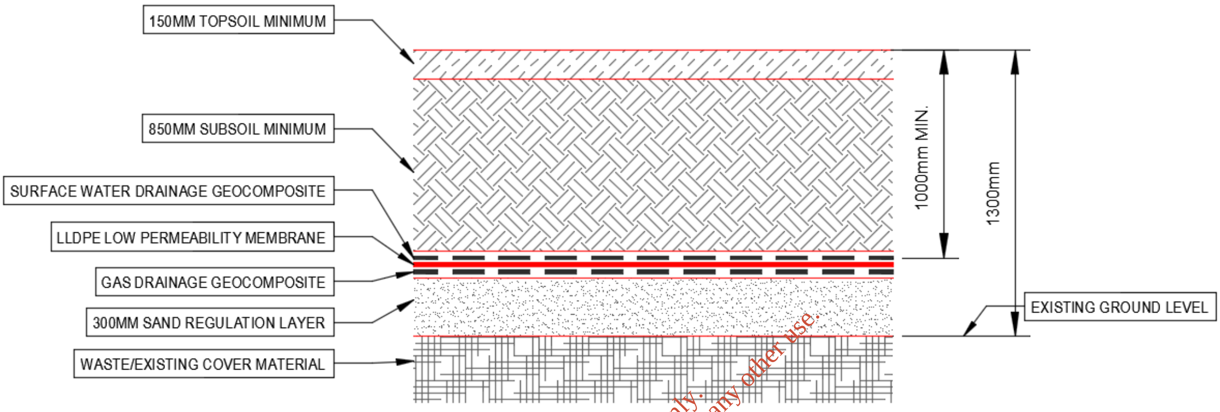


Figure 3.1 Proposed minimum capping system

The purpose of the subsoil and topsoil layers in landfill capping is to provide a 1m physical barrier to the capping system geocomposite and geomembrane layers. Having regard to the designated zoning of the sites, there may be areas above the landfills where development will occur and the finished ground level may be greater than 1.0m above the existing ground level. Where this occurs additional depths of general fill or subsoil materials would be used ensure the required depth is achieved. This would then be overlain by topsoil in landscaped areas. Areas to receive roads or pavements would similarly be required to maintain the 1m cover from the surface water geocomposite to finished road/pavement level. To represent this, the minimum capping system and the overlying materials proposed for the various potential post-capping land uses throughout the five sites are shown in **Drawing DG0009-01**.

3.2.3 Proposed Capping System Materials

The properties and function of the capping system materials are discussed below:

- **300mm sand regulation layer (where required)**: A regulation layers may be used to provide a smooth surface on which to lay the geocomposites and capping system and to ensure that when the overlying materials are being compacted and rolled, there is a physical barrier to any underlying sharp objects or protrusions. This will be particularly important in Sites 1, 2, 3a and 3c where trees and vegetation are to be stripped in order to install the capping system.

- **Gas collection geocomposite:** The primary purpose of the gas geocomposite is to provide flow capacity to maintain the landfill gas pressure within the geocomposite at an acceptable rate below the geomembrane. From a slope-stability point of view, gas pressure is an excess pore pressure that serves to reduce the effective normal stress. This pressure results in a decrease in the effective stress beneath the geomembrane that can lead to slope stability failure.

The gas geocomposite layer will be a two or three layered, three dimensional geosynthetic material consisting of a HDPE drainage core mechanically bonded to a geotextile filter layers. The geotextile can be non-woven needle-punched HDPE or Polypropylene. The thickness and compressive strength of the geocomposite will be specified at detailed design stage depending on the depth and loading of material to be placed above it.

- **Low Permeability LLDPE liner:** The purpose of the LLDPE geomembrane is to act as the low permeability ($1x10^{-9}$m/s) barrier minimising infiltration of rainwater and migration of landfill gas through the capped landfill. A geomembrane is used when low permeability clay is not available locally. Whilst some clay will be excavated as part of the proposed development, it is unlikely that the volume and properties of the clay on-site would meet the design requirements. The LLDPE geomembrane will be a 1mm thick liner will which will be laid on top of the gas collection geocomposite.

- **Surface water drainage geocomposite:** The surface water drainage geocomposite will be the same or similar material to the gas collection geocomposite. This fulfils the function of the 0.5m drainage layer proposed in the EPA Landfill Site Design Manual. Its purpose is to provide flow capacity above the LLDPE liner for rainfall which infiltrates through the overlying subsoil and topsoil.

- **Subsoil (850mm minimum) and topsoil (150mm minimum):** Subsoil and topsoil will be sourced from onsite excavations, or imported where required and will be placed in layers in accordance with the requirements of Series 600 of the NRA Specification for Roadworks. Care shall be taken during placement to avoid damage to the underlying geocomposites and geomembrane.

3.2.4 Confirmatory Slit trenches

The extent of the waste footprint at each of the five sites has been determined through a combination of boreholes, trial pits and geophysical survey investigations. Prior to installation of the capping systems a series of slit trenches will be excavated along the current interpretation of the waste perimeter to determine if any movement (inwards or outwards) of the perimeter is required.

3.2.5 Landfill Gas Risk Assessment

Given the continuing presence of landfill gas both within and off-site at the five landfills, as evidenced during the site investigations, a landfill gas risk assessment was undertaken as part of the ERA.

A review of the gas regime at the site (based on the currently available information) suggests that the main gas generation at the site is the waste within the landfills. The main pathway for gas migration from the waste materials is considered to be through the permeable superficial deposits, with limited contributions through groundwater and the deeper bedrock deposits which are considered to be of a lower permeability.

The five sites lie within the area of Fassaroe which is zoned for major new development under the Draft Bray Municipal District Local Area Plan 2018. The lands are zoned for residential high density new development with existing residential, open space, active open space, and neighbourhood centre. Protection measures will need to include gas barriers to prevent migration of gases from the landfills where further monitoring cannot dismiss the risk from gas within existing and any future proposed development areas.

RPS recommends that a tailored gas management strategy is developed for the site, taking account of the available data and any future development layout. This strategy should identify the gas protection measures that can be installed to limit gas migration from the landfills and the protection measures that will be required to properties, supported by relevant appraisal/ assessment.

The detailed gas protection system shall be designed in accordance with relevant guidance, including but not limited to:

- BS 8485:2015 – Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings (BSI, 2015);
- Protecting development from methane (CIRIA, 1995); and
- Assessing risks posed by hazardous ground gases to buildings (CIRIA. 2007).

3.2.6 Landfill Gas Management Design

At all five landfill sites the waste is generating a residual amount of landfill gas and will continue to do so for some years. Landfill gas migrates along the path of least resistance. At present, the gas simply migrates towards the surface of the landfills. In areas where the existing cover material is not well compacted the landfill gas will migrate through the cover material and into the atmosphere. In areas where the existing cover material is well compacted the landfill gas will be prevented from venting through the surface and will therefore migrate laterally through the underlying sand and gravel deposits. This lateral migration of landfill gas is evident in a number of boreholes which have been drilled outside of the waste areas.

With the installation of a low permeability capping layer the gas will be prevented from venting through the surface of the landfill and will therefore build up in pressure and eventually migrate laterally beneath the edges of the sites, potentially towards off-site receptors. To prevent this occurring a gas management system must be incorporated into the remediation measures on each of the five sites. The proposed landfill gas management measures would typically consist of passive venting by means of a Virtual Gas Curtain (VGC) around each of the five landfill sites (see next section).

It should be noted that any future zoned development on, or in the vicinity of, the five landfill areas must also have regard to the findings of the landfill gas risk assessment. Further off-site measures such as in-ground impermeable trenches, shallow venting trenches and building protection measures in accordance with CIRIA C665 may be required, depending on the layout and nature of the development.

3.2.7 Virtual Gas Curtain

A VGC is an effective means of controlling gas migration, due to its durability and ease of installation. The VGC reduces the risk posed by the presence of landfill gas to receptors by intercepting the preferential lateral pathway for gas migration out of the landfill site and thus breaking the source-pathway-receptor linkage. The VGC forms a low pressure or low gas concentration area relative to the surrounding gassing ground to encourage gas to flow towards the VGC barrier, and allow subsequent venting to atmosphere.

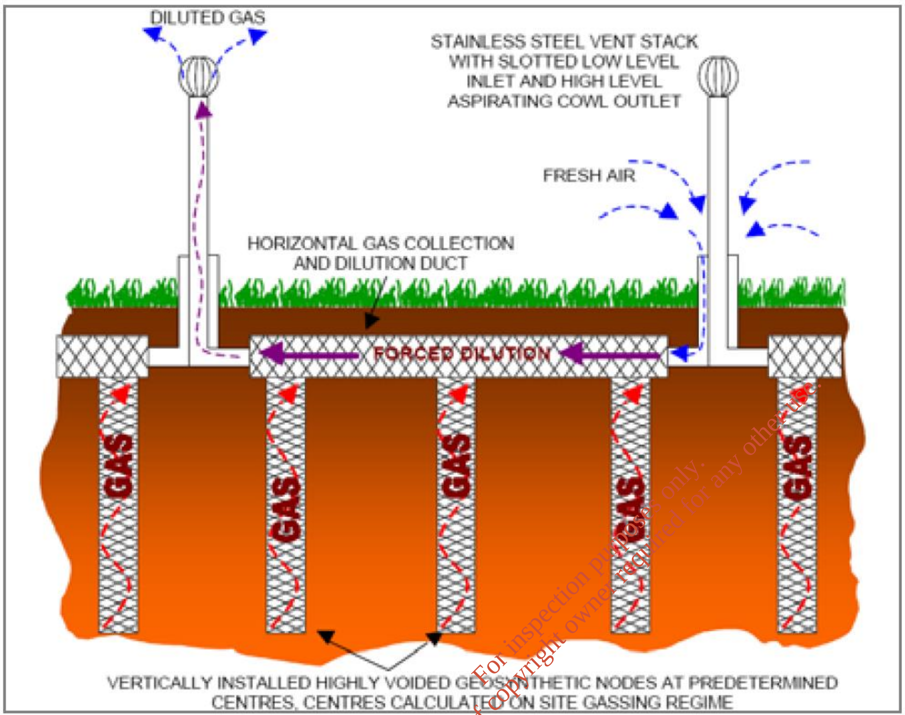


Figure 3.2 Virtual Gas Curtain Cross Section

Geo-composite nodes are inserted at 1m intervals along the curtain length with 3m high vent stacks located at every 20 – 25 m intervals. A collection duct is constructed over the nodes which dilutes any gas and vents it to the atmosphere via vent bollards.

The barrier would be advanced to a depth of circa 10 mbgl surrounding the landfill sites to intercept any migrating gases. A headerpipe connects all the vent nodes together. The nodes are vibrated into the ground using a mandrel attached to an excavator. The installation thus reduces the volume of spoil that requires disposal from site. If obstructions and hard ground conditions are encountered then pre-digging to remove them can be used at shallow depth, or the nodes can be repositioned.

The vent nodes and collection duct are constructed using robust geosynthetic units that are able to be driven over by construction plant with only minimal protective soil cover.

The installation technique uses a high frequency excavator mounted vibrator to vibrate the mandrel into the ground. This has been used on numerous sites close to existing structures (within 5m) without causing structural damage.

3.2.8 Leachate Management

As shown on the CSMs (**Appendix A**) for each of the five landfill sites, infiltration of rainwater and decomposition of the waste has resulted in leachate plumes beneath the waste bodies. These leachate plumes extend a considerable distance below the waste bodies (approximately 40m below the waste in the case of Site 2) and migrate in the direction of the groundwater flow regime, generally to the north east.

Groundwater has been shown to have been the impacted by leachate generated on the landfill sites. Similarly a water quality impact observed at a number of the springs situated down-gradient of the landfill sites has been demonstrated, although many springs do not show any impact being characterised by clear flow and tufa formation.

The landfill sites do have the potential to affect surface water quality within the County Brook river (Fassaroe Stream) although water quality effects are not routinely observed, are largely restricted to upstream sections when they occur and are observed at locations situated upstream of the landfill sites. It seems that the very high dilution capacity within the County Brook River does afford protection to that watercourse. These observations are consistent with the continued WFD Status of the County Brook Stream, which is classified as ‘good’.

The evidence collected to date demonstrates that the five landfill sites have the potential to affect conditions within the alkaline fen of the Ballyman Glen SAC and its associated drainage system. It is possible that this affect could have a localised impact on tufa forming potential and water quality within a small number of the streams situated downstream of affected springs, as evidenced at two springs.

The results of the Detailed Quantified Risk Assessment (DQRA) suggest that the mixing of leachate with laterally flowing groundwater in the saturated gravel aquifer affords significant protection to the SAC, its drainage system and watercourses situated down gradient of the landfill sites. The most significant effects of the landfills would appear to be restricted to those areas where leachate and groundwater are found to be in direct continuity (i.e. submerged landfill waste mass) although this is only occurs locally at some of the landfill sites. The results of the DQRA demonstrate that a significant net betterment, in terms of water quality, can be achieved by controlling infiltration using an engineered low permeability cap.

3.2.9 Leachate Seepage at Ground Level

Given the nature of the waste and the likely ad-hoc fashion in which it was filled, it is possible that, following removal of vegetation and grading of the waste surface to receive the capping system, seepage from wet/saturated pockets of waste may result in a build-up of leachate against the underside of the capping system geocomposites. This would be more likely to occur on the down-gradient side of the waste bodies. This leachate could then travel between the surface of the waste and the gas drainage geocomposite and make its way to the perimeter of the waste body. However, the nature of such leachate breakouts, if any, would be sporadic, localised and random to a certain extent. It is also likely that leachate would seep back down into the waste body again locally without traveling to the edge of the waste.

In order to redirect any localised leachate seepages back into the waste, it is proposed that the gas drainage geocomposite shall be returned into the ground at the edge of the waste body as shown in

Drawing DG0009-01. This will mean that any minimal amounts of leachate which may have seeped upwards into the geocomposite, will be directed back down into the waste body by the vertical element of the geocomposite. This volume of leachate would be minuscule in comparison to the total volume of leachate currently within and below the waste body.

3.2.10 Surface Water Drainage Design

Once the low permeability geomembrane liner has been installed, infiltration of surface water through the capping system will be minimal. Surface water at finished ground level (e.g. on grassed areas, pathways etc.) will drain overland towards the river, as currently takes place. However some infiltration of surface water will continue to occur through the soils overlying the capping system. This will need to be managed independently in a dedicated filter drainage system.

In order to prevent ponding of this water on the capping materials, a surface water collection geocomposite will be installed above the LLDPE geomembrane. As noted above, the surface water geocomposite will provide sufficient flow capacity above the LLDPE geomembrane to ensure that the water is drained towards the perimeter of the waste body. Here the LLDPE liner and surface water geocomposite will be continued through a subsurface drain as shown on **Drawing DG0009-02**. This will consist of a perforated pipe installed at a depth of 1.2m bgl, within a granular stone-filled trench. The plan layout of this subsurface drain is shown on **Drawings DG0010-02 and DG0010-03**. This surface drain will be laid at grade with the existing site topography and will be connected by a series of manholes directing surface water by gravity to two low points (Site 3A/3A and Site 1/2). prior to outfalling to the river. Flow arrest measures in accordance with SuDs principles will be required to minimise flow rate at these locations. However, the manner by which this subsurface drainage attenuates, and its effect on the peak flow and greenfield run-off rate is described below:

- Based on a permeability of 1 x 10^{-5} m/s for the backfill and a hydraulic conductivity of 1 x 10^{-4} m/s for the surface water geocomposite in the capping system (which is 1m minimum below the finished ground surface), the average time of concentration in the sub-surface infiltration drain is approximately 23.5 days.

- In a storm event, the precipitation which does not flow as surface run-off will infiltrate through to landfill cover soils, attenuating naturally through the cover soils as it does so, until it hits the geocomposite, where it will be further attenuated at 1x10^{-4}m/s. This attenuation and lengthy time of concentration means that there will not be a peak flow from the subsurface infiltration drain and therefore will be no increase to the greenfield run-off rate.

- Even when the ground is already saturated prior to a storm event, the cover soils would not have capacity to hold the water so the majority of the water flows as surface run-off, as would occur naturally in the absence of a capping system.

- To summarise, any infiltrating water will be naturally attenuated through the capping cover soils and surface water geocomposite as it makes its way to the perimeter drain. Due to the lengthy time of concentration, there will be no peak flow associated with the sub-surface infiltration drain.

Given the location of Site 3B, away from the river valley alternative outfall arrangements will need to be incorporated at detailed design stage for management of surface water runoff from the capped landfill.

3.3 SLOPE STABILISATION

Slope failures and potentially unstable slopes have been recorded along the northern boundary of landfill Site 2 above Ballyman Glen. Anecdotal evidence also suggests that landfill Site 3A and 3C have previously suffered slope failures/slips on their northern boundaries along the Glen and SAC. The presence of rock drains on the surface may be an indication of previous remediation works.

In order to accommodate both the construction of the landfill capping system and any subsequent development, slope stabilisation measures will need to be undertaken at the affected landslip areas and potentially unstable fill areas prior to the installation of the capping system.

A cross-section depicting typical slope stabilisation measures is shown in **Figure 4.3** below. As part of the stabilisation measures all material above the slip surface (to be determined at detailed design stage) will be excavated and replaced with acceptable fill material at a gradient of 1(V):3(H). The toe of the new slope will then extend slightly further toward the river than the existing toe. Above the shoulder of the existing top of the slope, the earthworks will be cut in order to provide a shallower gradient of 1(V):4(H). The new fill material will be benched into the existing slope at a gradient of 1(V):5(H) or steeper if required. All newly formed slopes will be backfilled following the excavation of material.

Depending on the specific slope profile, a steeper reinforced earth slope may also be constructed at mid slope (further away from the Glen) to further minimise incursion into the Glen. A combination of these measures in response to the specific profile at each location of the slope failures will allow upper part of the slope of the capped landfill to be constructed with new acceptable fill at a shallower gradient.

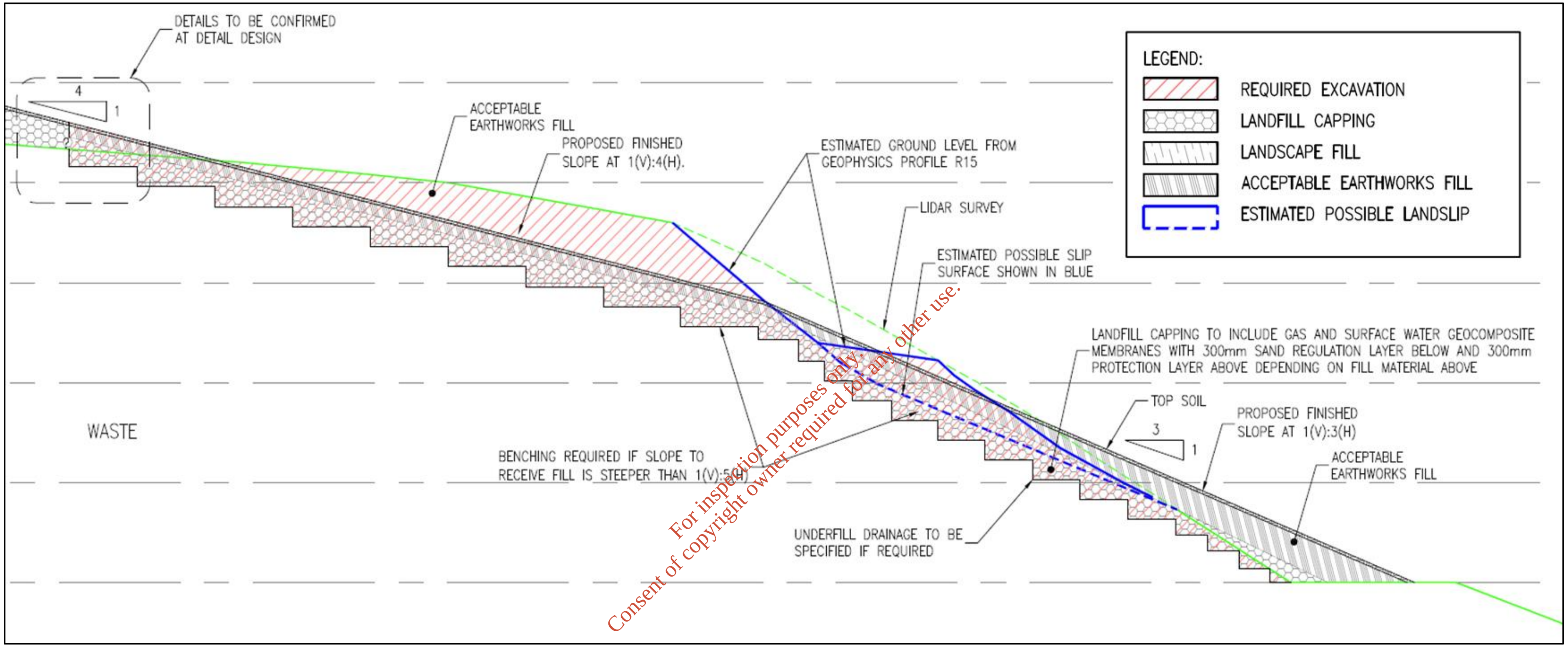
3.4 SETTLEMENT

It is likely that little or no compaction of waste occurred during filling operations. As such, with the installation of the capping layers including soils above the waste (and additional fill above this should any further development take place), this loading will result in settlement of the landfill areas. During the detailed design, consideration will therefore be given to the inclusion of a geogrid system in the capping system to reduce differential settlement.

3.5 PROPOSED FINAL PROFILE

With the exception of localised areas requiring slope stabilisation as discussed in **Section 3.3**, The final capped profile of the landfills shall, in general, follow the gradient and profile of the existing ground as shown in DG0008-01, DG0008-02, DG0008-03 with the capped level between 1.0 and 1.3m above the existing ground level.

Figure 3.3 Section through typical slope stabilisation measures



3.6 CAPPING SYSTEM CONSTRUCTION QUALITY ASSURANCE (CQA)

3.6.1 CQA Plan

As part of the design, a CQA Plan will be prepared for the installation of the capping system in accordance with the requirements of the *EPA Landfill Manual: Landfill Site Design*. The CQA Plan will set down the procedures for sourcing, transporting, placing, testing, repairing and protecting the capping materials prior to, during and after construction. The CQA Plan will set out the roles and responsibilities of the various parties on site and the reporting to be provided by the manufacturer, installer and CQA Monitor. This plan will help to ensure the design of the capping system is not compromised during its construction.

3.6.2 CQA Supervision

Third party supervision of the capping works by a specialist CQA consultant is required by the *EPA Landfill Manual: Landfill Site Design* and will be provided by a suitably qualified and experienced company. The CQA contractor will be responsible for overseeing the capping works and ensure that the main contractor adheres to the Works Requirements. A CQA validation report will be submitted to the EPA following the construction for the capping system. The CQA validation report will set out all aspects of the construction from supply through to final placement and testing.

A quality control system will be put in place for all documentation relating to the capping works. All documentation will be kept on-site and available for inspection at all times. CQA documentation will include the following:

- Delivery, handling and storage of materials,
- Geomembrane panel layout and programme,
- Geocomposite panel layout and programme,
- Monitoring programme,
- Geomembrane seam testing,
- Geocomposite seam testing,
- Soil inspection, and
- Laboratory testing results.

3.7 LANDSCAPING

As the afteruse of the five sites will require the establishment of vegetation, there needs to be a recuperation period during which the soil is allowed to recover from the movement, storage and replacement of materials during the construction period. Following this, a landscape plan will be implemented to establish, maintain and monitor vegetation in order to successfully develop the landscaped areas of the site to their intended after-use. This will include cultivating and improving the soil to allow for the establishment of vegetation. Timing of the final landscaping works will be influenced by a number of factors:

- Settlement rates across the site.
- Installation of environmental pollution control systems.
- Seasonal conditions.

3.8 POSSIBLE EXCAVATION OF WASTE TO ACCOMMODATE FUTURE DEVELOPMENT

Given the mixed use zoning of the lands, it is possible in the future that development of some infrastructure other than open space (eg. an access road) may be required within the footprint of the landfills. Where this is the case, it is likely that minor quantities of waste would need to be excavated and disposed offsite in order to accommodate suitable foundations for such infrastructure. A full risk assessment and implementation of appropriate mitigation measures would be required during such works.

4 POST CAPPING MANAGEMENT AND MONITORING

4.1 MONITORING PLAN

In order to demonstrate that the objectives of the proposed remediation strategy are being met, a programme of monitoring in accordance with the EPA Manual for Landfill Monitoring, 2nd edition 2003, is proposed as set out in **Table 4.1** below. Monitoring points are as shown on ERA Figure 15 **(Appendix B).**

Table 4.1 Proposed monitoring programme

Parameter		Monitoring Points	Monitoring Frequency*	Compliance with EPA Landfill Monitoring Manual (2003)	Demonstration of how monitoring or assessment will confirm objectives of remediation have been met
Leachate	Leachate levels	Site 1 - Two leachate boreholes Site 2 - Three leachate boreholes Site 3A - Two leachate boreholes Site 3B - Two leachate boreholes Site 3C - Two leachate boreholes	Biannually	Yes	Reduction in leachate levels and reduced concentrations of constituents over time
	Leachate Composition	1 per landfill body	Biannually	Yes	
	Leachate Discharge volume	N/A - no leachate being collected or discharged	N/a	Yes	N/A
Landfill Gas	Methane , carbon dioxide, oxygen, atmospheric pressure, temperature	Perimeter boreholes - To be determined Do be determined at detailed design stage and agreed with agency	Biannually	Yes	Significantly reduced landfill gas concentrations in perimeter boreholes
		Boreholes within virtual gas curtains – Do be determined at detailed design stage and agreed with agency	Biannually	Yes	
		Collection wells and associated manifolds	N/A	N/A	
	Methane , Flow rate	Surface emissions	Annually	Yes	Significantly reduced landfill gas concentrations through surface of landfills
	Table C5 of EPA landfill Monitoring Manual	Inputs and outputs of flare/Utilisation plant	N/a - no flare/utilisati on proposed	N/A	N/A

	Parameter	Monitoring Points	Monitoring Frequency*	Compliance with EPA Landfill Monitoring Manual (2003)	Demonstration of how monitoring or assessment will confirm objectives of remediation have been met
Surface Water	Sampling and assessment of results against trigger levels and/or standard reference values for relevant pollutants including environmental quality standards in the *European Communities Environmental Objectives (Surface Waters) Regulations 2009*	Upstream and downstream locations (SW1 to SW5) of the closed landfill	Biannually	Yes	Reduction in downstream parameters, towards consistency with upstream values
Groundwater	Sampling and assessment of results against trigger levels and/or standard reference values for relevant pollutants including environmental quality standards *European Communities Environmental Objectives (Groundwater) Regulations 2010*	BH01, BH03, BH04, BH05, BH06, BH07, BH08, BH09, BH10(d), BH11, BH13, G20	Biannually	Yes	Reduction in downgradient parameters, towards consistency with upgradient values
Topography and visual assessment	Visual assessment	Site levels on all five sites	Annually for first 2 years post capping. Every 2 years thereafter.	Yes	No changes in topographic level or evidence of failure or stress in capping system
Environmental: Invasive Species	Visual Inspection for presence of Japanese Knotweed	Landfill Site No. 1	3 No. times per annum (July – Sept every 4 – 6 weeks) for 5 years	N/A	No presence of Japanese Knotweed identified on site.

**** Frequency of monitoring to be reviewed and agreed with Agency following first 2 years post capping***

4.2 LANDFILL GAS

A monitoring plan will be developed in accordance with the EPA Manual for Landfill Monitoring, 2nd edition 2003 as part of the Landfill Gas Strategy. Boreholes in the gas flow path shall be monitored biannually to demonstrate the remedial measures, in particular, the Virtual Gas Curtain, are working. Once the level of certainty in the effectiveness of the remedial measures has increased to an acceptable level, monitoring frequency can be reduced to only periodically.

4.3 SURFACE WATER

To ensure that the constructed surface water management system for the landfill cap is functioning effectively following the remediation, samples should be taken at all discharge points twice annually and tested for evidence of leachate and suspended solids against recognised water quality standards. Where the results indicate the presence of contaminants, the source of the contamination should be identified and action taken to remedy any failures in the system. A physical inspection of the surface water management system during sampling rounds should also be carried out to ensure that it is operating effectively.

Bi-annual sampling of surface water from the upstream and downstream locations (SW1 to SW5) of the closed landfill (parameters as identified in the Environmental Risk Assessment);

After the first five years following the rehabilitation of the landfill, monitoring can be carried out at a reduced frequency of once a year. After this time, further monitoring may not be required if results indicate that the surface water management system is effective.

4.4 LEACHATE

Biannual monitoring to detect the presence of leachate should be carried out at carefully selected boreholes for the first 12 months following installation of the capping. Sampling analysis and characterisation should be carried out at for at least two boreholes per site. Leachate monitoring should be reduced to a frequency of once per year after two years, with agreement from the Agency.

4.5 GROUNDWATER MONITORING

Biannual ground monitoring shall be undertaken up-gradient and downgradient of the five landfills and an assessment against existing baseline values undertaken.

4.6 TOPOGRAPHY/SETTLEMENT

As the waste landfilled at the site has received only a small degree of compaction, it is expected that, following the installation of the capping system and restoration soils/fill above the capping system, settlement will occur. In general, most of the settlement occurs in landfills in the first two years following rehabilitation.

It is therefore proposed that annual topographical surveys be undertaken at the site to monitor the settlement rate for the first two years. Following this, topographical surveys will be conducted every two years (up to 10 years post rehabilitation), unless the settlement rate observed indicates that more frequent surveys are required. By this time it is anticipated that settlement will be very minor so surveys of the site should be undertaken every 5 years, or until the topography of the cell has stabilised.

4.7 INVASIVE SPECIES MONITORING

Four stands of Japanese Knotweed have been identified at historic landfill Site 1. A management plan is proposed as part of the Natura Impact Statement prepared for the site; which is to excavate the knotweed on site and haul it to a licensed facility. Thereafter it is proposed that the site be monitored for regrowth throughout the growing season over the next four years or until no further re-growth appears.

Based on a proposed site remediation year of 2019, the monitoring shall be undertaken from July – September for 2019 – 2023. During these months the monitoring shall be undertaken every 4 – 6 weeks, which equates to three visits per year.

5 CONCLUSIONS

RPS has been engaged by Wicklow County Council to prepare a remediation strategy for five historic landfills known as Site 1, Site 2, Site 3A Site 3B and Site 3C located in Fassaroe, Bray, Co. Wicklow The five landfill sites lie within the area of Fassaroe which is zoned for major new development under the Draft Bray Municipal District Local Area Plan 2018. Approximately 625,500 tonnes of waste are estimated to have been landfilled across the five sites.

An Environmental Risk Assessment (document ref. MDR01206Rp0007F01) undertaken in accordance with the Code of Practice - Environmental Risk Assessment for Unregulated Waste Disposal Sites (EPA, 2007) has concluded that capping of the five landfills with a low permeability barrier is the preferred remedial option.

The proposed capping system will be in accordance with the EPA Landfill Design Manual and will include a low permeability barrier, surface water and gas collection layers and a minimum of 1m of cover soils. Given the continuing presence of landfill gas both within and offsite at the landfills, gas protection measures to limit gas migration from the landfills should be incorporated into the capping solution.

Slope failures and potentially unstable slopes have been recorded along the northern boundary of landfill of three of the landfill sites. In order to accommodate both the construction of the landfill capping system and any subsequent development, slope stabilisation measures will need to be undertaken at the affected areas landslips.

Infiltration of rainwater through the waste will be significantly reduced by the capping system which will also lead to a significant reduction in leachate generation.

A surface water drainage system will also be installed along the downgradient perimeter of the landfills to collect clean run-off from the capping landfill and directed outfall in the County Brook (Fassaroe Stream).

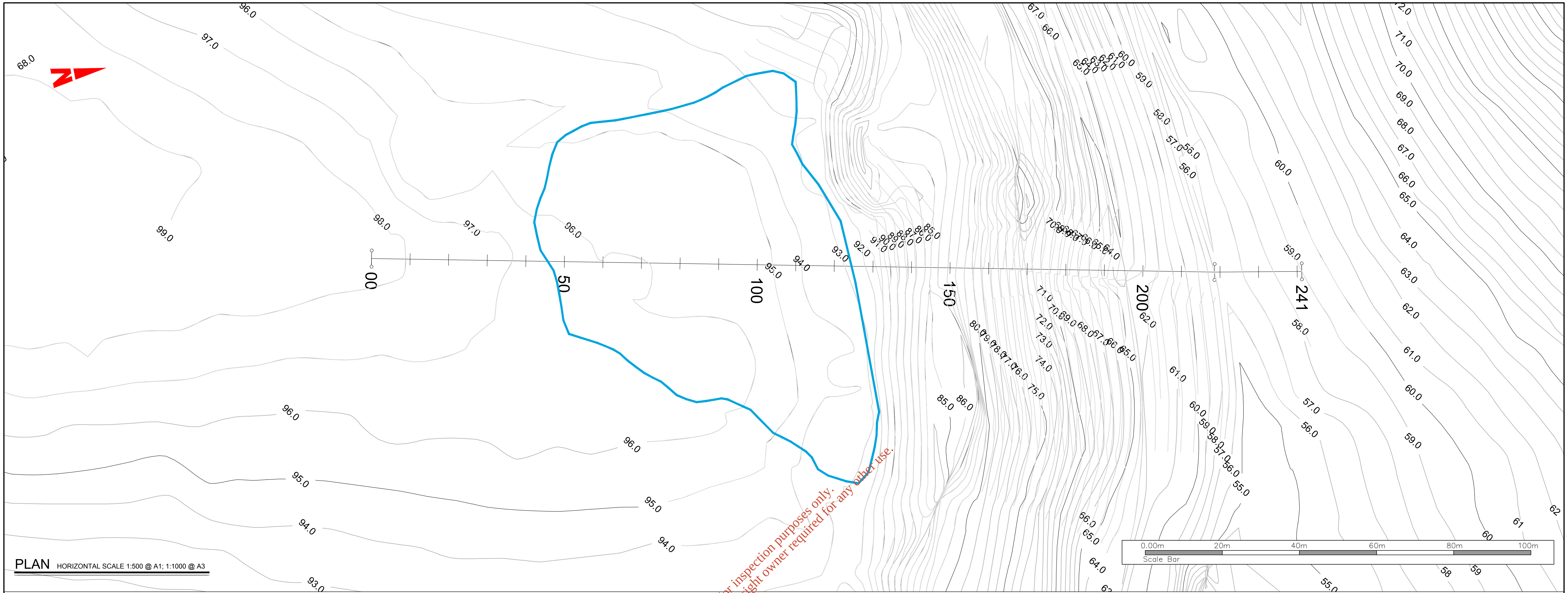
Given the mixed use zoning of the lands, it is possible in the future that development of some infrastructure other than open space (e.g. an access road) may be required within the footprint of the landfills. Where this is the case, it is likely that minor quantities of waste would need to be excavated and disposed offsite in order to accommodate suitable foundations for such infrastructure. A full risk assessment and implementation of appropriate mitigation measures would be required during such works.

As part of the landfill capping detailed design, a CQA Plan will be prepared for the installation of the capping system in accordance with the requirements of the *EPA Landfill Manual: Landfill Site Design*. The CQA Plan will set down the procedures for sourcing, transporting, placing, testing, repairing and protecting the capping materials prior to, during and after construction.

Following capping of the landfills, a monitoring programme for leachate, surface water, landfill gas and settlement must be implemented to ensure that the systems installed are operating effectively and that the remediation objectives are being met.

APPENDIX A

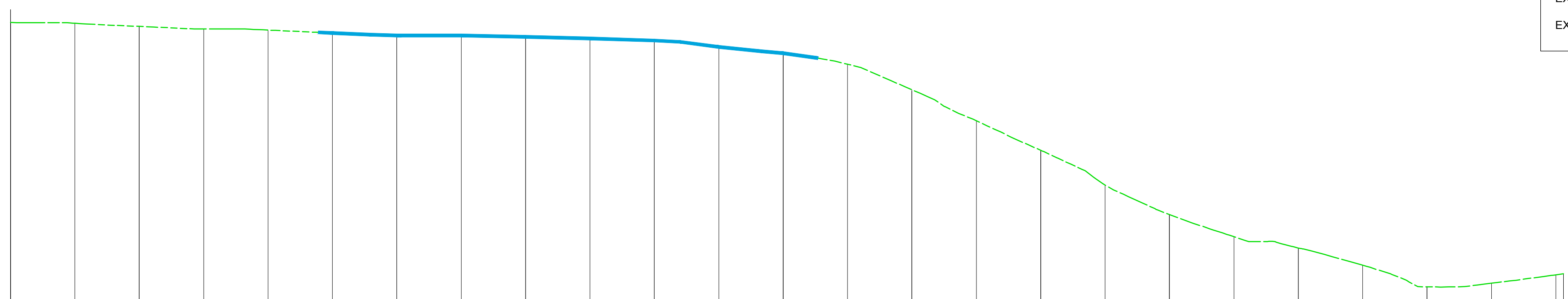
DRAWINGS



PLAN HORIZONTAL SCALE 1:500 @ A1; 1:1000 @ A3

LEGEND

- EXTENT OF WASTE
- EXISTING GROUND LEVEL
- EXISTING 5m CONTOURS
- EXISTING 1m CONTOURS



Datum 55.000 m

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20.000	97.400
30.000	97.011
40.000	96.835
50.000	96.375
60.000	96.000
70.000	96.001
80.000	95.775
90.000	95.512
100.000	95.211
110.000	94.204
120.000	93.251
130.000	91.521
140.000	87.559
150.000	82.761
160.000	78.177
170.000	72.771
180.000	68.174
190.000	64.754
200.000	62.999
210.000	60.328
220.000	56.979
230.000	57.528
240.000	58.834
241.195	59.000

VERTICAL GEOMETRY

G	L
-0.036%	8.788
-4.664%	21.212
-3.478%	25.357
-0.819%	17.045
-3.002%	30.509
-12.262%	7.089
-9.592%	12.852
-23.080%	10.075
-46.186%	17.073
-45.931%	16.896
-37.318%	29.659
-31.509%	22.000
0.071%	7.312
13.014%	15.328

SITE 1 - LONGSECTION
DATUM: 55.000

PROFILE VERTICAL SCALE 1:500 @ A1; 1:1000 @ A3
HORIZONTAL SCALE 1:500 @ A1; 1:1000 @ A3

Client

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Drawn	DN
Checked	KG
Approved	KG
Date	April 2018
Scale	@ A1
As Shown	@ A3
Job No.	MDR1206

Project: **FASSAROE HISTORIC LANDFILL**

Title: SITE 1
EXISTING PLAN & PROFILE
(Sheet 1 of 1)

File Ref. MDR1206DG0008 | Drg. No. DG0008-01 | Rev. A01

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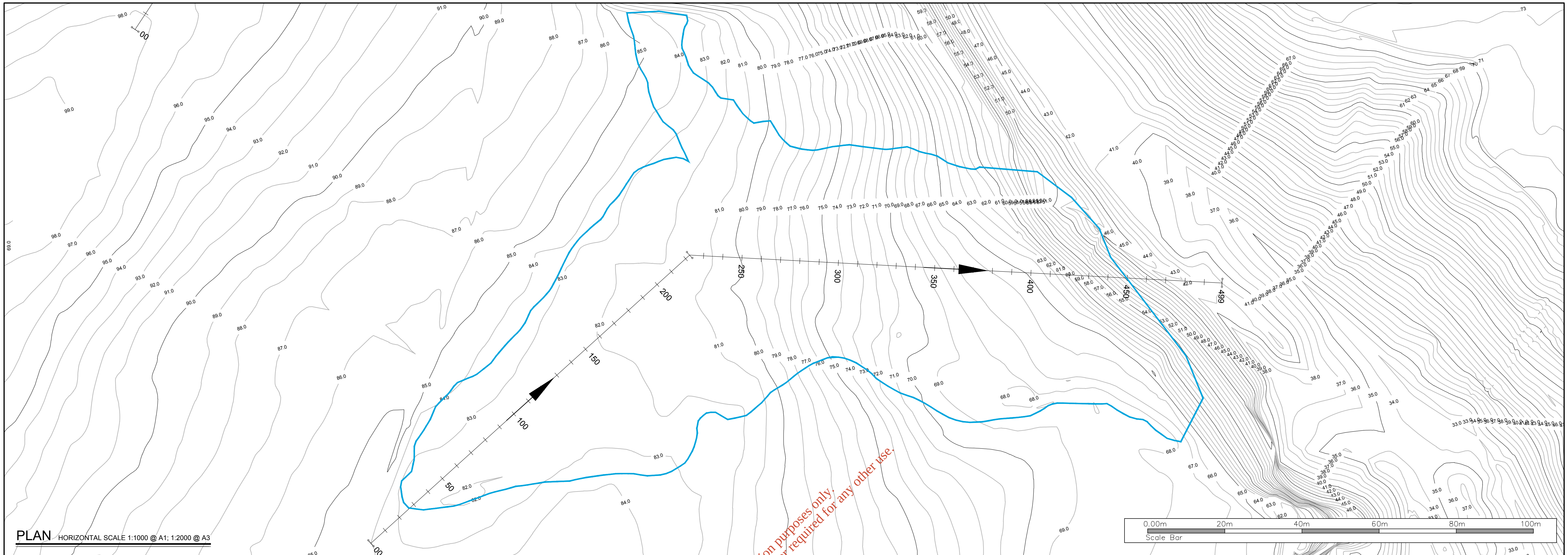
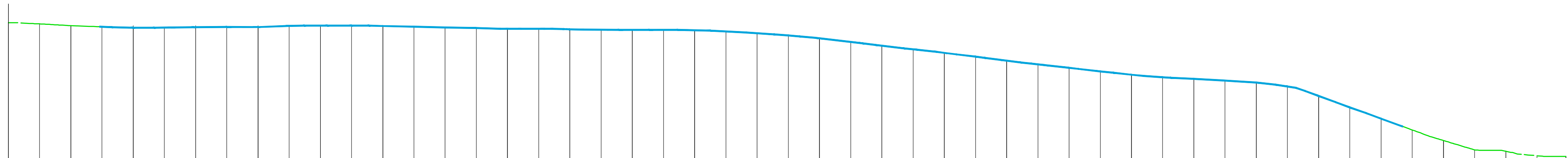


PLAN HORIZONTAL SCALE 1:1000 @ A1; 1:2000 @ A3

LEGEND

- EXTENT OF WASTE
- EXISTING GROUND LEVEL
- EXISTING 5m CONTOURS
- EXISTING 1m CONTOURS



Datum 40.000 m

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50.000	82.374
60.000	82.503
70.000	82.577
80.000	82.558
90.000	82.939
100.000	82.998
110.000	82.997
120.000	82.890
130.000	82.649
140.000	82.408
150.000	82.227
160.000	81.999
170.000	81.996
180.000	81.858
190.000	81.645
200.000	81.652
210.000	81.745
220.000	81.571
230.000	81.184
240.000	80.596
250.000	79.892
260.000	78.979
270.000	77.739
280.000	76.546
290.000	75.415
300.000	74.263
310.000	73.064
320.000	71.749
330.000	70.559
340.000	69.442
350.000	68.316
360.000	67.241
370.000	66.425
380.000	65.894
390.000	65.324
400.000	64.732
410.000	63.450
420.000	60.402
430.000	56.717
440.000	53.121
450.000	49.484
460.000	46.092
470.000	43.076
480.000	42.647
490.000	41.195
499.242	41.000

VERTICAL GEOMETRY

G	L
-3.475%	4.352
-5.660%	14.993
-0.004%	96.215
-2.411%	29.436
-1.890%	15.199
-0.034%	13.401
-2.133%	16.372
0.504%	20.350
-3.263%	25.004
-7.925%	24.646
-12.082%	63.599
-11.134%	36.746
-8.184%	9.180
-5.493%	29.163
-13.178%	14.044
-36.106%	26.048
-36.516%	17.355
-30.161%	14.116
-0.141%	8.315
-14.859%	13.160
0.000%	7.517

SITE 2 - LONGSECTION
DATUM: 40.000

PROFILE VERTICAL SCALE 1:1000 @ A1; 1:2000 @ A3
HORIZONTAL SCALE 1:1000 @ A1; 1:2000 @ A3

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Drawn	DN
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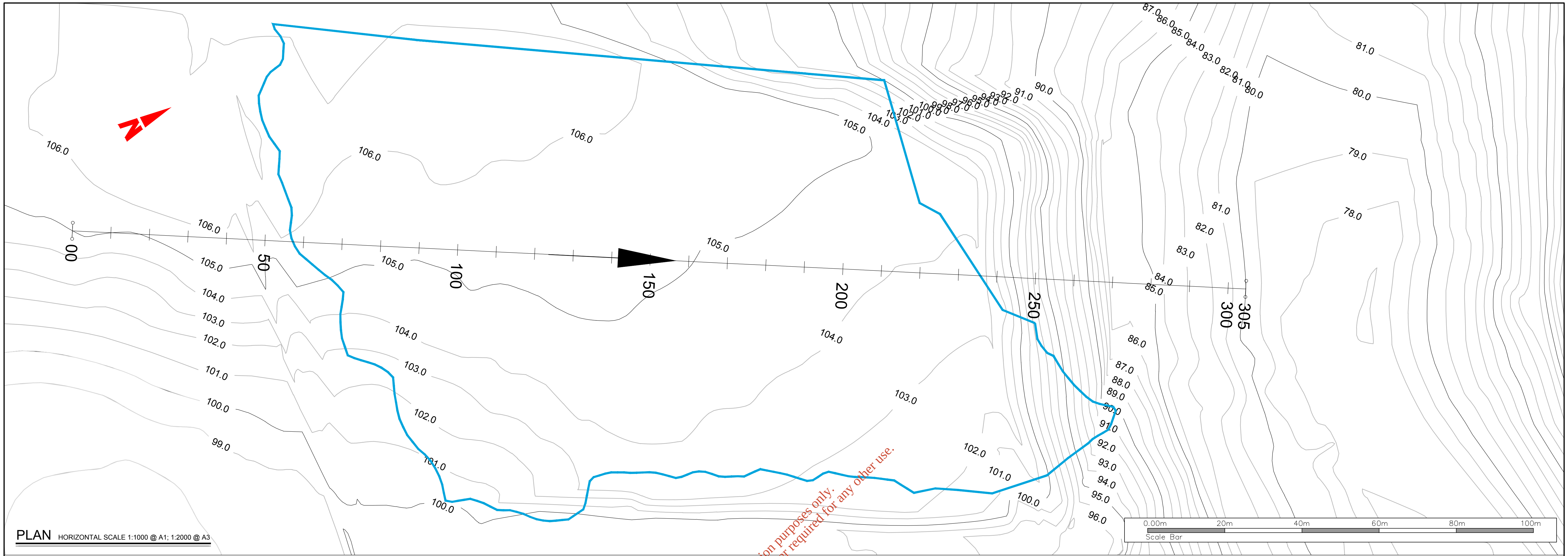
Approved	KG
Date	April 2018
Scale	@ A1 / As Shown @ A3
Job No.	MDR1206

Project: **FASSAROE HISTORIC LANDFILL**

Title: SITE 2
EXISTING PLAN & PROFILE
(Sheet 1 of 1)

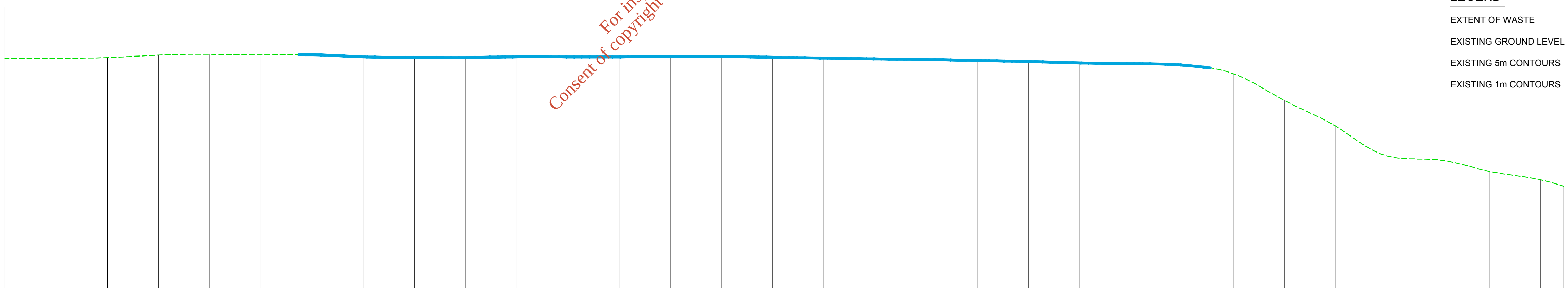
File Ref. MDR1206DG0008 | Drg. No. DG0008-02 | Rev. A01



PLAN HORIZONTAL SCALE 1:1000 @ A1; 1:2000 @ A3

LEGEND

- EXTENT OF WASTE
- EXISTING GROUND LEVEL
- EXISTING 5m CONTOURS
- EXISTING 1m CONTOURS



Datum 60.000 m

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EXISTING LEVELS	105.000	105.005	105.118	105.602	105.746	105.627	105.676	105.253	105.169	105.142	105.272	105.262	105.286	105.326	105.322	105.175

CHAINAGE	160.000	170.000	180.000	190.000	200.000	210.000	220.000	230.000	240.000	250.000	260.000	270.000	280.000	290.000	300.000	304.569
EXISTING LEVELS	105.026	104.862	104.748	104.547	104.346	104.078	103.922	103.656	101.971	96.730	91.726	85.920	85.145	82.901	81.259	80.000

SITE 3A - LONGSECTION
DATUM: 60.000

PROFILE VERTICAL SCALE 1:1000 @ A1; 1:2000 @ A3
HORIZONTAL SCALE 1:1000 @ A1; 1:2000 @ A3

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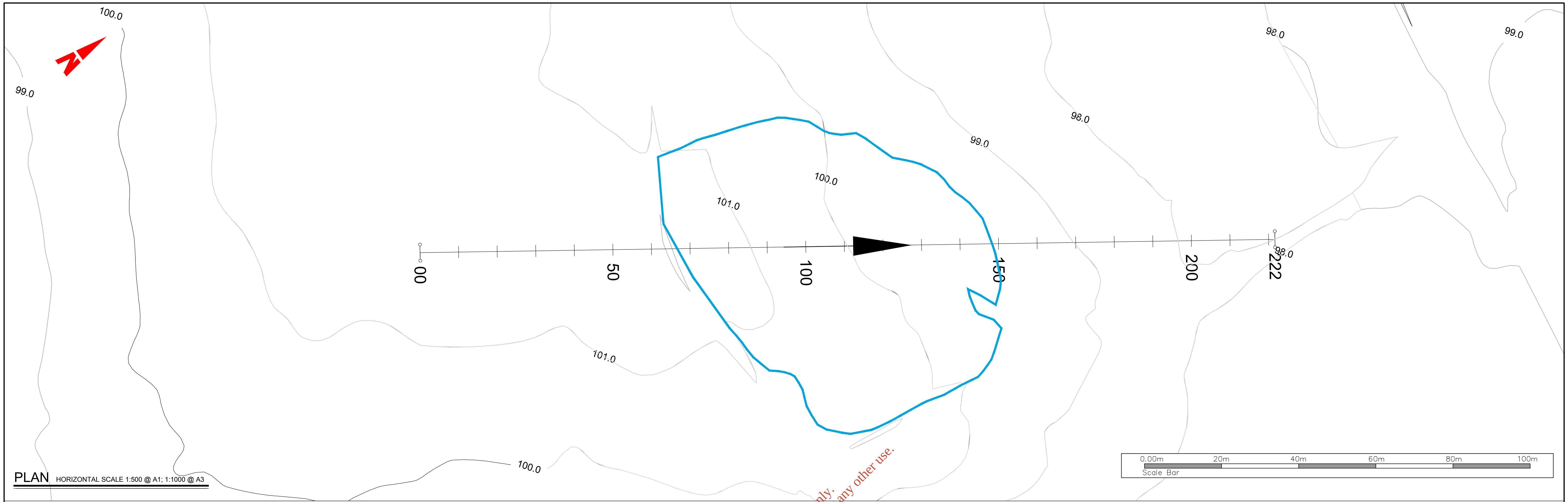
Date	April 2018
Scale	As Shown @ A1 @ A3
Job No.	MDR1206

Project: **FASSAROE HISTORIC LANDFILL**

Title: SITE 3A
EXISTING PLAN & PROFILE
(Sheet 1 of 1)

File Ref. MDR1206DG0008 | Drg. No. DG0008-03 | Rev. A01

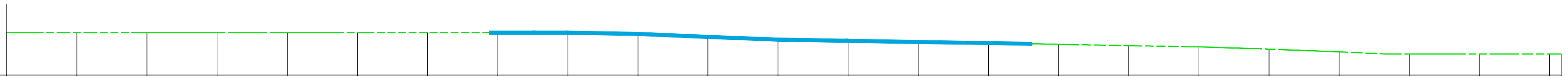


PLAN HORIZONTAL SCALE 1:500 @ A1; 1:1000 @ A3

LEGEND

- EXTENT OF WASTE
- EXISTING GROUND LEVEL
- EXISTING 5m CONTOURS
- EXISTING 1m CONTOURS

Datum 95.000 m



CHAINAGE	EXISTING LEVELS
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10.000	101.003
20.000	101.003
30.000	101.002
40.000	101.002
50.000	101.002
60.000	101.001
70.000	101.001
80.000	101.000
90.000	100.823
100.000	100.415
110.000	100.032
120.000	99.841
130.000	99.681
140.000	99.533
150.000	99.357
160.000	99.168
170.000	98.982
180.000	98.674
190.000	98.289
200.000	98.000
210.000	98.000
220.000	98.000
221.644	98.000

VERTICAL GEOMETRY

G	L
-0.003%	65.348
-0.005%	20.376
-3.980%	25.128
-1.699%	57.828
-3.623%	26.918
0.000%	26.045

SITE 3B - LONGSECTION
DATUM: 95.000

PROFILE VERTICAL SCALE 1:500 @ A1; 1:1000 @ A3
HORIZONTAL SCALE 1:500 @ A1; 1:1000 @ A3

X:\Monthly Folders\Apr 2018\Kieran Garvey\Fassaroe\MDR1206DG0008A01.dwg

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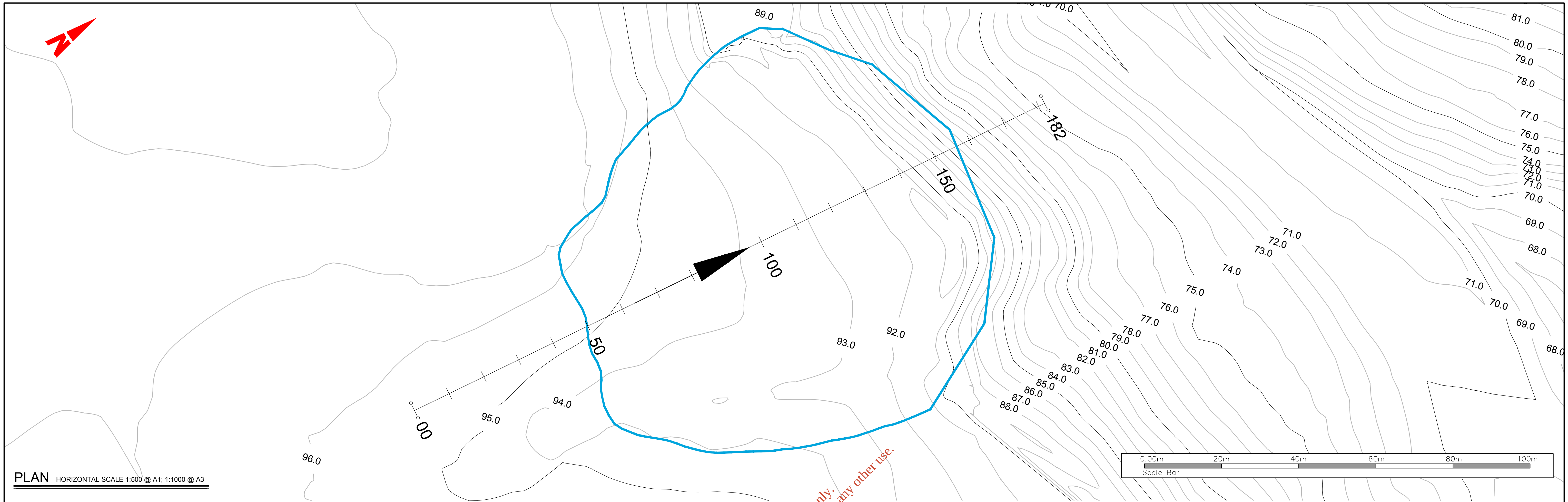
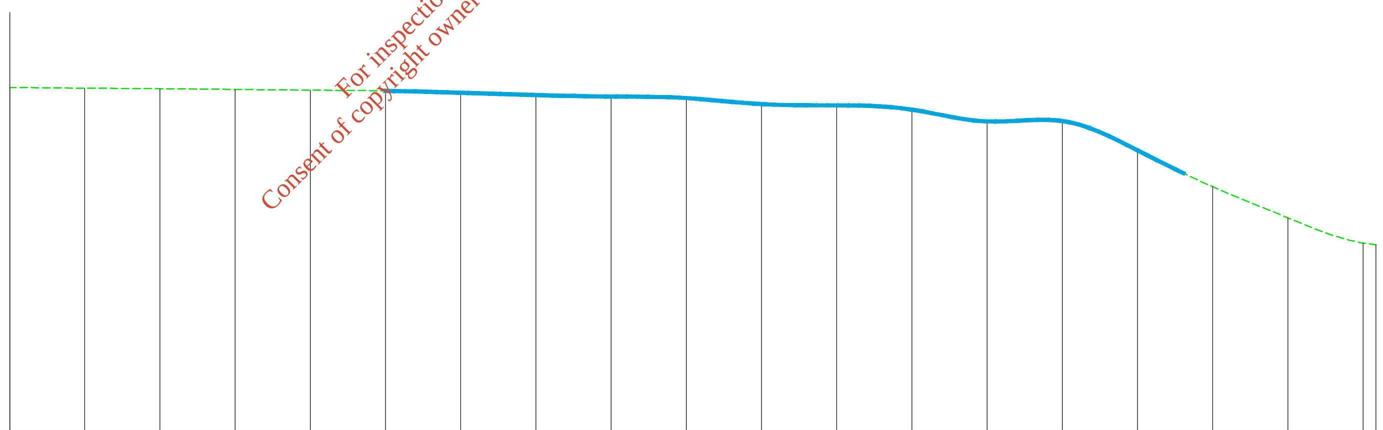
Drawn	DN	Project	FASSAROE HISTORIC LANDFILL
Checked	KG		
Approved	KG		
Date	April 2018	Title	SITE 3B EXISTING PLAN & PROFILE (Sheet 1 of 1)
Scale	As Shown @ A1 @ A3		
Job No.	MDR1206	File Ref.	MDR1206DG0008
Drg. No.	DG0008-04	Rev.	A01



PLAN HORIZONTAL SCALE 1:500 @ A1; 1:1000 @ A3

LEGEND

- EXTENT OF WASTE
- EXISTING GROUND LEVEL
- EXISTING 5m CONTOURS
- EXISTING 1m CONTOURS



Datum 50.000 m

CHAINAGE	EXISTING LEVELS
00.000	95.574
10.000	95.474
20.000	95.407
30.000	95.306
40.000	95.217
50.000	95.120
60.000	94.873
70.000	94.561
80.000	94.365
90.000	94.164
100.000	93.357
110.000	93.169
120.000	92.627
130.000	91.052
140.000	91.115
150.000	87.208
160.000	82.378
170.000	78.244
180.000	74.901
181.707	74.670

SITE 3C - LONGSECTION
DATUM: 50.000

PROFILE VERTICAL SCALE 1:500 @ A1; 1:1000 @ A3
HORIZONTAL SCALE 1:500 @ A1; 1:1000 @ A3

X:\Monthly Folders\Apr 2018\Kieran Garvey\Fassaroe\MDR1206DG0008A01.dwg

Client

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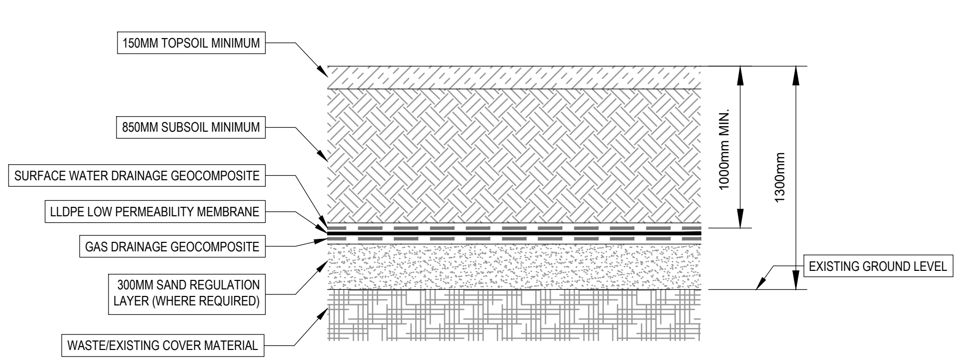
Drawn	DN
Checked	KG
Approved	KG
Date	April 2018
Scale As Shown	@ A1 @ A3
Job No.	MDR1206

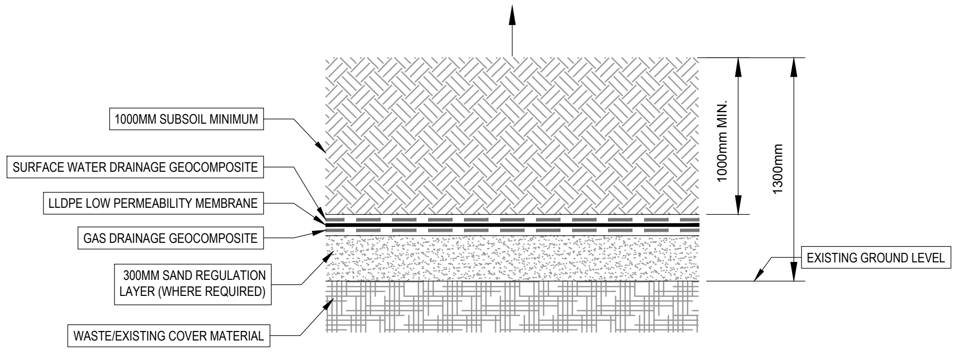
Project: **FASSAROE HISTORIC LANDFILL**

Title: SITE 3C
EXISTING PLAN & PROFILE
(Sheet 1 of 1)

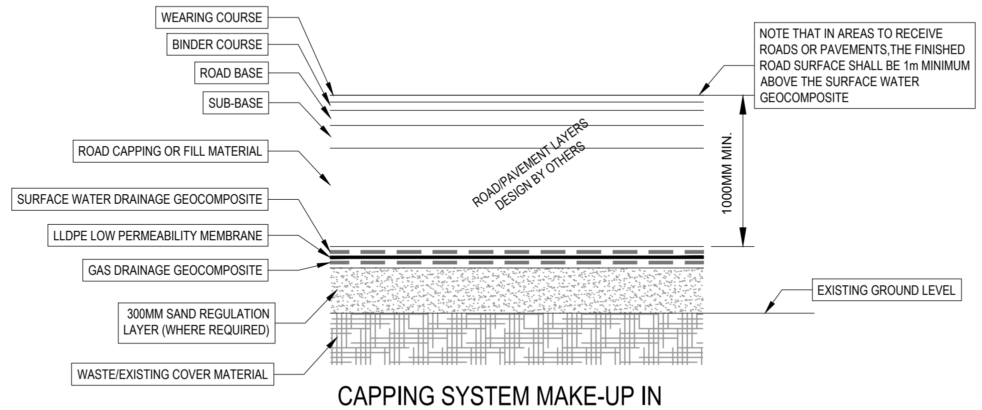
File Ref. MDR1206DG0008 | Drg. No. DG0008-05 | Rev. A01



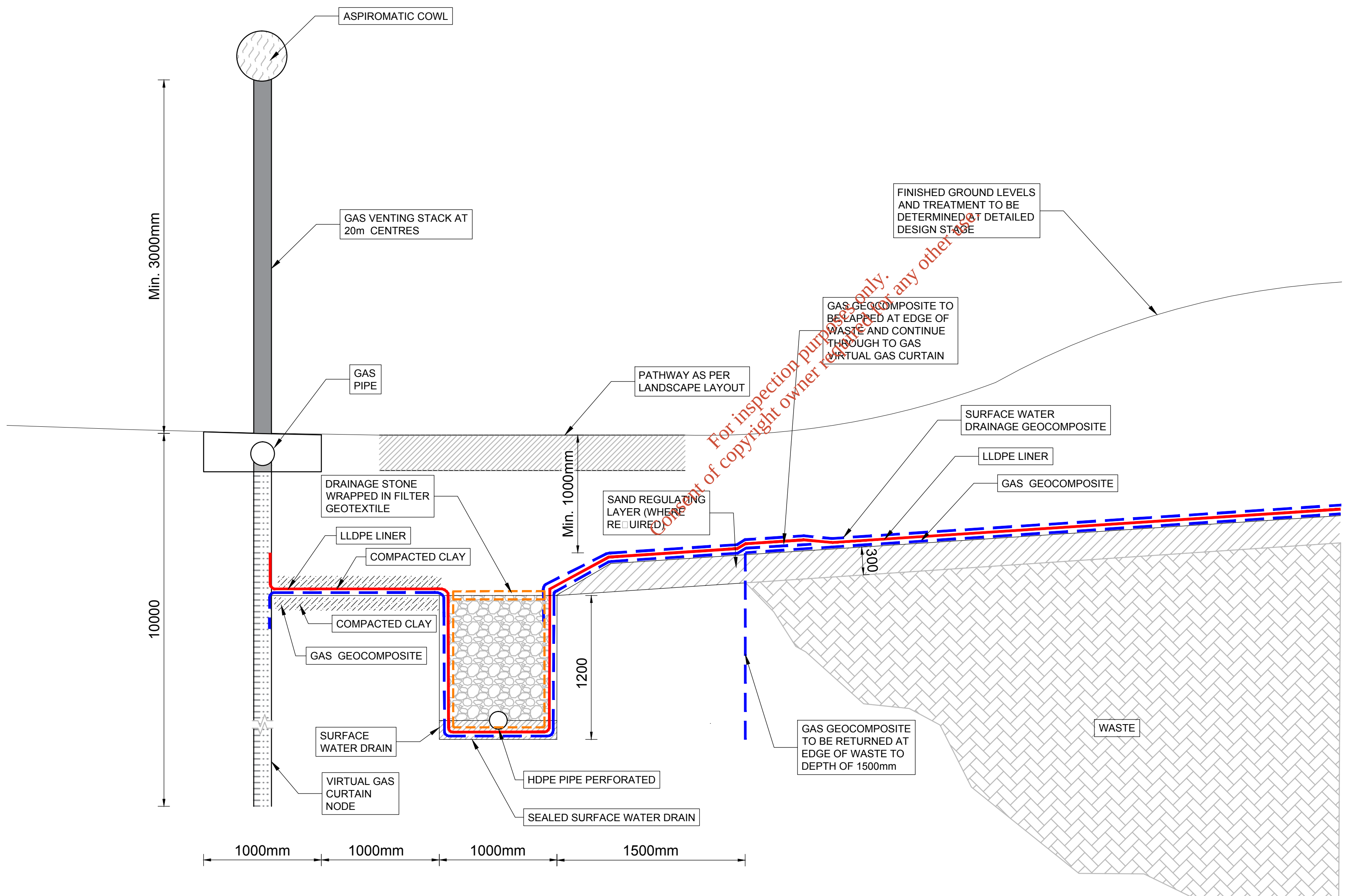
TYPICAL CAPPING SYSTEM MAKE-UP



CAPPING SYSTEM MAKE-UP IN AREAS TO BE RAISED >1.3M ABOVE EXISTING GROUND LEVEL



CAPPING SYSTEM MAKE-UP IN AREAS TO RECEIVE ROADS OR PAVEMENTS



TYPICAL EDGE OF WASTE CAPPING DETAIL SCALE 1:25 @A1 ; 1:50 @A3

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Date	June 2016
Scale	1:25 @ A1 1:50 @ A3
Job No.	MDR1206

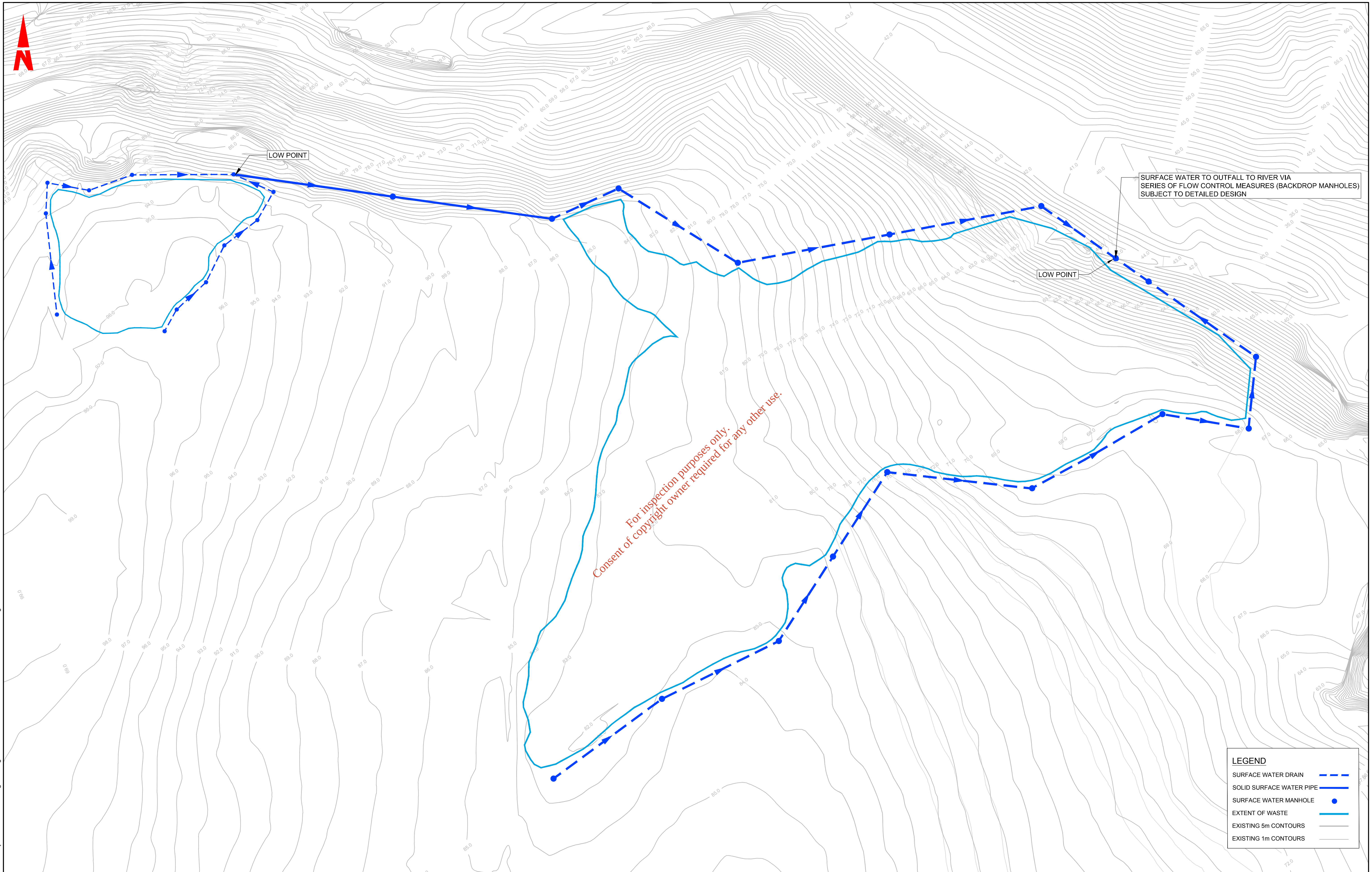
Project: FASSAROE HISTORIC LANDFILL

Title: TYPICAL CAPPING DETAILS

(SHEET 1 OF 1)

File Ref. MDR1206DG0009 | Drg. No. DG0009-01 | Rev. F01

V:\8.0 Drawings\DG\MDR1206DG0009A01 TYPICAL CAPPING DETAILS.dwg



X:\Monthly Folders\Apr 2018\Kieran Garvey\Fassaroe\SW drainage drawing\MDR1206DG0010A01 SURFACE WATER LAYOUT.dwg

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Scale	@ A1 / N.T.S. @ A3
Job No.	MDR1206

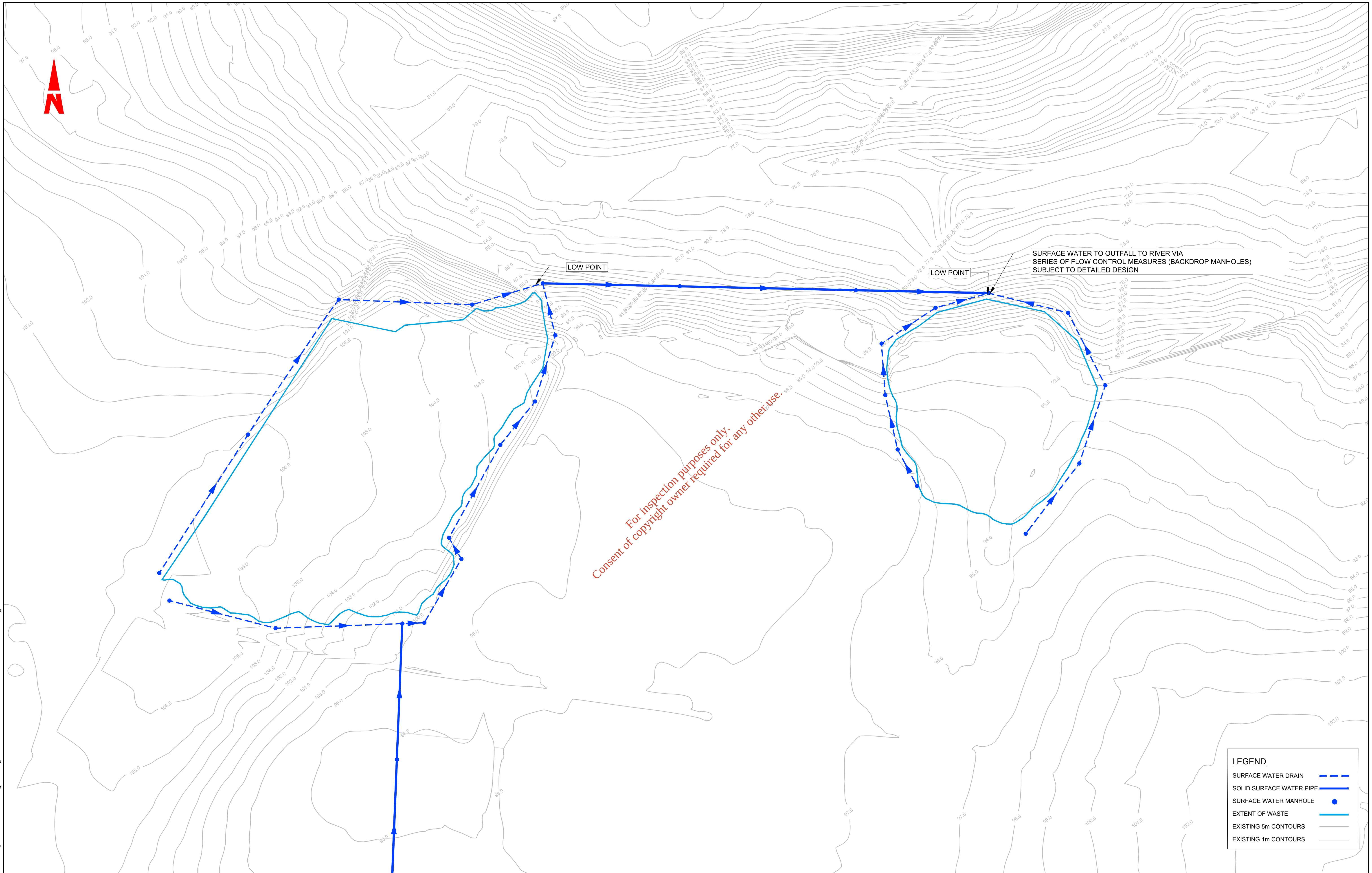
Project

FASSAROE HISTORIC LANDFILL

Title

SITES 1 AND 2
SW DRAINAGE LAYOUT
(Sheet 1 of 1)

File Ref. MDR1206DG0010 | Drg. No. DG0010-03 | Rev. A01



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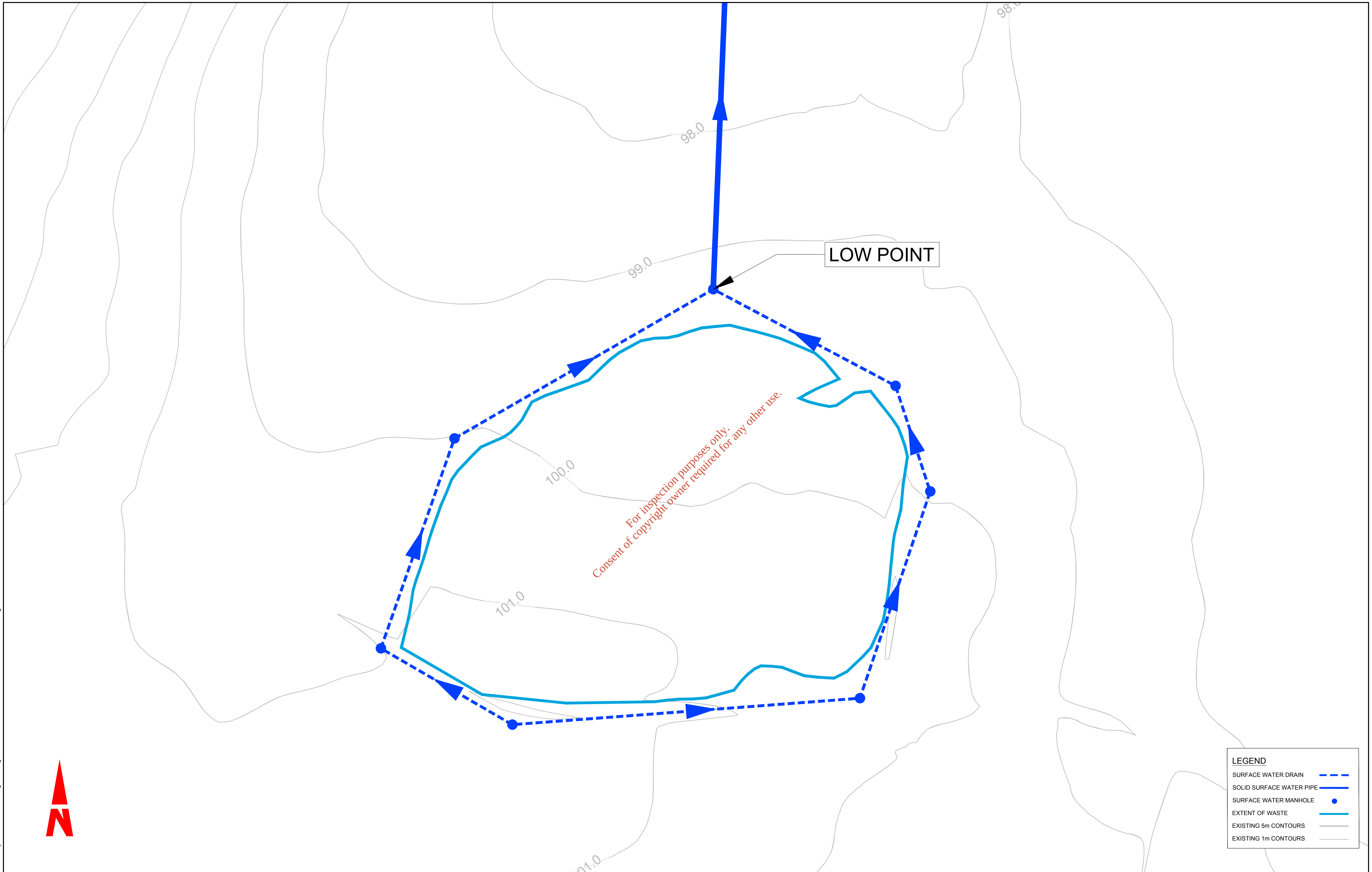
Approved	KG
Date	April 2018
Scale	N.T.S. @ A1 / @ A3
Job No.	MDR1206

Project: **FASSAROE HISTORIC LANDFILL**

Title: SITES 3A AND 3C
SW DRAINAGE LAYOUT
(Sheet 1 of 1)

File Ref. MDR1206DG0010 | Drg. No. DG0010-03 | Rev. A01



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Date	April 2018
Scale	@ A1 / N.T.S. @ A3
Job No.	MDR1206

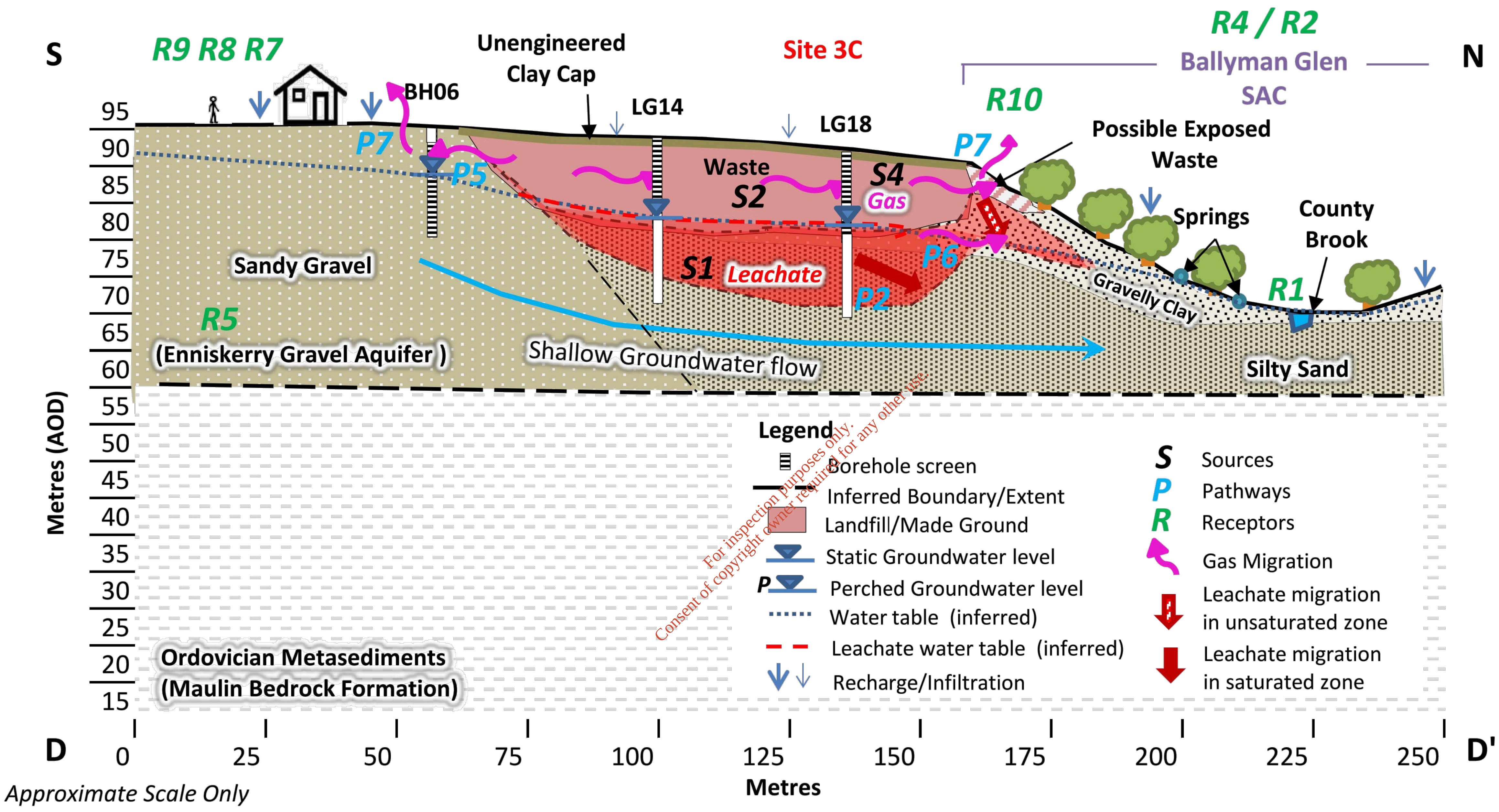
Project: **FASSAROE HISTORIC LANDFILL**

Title: SITES 3B
SW DRAINAGE LAYOUT
(Sheet 1 of 1)

File Ref. MDR1206DG0010 | Drg. No. DG0010-03 | Rev. A01

APPENDIX B

ENVIRONMENTAL RISK ASSESSMENT (ERA) FIGURES



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Job No.	MDR1206

Project
FASSAROE HISTORIC LANDFILL

Title
CONCEPTUAL SITE MODEL
SITE 3C

File Ref.	Drg. No.	Rev.
MDR1206FG0022F02.dwg	Figure 22	F02

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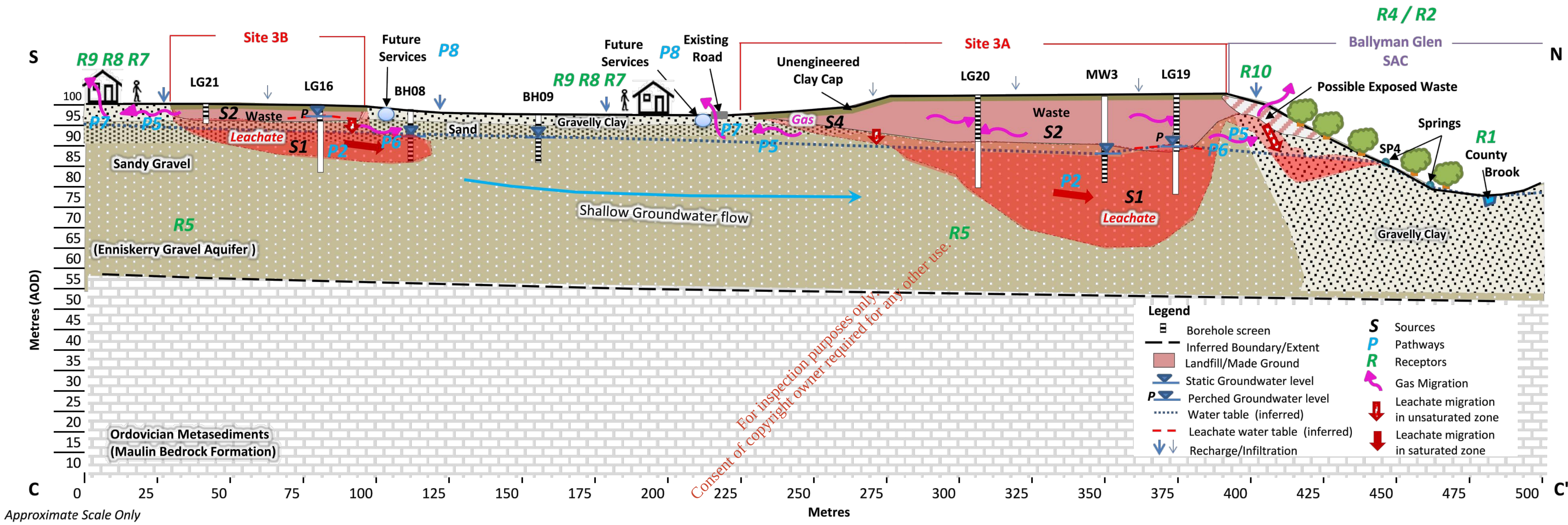

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Checked LD
Approved CC
Date May 2016
Scale NTS @ A1, NTS @ A3

Project: **FASSAROE HISTORIC LANDFILL**

Title: CONCEPTUAL SITE MODEL SITES 3A & 3B

Job No. MDR1206
File Ref. MDR1206FG0021F02.dwg
Drg. No. Figure 21
Rev. F02

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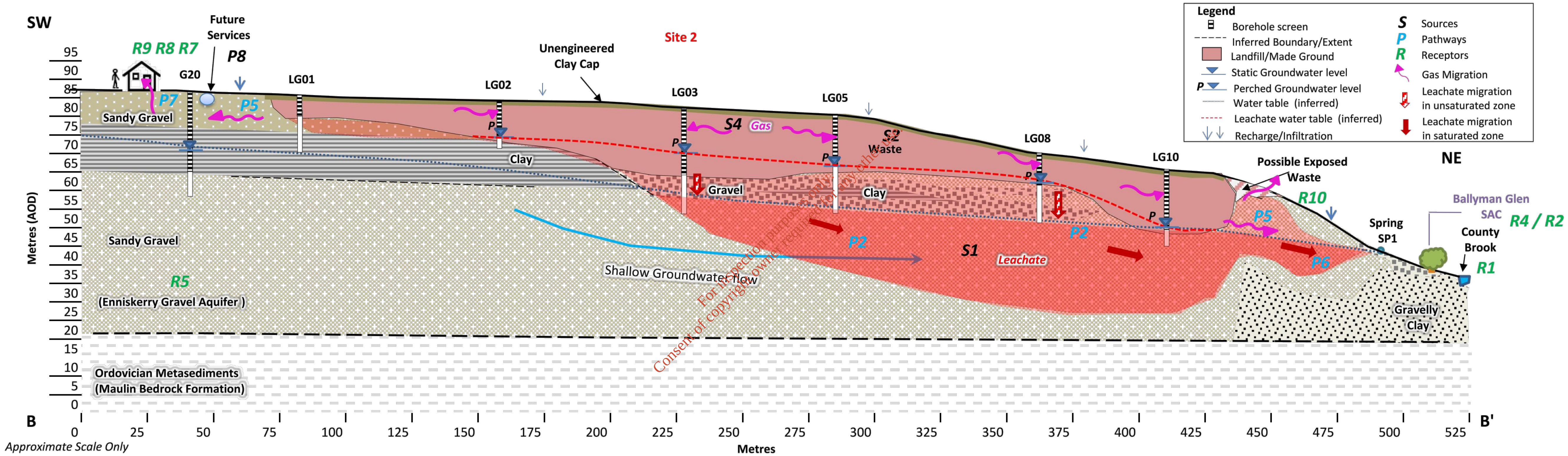

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Job No.	MDR1206

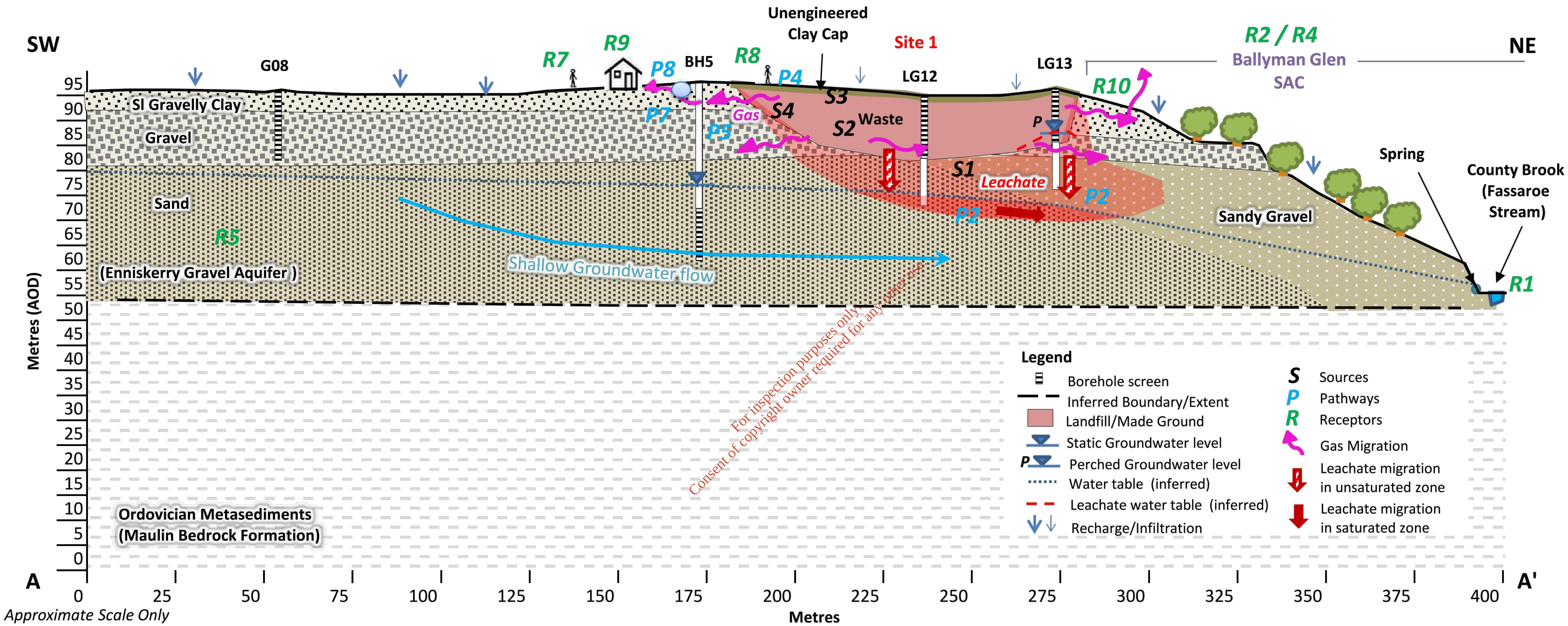
Project

FASSAROE HISTORIC LANDFILL

Title

CONCEPTUAL SITE MODEL SITE 2

File Ref.	Drg. No.	Rev.
MDR1206FG0020F02.dwg	Figure 20	F02



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Project: FASSAROE HISTORIC LANDFILL

Title: CONCEPTUAL SITE MODEL SITE 1

File Ref.	Drg. No.	Rev.
MDR1206FG0020F02.dwg	Figure 19	F02

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SITE INVESTIGATION CO-ORDINATES		
ID	X Co-ordinate	Y Co-ordinate
Surface Water Monitoring Locations		
SW1	724137.00	718407.00
SW2	723733.00	718594.00
SW3	723598.00	718560.00
SW4	722837.00	718475.00
SW5	722609.00	718667.00

SITE INVESTIGATION CO-ORDINATES		
ID	X Co-ordinate	Y Co-ordinate
Spring Locations		
Spring 1	724052.00	718436.00
Spring 2	723554.00	718552.00
Spring 3	723365.00	718567.00
Spring 4	723200.00	718486.00
Spring 5	723100.00	718489.00
Spring 6	723038.00	718488.00
Spring 7	722982.00	718476.00
Spring 8	722842.00	718471.00
Spring 9	722780.00	718489.00
Spring 10	722783.12	718446.41

LEGEND

- EO — ESB Overhead (38 kv)
- EO1 — ESB Overhead (110kv)
- EO2 — ESB Overhead (220kv)
- EO3 — ESB Overhead (400kv)
- EO4 — ESB Overhead (LV)
- EO5 — ESB Overhead (MV)
- EU — ESB Underground (38kv)
- EU1 — ESB Underground (MV & LV)
- EU2 — ESB Underground (Spare)
- Extent of Waste
- Special Areas of Conservation (SAC's)

Site Investigation

- MW1 — Existing Boreholes
- G01 — Gas Monitoring Borehole
- LG01 — Combined Gas/Leachate Monitoring Boreholes (Rotary)
- LG02 — Combined Gas/Leachate Monitoring Boreholes (Cable Percussive)
- Combined Gas/Leachate Monitoring Boreholes (Cable Percussive with Rotary follow on)
- BH01 — Combined Groundwater/Gas Monitoring Boreholes
- SW1 — Surface Water Monitoring Location
- Spring 1 — Spring Location
- SP1 — Spring Sampling Location

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Approved	CC
Date	May 2016
Scale	1:2500 @ A1 1:5000 @ A3
Job No.	MDR1206

Project: FASSAROE HISTORIC LANDFILL

Title: PLAN SHOWING MONITORING LOCATIONS

File Ref. MDR1206FG0015F02.dwg | Drg. No. Figure 15 | Rev. F02

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