



## **Non-Technical Summary**

### **New Bespoke Installation Permit**

### **BioConstruct NewEnergy Limited**

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**Lower Drayton Farm AD, Lower Drayton Farm, Lower Drayton Lane, Penkridge, Stafford, South Staffordshire, ST19 5RE**

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ETL437/2020

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17 July 2020

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## QUALITY CONTROL

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## Quality control sign off

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## TABLE OF CONTENTS

1. INTRODUCTION.....	2
2. OVERVIEW.....	2
3. KEY SENSITIVITIES .....	4
4. MANAGEMENT.....	5
5. CONTROL OF EMISSIONS TO LAND AND WATER .....	5
6. CONTROL OF EMISSIONS TO AIR.....	7
7. CONTROL OF AMENITY IMPACTS.....	8
FIGURES.....	10
APPENDIX A – SCHEDULE 1 LISTED ACTIVITY AND DIRECTLY ASSOCIATED ACTIVITIES.....	17
APPENDIX B – PROCESS FLOW DIAGRAM.....	20
APPENDIX C – DRAINAGE DESIGN REPORT .....	22
APPENDIX D – CONTAINMENT BUND DESIGN REPORT .....	80
APPENDIX E – DRAINAGE PROCESS FLOW.....	127
APPENDIX F – EFFLUENT INFILTRATION ASSESSMENT .....	129
APPENDIX G - SITE SPECIFIC BIOAEROSOL RISK ASSESSMENT.....	146

## 1. Introduction

- 1.1. This Non-Technical Summary has been prepared by Earthcare Technical Ltd (ETL) on behalf of Lower Drayton Biogas Projectco Limited to support a permit application for a new bespoke installation permit for an anaerobic digestion plant including the use of resultant biogas at Lower Drayton Farm, Lower Drayton Lane, Penkridge, Stafford, South Staffordshire, ST19 5RE, herein termed 'the Site'. BioConstruct GmbH designed the plant and are building and commissioning it.
- 1.2. The application has been prepared by ETL in conjunction with and on behalf of the Operator BioConstruct NewEnergy Limited (BCNE).
- 1.3. Basic pre-application advice has been sought from the Environment Agency with respect to this new permit application (Reference EA/EPR/EP3507BH) to ensure that all of the relevant supporting documents have been provided.
- 1.4. A full Environmental Risk Assessment has been carried out and is provided in Appendix A of the Environmental Management System (EMS) Manual (**BCNE EMS Man 001**) which accompanies this application. This Non-Technical Summary highlights the key control measures that will be employed to minimise any impacts from the operational site and signposts the reader to the key supporting documents.

## 2. Overview

- 2.1. The site is located in a rural area approximately 700m to the northern fringes of the town of Penkridge and directly south of Lower Drayton Farm. The site is approximately 3.8 hectares (9.5 acres) in area and is on land previously used for storage by Lower Drayton Farm and other businesses who rent premises in the farm yard. Part of the site has until recently been used as a motor cross track. Full details of the previous land uses and site condition can be found in the Site Condition Report which supports the permit application.
- 2.2. The planning permission for the Lower Drayton Farm AD plant was obtained from South Staffordshire Council on the 21st December 2016 (Reference 16/00717/FUL).
- 2.3. The activity is classified as an 'Installation' and therefore the requirements of the Industrial Emissions Directive apply, since the anaerobic digestion plant has a treatment capacity of more than 100 tonnes per day. The permit will be 'bespoke' by virtue of the requirement for an associated discharge to ground for treated water from the on-site digestate treatment process (Ekogea technology). In all other respects the site complies with location criteria set out within Standard Rules 2012 No 9 – *On-farm anaerobic digestion facility using farm wastes only, including use of the resultant biogas Part A installation– treatment capacity over 100 tonnes of waste per day* (SR2012 No.9).
- 2.4. The Environmental Risk Assessment (Appendix A of the EMS Manual (**BCNE EMS Man 001**)) is therefore based upon the generic risk assessment for SR2012 No.9. The additional hazards and risks associated with the discharge of polished water to ground have been considered within the Environmental Risk Assessment.



- 2.5. The proposed Schedule 1 Listed Activity is S5.4 Part A(1)(b)(i) *Recovery or a mix of recovery and disposal of non-hazardous waste with a capacity exceeding 75 tonnes per day (or 100 tonnes per day if the only waste treatment activity is anaerobic digestion involving biological treatment)*. The proposed Directly Associated Activities are detailed in Appendix A.
- 2.6. The process is depicted in a Process Flow Diagram included as Appendix B of this document. A full process description is provided in Section 5 of the EMS Manual (**BCNE EMS Man 001**) which accompanies this permit application.
- 2.7. The proposed feedstocks are energy crops namely maize and grass silage, poultry manure, cattle manure and rape straw.
- 2.8. The proposal is to use an Ekogea system which comprise:
- A micronisation system which treats feedstocks to enhance digestibility and reduce hydraulic retention time;
  - Polymer dosing and thickening of the digestate to reduce storage capacity requirements and reduce the cost and impacts of digestate transportation; and
  - Single stage anaerobic waste water treatment plant or polishing plant (H2E) to treat the grey water from the digestate thickening process.
- 2.9. The polished water will be used in the micronisation process. It is proposed to discharge the excess polished water (up to 23m<sup>3</sup> a day) into an infiltration pond to the south of the site. Consent for this discharge to ground is sought as part of the permit application.
- 2.10. The AD plant will process up to 40,610 tonnes per year of agricultural feedstocks.
- 2.11. Biogas will be upgraded to biomethane and exported to the gas network. There will be one combined heat and power engine (CHP) which will provide all of the heat and the majority of the power for the AD plant.
- 2.12. The proposed site infrastructure comprises:
- Access road
  - Weighbridge
  - 4 x silage clamps (total 12,000 tonnes capacity)
  - Solid feed hopper (155m<sup>3</sup> capacity)
  - Ekogea feedstock micronisation system
  - Buffer tank (610m<sup>3</sup>)
  - 2 x digesters (3,325m<sup>3</sup> and 4,619m<sup>3</sup> capacity)
  - Digestate storage tank (3,325m<sup>3</sup>)
  - Screw press separator (in place as contingency)
  - Digestate off-take point
  - Ekogea digestate thickening system comprising:
    - Polymer dosing unit
    - 2 x concentrators
    - Grey water storage tank (50m<sup>3</sup>)
  - Ekogea grey water polishing plant
  - Polished water storage tank (50m<sup>3</sup>)

- Biogas treatment comprising:
  - Chiller
  - Ammonia scrubber
  - Carbon filter
  - Compressors
- Gas upgrade unit (Pentair)
- Propane gas storage
- Odourant storage
- Grid entry unit (Thyson Technology)
- 500kWe combined heat and power engine (2G Avus 500 plus);
- Dual fuel emergency flare
- Emergency diesel generator
- Transformer
- Substation
- LV board
- Power to heat unit
- Heat exchanger unit
- Surface water infiltration pond
- Underground leachate tank
- Dirty water lagoon (1,140m<sup>3</sup>)
- Technical area between the 3 main tanks
- Site office and welfare facilities; and
- Staff car parking.

2.13. The proposed site layout is shown on Figure 5 (Proposed Site Layout).

### 3. Key Sensitivities

- 3.1. There are a number of sensitive receptors within close proximity to the site by virtue of the fact that the land and buildings at Lower Drayton Farm have been used for diversification and there are a number of businesses located there. Within 200m of the site there is a bed and breakfast, play barn, picnic area and outdoor animal area.
- 3.2. Lower Drayton Farm itself is occupied by the farmer who has an interest in the AD plant. Therefore this property is not deemed to be a sensitive receptor in terms of amenity impacts but has been considered in relation to the potential for emissions to air to impact upon human health.
- 3.3. The site is situated upon a Secondary A superficial aquifer and a Secondary B bedrock aquifer. Groundwater vulnerability is classified as medium to high. However, the site is not within a Groundwater Source Protection Zone or within a Drinking Water Protected Area or Safeguard Zone.
- 3.4. A small tributary of the River Penk runs in a northerly direction approximately 55 metres from the eastern site boundary.
- 3.5. Full details of Environmental Sensitivities can be found in Section 4 of the EMS Manual (**BCNE EMS Man 001**).

## 4. Management

- 4.1. The site will be operated by BCNE. There will be a Plant Manager who is responsible for the day to day operation of the AD plant and who will also act as the Technically Competent Manager. The Plant Manager is supported by the Plant Supervisor and Plant Operators. Roles and responsibilities are detailed in Section 10 of the EMS Manual (**BCNE EMS Man 001**).
- 4.2. There is a contract in place with Preston Contractors to supply all of the feedstocks and off-take of all digestate produced to be applied to land for agricultural benefit.
- 4.3. The EMS Manual (**BCNE EMS Man 001**) forms part of the permit application and has been developed by ETL in conjunction with BCNE. The management system documents to which the EMS Manual refers including policies and procedures are being developed by BCNE with the exception of the Odour Management Plan and the Accident Management Plan which have been developed by ETL. A Noise Management Plan has been developed by Inacoustic noise consultants.

## 5. Control of Emissions to Land and Water

- 5.1. The buffer tank, two digesters and the digestate storage tank are all monolithic poured reinforced concrete tanks made by Wolf Systems. All hazardous substances including oil, diesel and chemicals will be stored appropriately and within the secondary containment system. Further detail can be found in Section 6.1 of the EMS Manual (**BCNE EMS Man 001**).
- 5.2. The dirty water lagoon (capacity of 1,140m<sup>3</sup>) will be used as buffer storage of dirty water. It is a lined with 2mm HDPE. The level of the lagoon will be checked on a daily basis and a freeboard of 750mm maintained at all times. Dirty water will be used within the process or if in excess of requirements will be tankered off-site for application to land. The condition of the lagoon will be checked as part of the daily inspection and a full inspection will be carried out when it is empty and any repairs made as required.
- 5.3. Plandescil Consulting Engineers were contracted to design the site drainage and secondary containment in accordance with the relevant guidance; SSAFO and CIRIA C736. The reports that support their design namely the Drainage Design Report and the Containment Bund Design Report are Appendix C and D of this report respectively. The key aspects of the design are summarised below.
- 5.4. The silage clamps have been designed in accordance with the SSAFO regulations. They have concrete panel walls and asphalt surfacing designed for longevity. There are eight silage effluent sumps which drain to a 22,000l Kingspan Silage/Leachate Effluent Tank. Any effluent is pumped to the dirty water lagoon for storage prior to being used within the AD process.
- 5.5. The containment capacity is designed in accordance with CIRIA C736, with the calculations demonstrating 110% of the largest tank volume to be a greater volume than 25% of the combined volume. The proposed footprint of the containment area allowed for the walls to be constructed to a minimum height of 1.6m, which included 250mm freeboard capacity as per CIRIA C736 requirements.

- 5.6. All pipes, ducts and cables are fixed on cable trays and stanchions positioned above the concrete containment, so as to not penetrate the containment floor or walls.
- 5.7. The Drainage Process Flow Diagram is Appendix E. The Proposed Drainage Layout is Figure 6.
- 5.8. The digestate off-take, silage clamps, the area around the solids feeder, and the apron between them, are all designated as dirty and any run-off from these areas flows to the below ground 22,000l underground leachate tank. From there dirty water is pumped into the dirty water lagoon for storage prior to use within the AD process.
- 5.9. The rest of the site is designated as clean, and provided it has been tested to be clean, drains to the infiltration pond via a full retention fuel separator. If the containment sump water is tested as 'clean', (via visual and olfactory checks), then the liquid will be pumped over the containment wall into the surface water system to the west of the site, out-falling to the 365m<sup>3</sup> infiltration pond located to the south of the site. If tested as 'dirty', the water will either be pumped to the pre-storage (buffer) tank within the containment bund to be used within the process or to the dirty water lagoon located to the east of the site. All options involve manually operated pumped pipework.
- 5.10. Plandescil have proposed a maintenance regime for the drainage and containment infrastructure which is detailed in Section 6.0 of the Drainage Design Report (Appendix C). This will be adopted by BCNE and form part of the site environmental management system.
- 5.11. Condensate is collected in a condensate pit and then pumped to the digestate storage tank.
- 5.12. Up to 23m<sup>3</sup>/day of polished water from the Ekogea H2E polishing plant, that is surplus to the AD plant requirements, will be released to the infiltration pond via separate pipework and an inline quality monitoring unit to the infiltration pond.
- 5.13. In order to assess the potential impacts of the discharge to ground of the polished water TerraConsult Limited were commissioned to produce an Effluent Infiltration Assessment (Appendix F). The assessment included a desktop study and concluded that the infiltrate will enter a shallow, thin groundwater body which is in hydraulic continuity with the River Penk.
- 5.14. The biochemical oxygen demand of the polished water is expected to be low whilst other determinants which could act as potential pollutants if released to a waterbody would either be treated by the process or accumulate within the digestate and then usefully applied to land as nutrients for crops. The infiltration assessment concluded that a load of 50mg/l ammoniacal nitrogen discharged directly to surface water or a discharge of 636mg/l to soakaway would cause no discernible change in water chemistry i.e. an insignificant discharge load. Therefore as a very conservative approach a discharge consent limit of 50mg/l ammoniacal nitrogen has been proposed.
- 5.15. The polished grey water will be tested using a continuous, online dissolved ammonia monitor as it is discharged from the H2E plant. The detection range of the monitor is proposed to be 0 – 20mg/l to allow the monitor to act as a process optimisation tool so that corrective actions can be taken if there is an increasing trend in ammoniacal nitrogen well before any consented limit is reached. The technology provider, Ekogea have confirmed that these levels can be achieved by the polishing plant.

## 6. Control of Emissions to Air

- 6.1. The emission points to air 1-12 inclusive are shown on Figure 3 Emission Point Plan.
- 6.2. The control of emissions from the CHP stack (emission point 7) is primarily through planned preventative maintenance and inspection of the engine which is carried out by a specialist third party contractor (2G Energy AG).
- 6.3. The emissions from the flare (emission point 9) and the pressure release valves (PRVs) (emission points 1-4) will be controlled through process monitoring and management of biogas production. Alteration of AD plant feeding regime varies biogas production and load to the CHP and upgrade plant will be varied. Matching production to use requirement correctly ensures that the production of excess biogas and hence emissions of raw biogas through the PRVs and use of the flare is minimised. The PRVs will operate at 3.5mbar (relief) and -1.0mbar (vacuum). The flare will automatically operate if the pressure in the gas storage domes reaches 3.0mbar. Therefore emissions of raw biogas will be minimised. Control of gas pressures is described in detail in the BAT Assessment which supports this application (BAT 8, BAT 15 and Indicative BAT requirements for biogas treatment (AD TGN)).
- 6.4. The flare is a BAT compliant, high temperature, ground enclosed flare.
- 6.5. The Air Quality Assessment (ETL437/AQA/V1.0/Lower Drayton) which accompanies this application provides a full assessment of potential impacts of emissions to air from the proposed operation upon nearby human and ecological receptors.

## 7. Control of Amenity Impacts

- 7.1. As previously noted, the Environmental Risk Assessment (Appendix A of the EMS Manual **(BCNE EMS Man 001)**) is based upon the generic risk assessment for SR2012 No.9. There are no perceived additional amenity impacts associated with the Ekogea plant and proposed discharge to ground of polished water. However the potential for odour, noise and bioaerosol impacts from the Ekogea plant have been considered as part of these individual assessments.
- 7.2. The primary control of odour is at source as silage clamps will be covered and only exposed for removal of feedstocks. Manure will be transported to site via trailer as and when required on a just in time basis. Manure will be stored within the permitted area within the silage clamp and loaded to the feed hopper directly. Manures will be covered with silage within the feed hopper to reduce odour potential from this source.
- 7.3. In order to minimise emissions from the Ekogea plant and associated storage tanks, namely hydrogen sulphide, the following vents will be fitted with filters comprising iron pellets and active carbon:
- 1 No. on the Combined vent for polishing plant, grey water and clean water storage tanks
  - 2 No. on the Concentrators
  - 1 No. on the Micronisation plant
- 7.4. In addition, the whole Ekogea system is operated under negative pressure.
- 7.5. An Odour Management Plan has been developed by ETL as part of the permit application for use as part of the management system once the site is operational.
- 7.6. A Site Specific Bioaerosol Risk Assessment has been undertaken by Redmore Environmental (Appendix G). Their report concludes: *"The results of the assessment indicated residual risk from all sources was determined as low or very low. As such, potential impacts as a result of bioaerosol emissions from the proposed facility are not considered to represent a constraint to the proposals."*
- 7.7. Pre-application advice from the Environment Agency confirmed the requirements for a Noise Impact Assessment to form part of the permit variation application. A noise assessment for the proposed site was carried out by Inacoustic noise consultants at the planning stage.<sup>1</sup> The assessment indicated that sound emissions associated with the proposed development are likely to have a low impact at the nearest receptors. Inacoustic noise consultants have updated this report to reflect the updated site layout and proposed activities. The resulting Technical Noise Assessment forms part the permit application.
- 7.8. Whilst not restricted under the planning consent, the proposed operating hours are 06:00 to 18:00, Monday to Sunday inclusive. Appropriate noise mitigation measures will be employed were required in accordance with specialist advice.

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<sup>1</sup> Noise Assessment for Planning Application, Inacoustic, 13<sup>th</sup> April 2016

- 7.9. In accordance with the Environmental Risk Assessment (Appendix A of the EMS Manual (**BCNE EMS Man 001**)), there are no other significant amenity hazards.

## **Figures**

**Figure 1: Site Location Plan – ETL437/SPC0107 /EPR01**

**Figure 2: Permit Boundary Plan - ETL437/SPC0107 /EPR02**

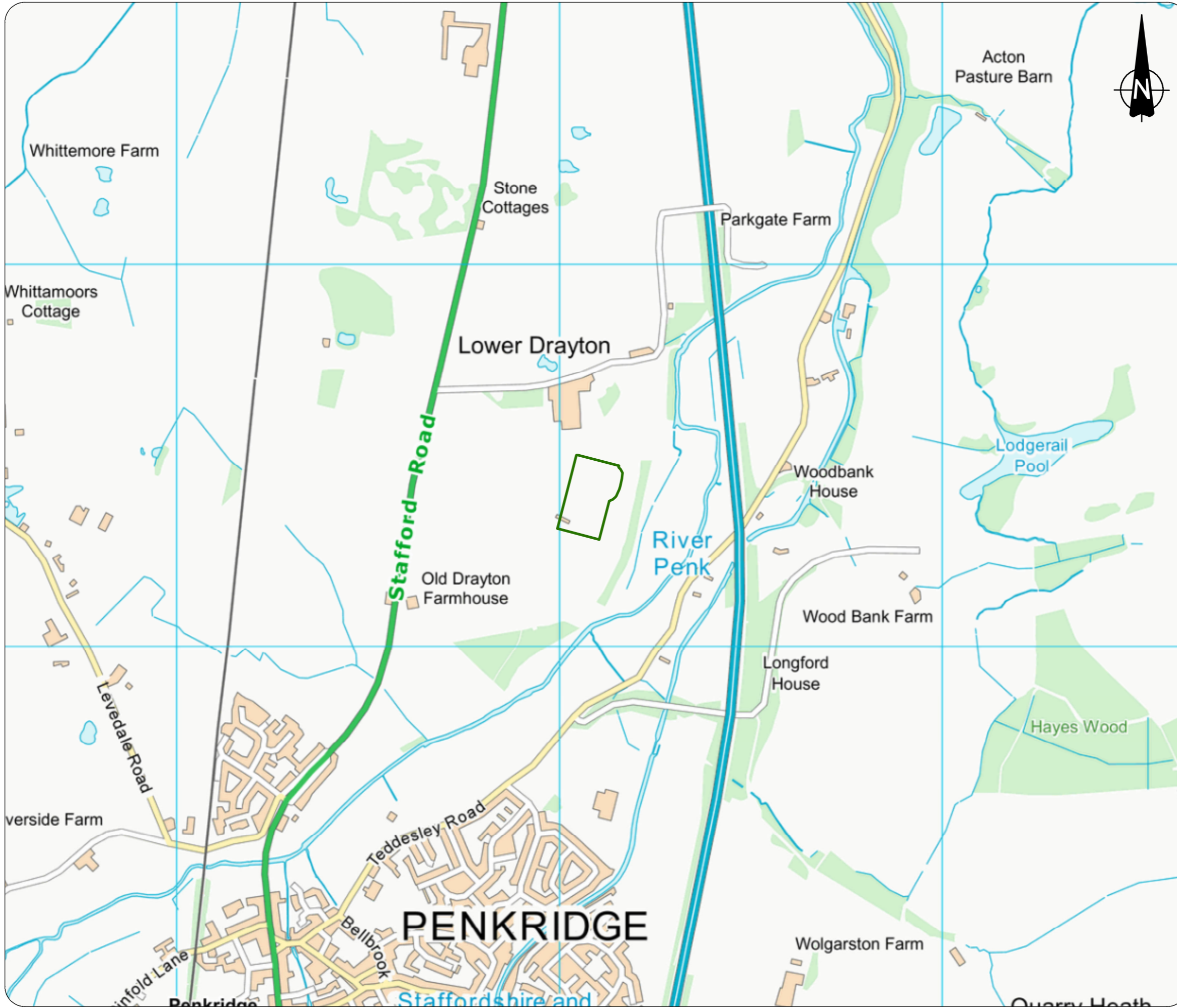
**Figure 3: Emission Point Plan – ETL437/SPC0107/EPR03**

**Figure 4: Human Receptor Plan – ETL437/SPC0107/EPR04**

**Figure 5: Proposed Site Layout – Plandescil, 25998 - 005 Rev F**

**Figure 6: Proposed Drainage Layout – Plandescil 25998 - 007 Rev F**





REVISIONS					
REV	DATE	DESCRIPTION	DWN	CHK	APP
-	16/07 2020	First Issue	JJ	MF	MF

**LEGEND**

Permitted boundary

Scale at A3: 1:10,000

**Client**  
Lower Drayton Biogas Projectco Limited

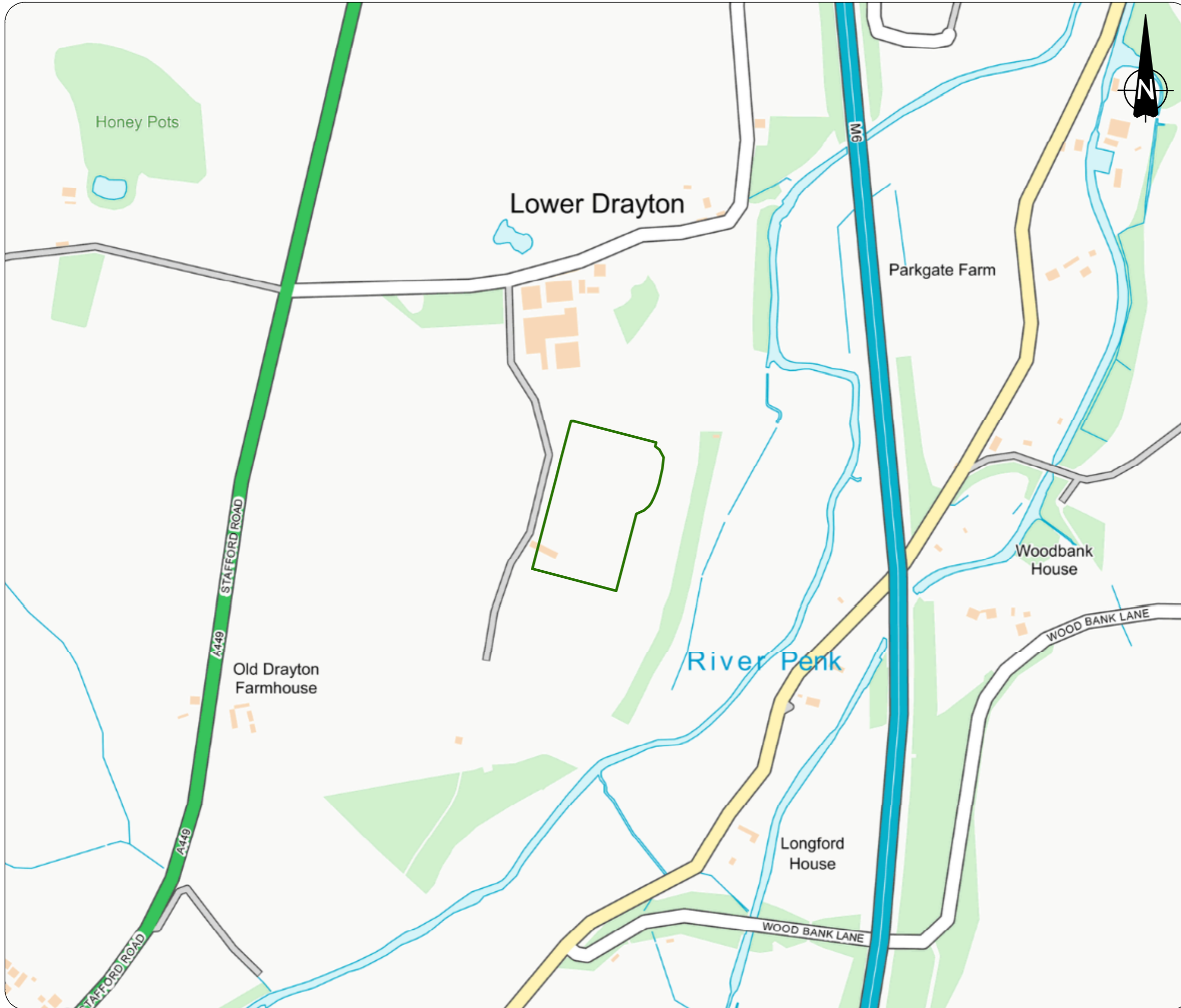
**Project**  
Lower Drayton Farm AD  
New Bespoke Installation Application

**Title**  
Site Location Plan

**Earthcare**  
TECHNICAL


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Drawn JJ	Checked MF	Approved MF	Revision
Date July 2020	Scale 1:10,000	Sheet Size A3	
Drawing Number ETL437/SPC107/EPR01		File Reference ELT-00437	



REVISIONS					
REV	DATE	DESCRIPTION	DWN	CHK	APP
-	16/07 2020	First Issue	JJ	MF	MF

**LEGEND**

 Permitted boundary

0 100 200 300 m  
Scale at A3: 1:5,000

Client  
Lower Drayton Biogas Projectco Limited

Project  
Lower Drayton Farm AD  
New Bespoke Installation Application

Title  
Permit Boundary Plan

**Earthcare**  
TECHNICAL

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REVISIONS					
REV	DATE	DESCRIPTION	DWN	CHK	APP
-	16/07 2020	First Issue	JJ	MF	MF

LEGEND	
	Permitted boundary
	Emergency pressure relief valve on fermenter 1
	Emergency pressure relief valve on fermenter 2
	Emergency pressure relief valve on digestate storage tank
	Emergency pressure relief valve on buffer tank
	CO <sub>2</sub> vent at gas upgrading unit
	Emergency pressure relief valve on gas upgrading unit
	Exhaust stack CHP
	Exhaust stack emergency generator
	Emergency gas flare
	Filter on vent from polishing plant
	Filter on vent from concentrators
	Filter on vent from micronisation plant
	Polished water and surface water discharge to infiltration pond

0 m 50 m  
Scale 1:1000 @ A3

Client  
Lower Drayton Biogas Projectco Limited

Project  
Lower Drayton Farm AD  
New Bespoke Installation Application

Title  
Emission Point Plan

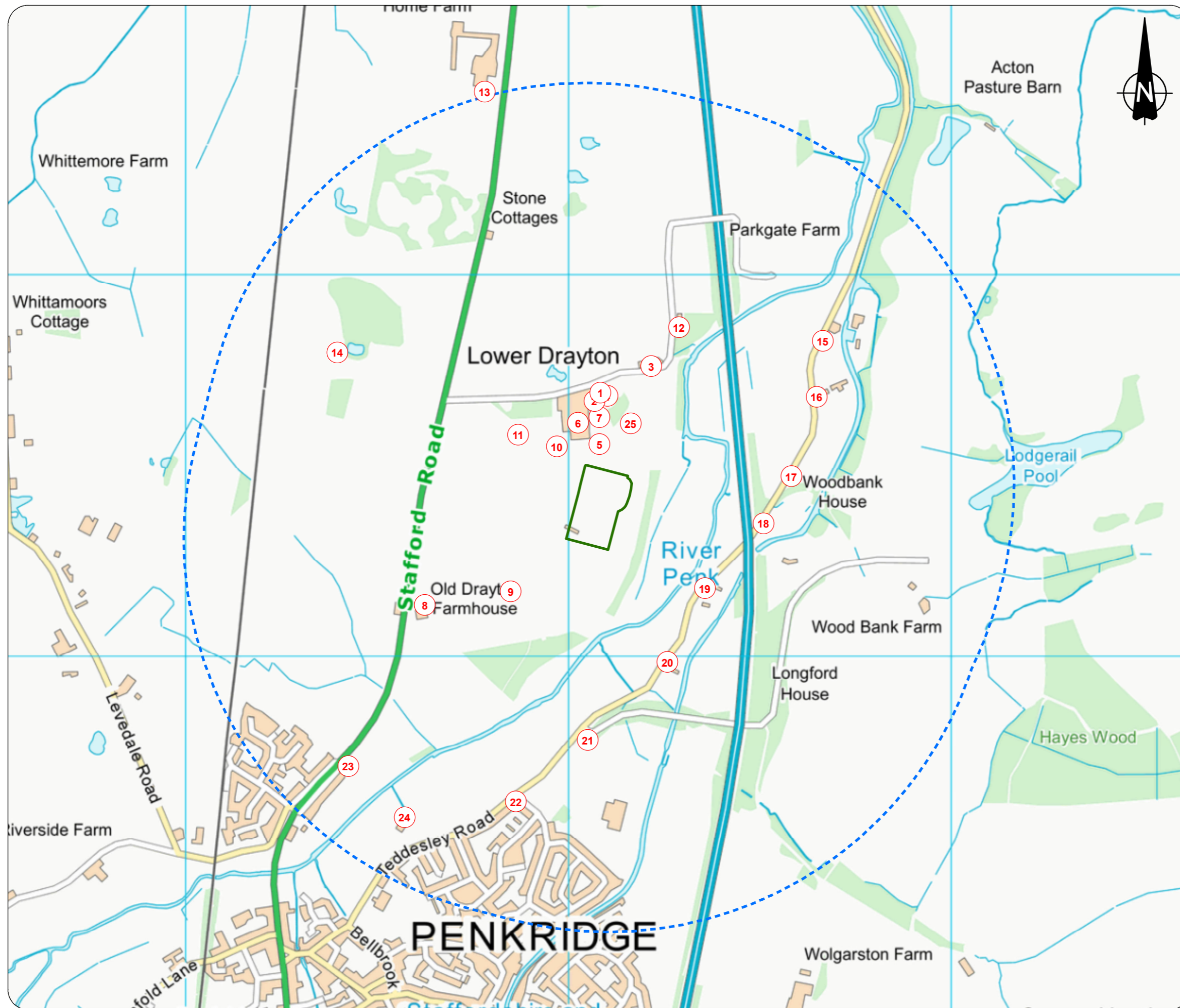
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Drawing Number ETL437/SPC107/EPR03		Revision	

Based on drawing '25998 - 005E, 006E, 007E, 008B - Proposed Site Layout (Email Issue 26.06.20) - Rev A' supplied by Plandescil Ltd.





REVISIONS					
REV	DATE	DESCRIPTION	DWN	CHK	APP
-	17/07 2020	First Issue	JJ	MF	MF

**LEGEND**

- Permitted boundary
- Permitted boundary 1km buffer
- Receptor location

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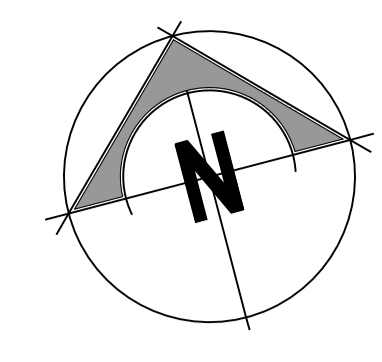
Client Lower Drayton Biogas Projectco Limited
Project Bespoke Environmental Permit Application
Title Receptor Location Plan (1km Buffer)

**Earthcare**  
TECHNICAL

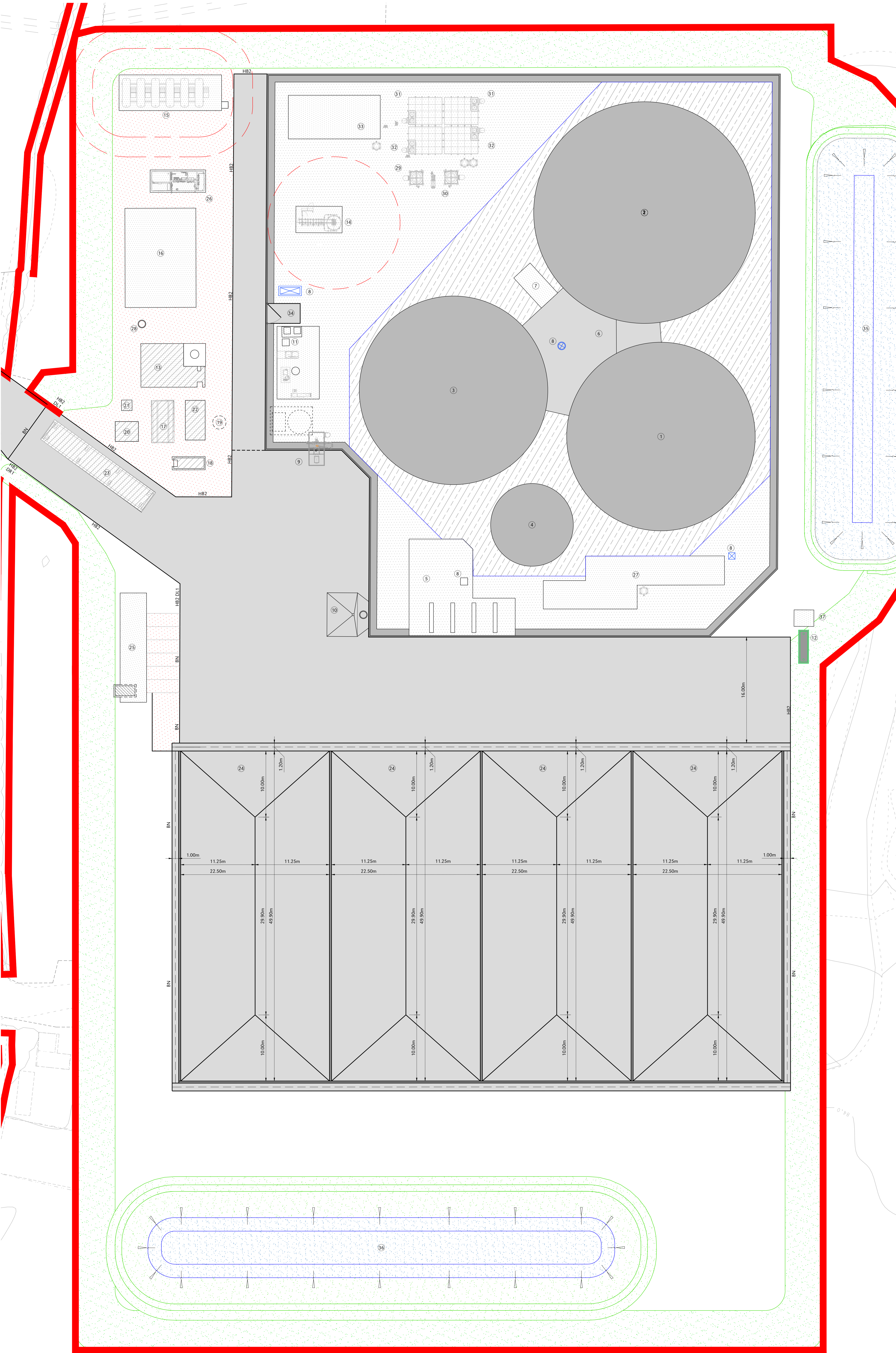
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  - This drawing is to be read in conjunction with all other relevant documents relating to the project.
  - All setting out to be coordinated by the Contractor and to be checked onsite prior to construction.
  - Refer to BioConstruct Drg B202002/A01 - Plant Layout



- Proposed Plant Key**
- 1 Fermenter Tank (28.00mØ)
  - 2 Fermenter Tank (33.00mØ)
  - 3 Digestate Storage Tank (28.00mØ)
  - 4 Buffer Tank (12.00mØ)
  - 5 Feeding System
  - 6 Technical Building
  - 7 Switchboard Room
  - 8 Containment Sump Area
  - 9 Separation
  - 10 Filling Station & Extraction Station
  - 11 Gas Cooling/Chiller & Gas Drying
  - 12 Leachate Tank
  - 13 CHP
  - 14 Flare (10.00m exclusion zone)
  - 15 Propane Tanks
  - 16 Biogas Upgrading Unit
  - 17 LV Switchboard
  - 18 Emergency Generator
  - 19 Diesel Tank (Location TBC by Client)
  - 20 Substation
  - 21 Transformer
  - 22 Power to Heat Module
  - 23 Weighbridge
  - 24 Silage Clamps (4No. 22.5m x 49.9m)
  - 25 Site Office
  - 26 Grid Entry Unit
  - 27 Ekogea
  - 28 Condensate Pit
  - 29 Filters & Concentrators
  - 30 IBC Equipment & Mixing Tanks
  - 31 SW & Clean Water Storage Tank (1No. Proposed & 1No. Future Expansion)
  - 32 Grey Water Storage Tank (1No. Proposed & 1No. Future Expansion)
  - 33 Polishing Plant
  - 34 Bund Ramp
  - 35 Dirty Water Lagoon (1140m³ Capacity)
  - 36 Infiltration Lagoon (0.68m Max. W.L.)
  - 37 3.0m x 2.5m Pump Slab

- GENERAL KEY:**
- Site Boundary
  - Proposed Concrete
  - As Built Slab
  - Proposed D.o.T Type 1
  - Proposed Asphalt Surfacing
  - 200mm thick Concrete Slab with A393 mesh reinforcement

**APPROVAL & COMMENT**

Rev	Date	Rev By	Chkd	Description
F	17.07.20	AF	OAJ	Amended to Suit BioConstruct Layout
E	26.06.20	AF	OAJ	Amended to Suit BioConstruct Layout
D	16.06.20	AF	OAJ	Minor Amendments
C	04.05.20	CMH	AF	Clamp access track removed
B	20.05.20	CMH	AF	Bund amended following comments
A	14.05.20	CMH	AF	Amendments following client comments
O	07.05.20	-	AF	First Issue

**plandescil**  
consulting engineers

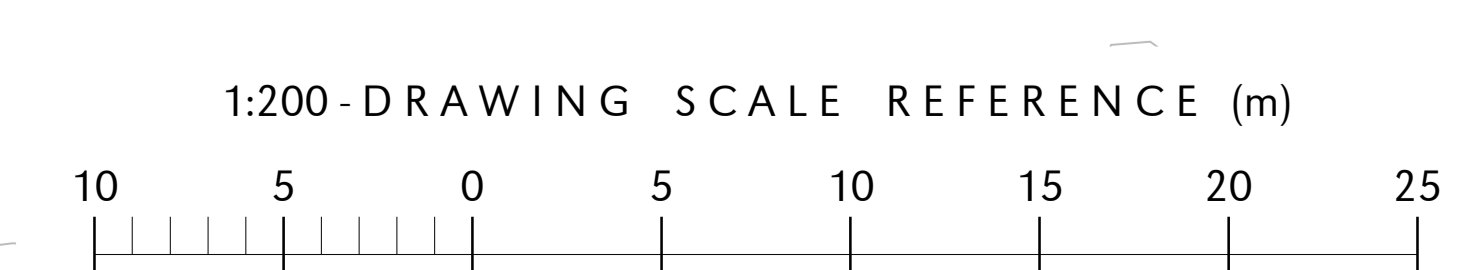
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Client:  
**O'Brien Moran & Co Ltd.**

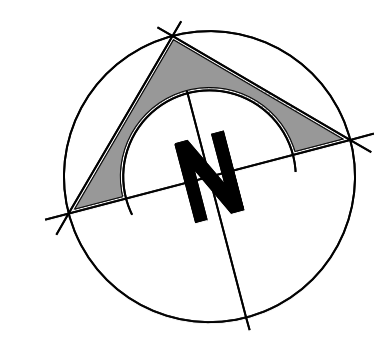
Project:  
**Proposed AD Plant  
Lower Drayton Farm  
Penkridge, Stafford, ST195RE**

Drawing Title:  
**Proposed Site Layout**

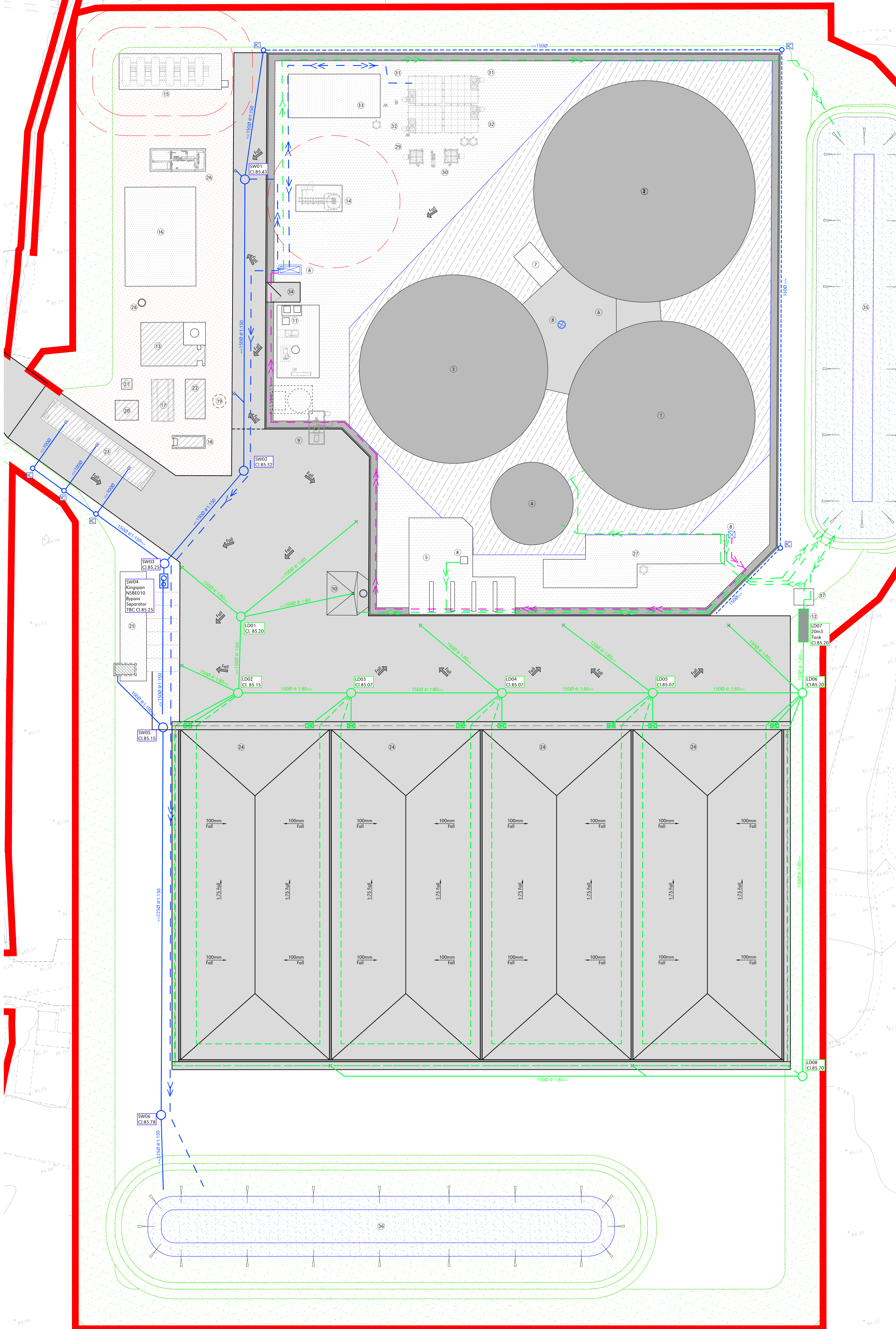


Scale	U.N.O.	Date	Drawn By
1:200 (A0)		April 2020	CMH
Drawing No.	25998/005		Rev
			F





- GENERAL NOTES:**
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  - Do not scale from this drawing, if dimensions are not clear ask.
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  - All setting out to be coordinated by the Contractor and to be checked onsite prior to construction.



- Proposed Plant Key**
- Fermenter Tank (28.00mØ)
  - Fermenter Tank (33.00mØ)
  - Digestate Storage Tank (28.00mØ)
  - Buffer Tank (12.00mØ)
  - Feeding System
  - Technical Building
  - Switchboard Room
  - Containment Sump Area
  - Separation
  - Filling Station & Extraction Station
  - Gas Cooling/Chiller & Gas Drying
  - Leachate Tank
  - CHP
  - Flare (10.00m exclusion zone)
  - Propane Tanks
  - Biogas Upgrading Unit
  - LV Switchboard
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  - Diesel Tank (Location TBC by Client)
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  - Transformer
  - Power to Heat Module
  - Weightbridge
  - Silage Clamps (4No. 22.5m x 49.9m)
  - Site Office
  - Grid Entry Unit
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  - Condensate Pit
  - Filters & Concentrators
  - IBC Equipment & Mixing Tanks
  - SW & Clean Water Storage Tank (1No. Proposed & 1No. Future Expansion)
  - Grey Water Storage Tank (1No. Proposed & 1No. Future Expansion)
  - Polishing Plant
  - Bund Ramp
  - Dirty Water Lagoon (1140m³ Capacity)
  - Infiltration Lagoon (0.68m Max. W.L)
  - 3.0m x 2.5m Pump Slab

- PROPOSED DRAINAGE KEY:**
- Leachate Drainage Pumped Pipe (LD)
  - Leachate Drainage (LD)
  - Leachate Gully (LD)
  - Leachate Manhole (LD)
  - Proposed Leachate Sump (LD)
  - Surface Water Drainage (SW)
  - Surface Water Perforated Pipe (SW)
  - Surface Water Pumped Pipe (SW)
  - Surface Water Manhole (SW)
  - Surface Water Gully (SW)
  - Inspection Chamber (SW)
  - Pumped Containment Water Pipe

- GENERAL KEY:**
- Site Boundary
  - Proposed Concrete
  - As Built Slab
  - Proposed D.o.T Type 1
  - Proposed Asphalt Surfacing
  - 200mm thk Concrete Slab with A393 mesh reinforcement

**APPROVAL & COMMENT**

Rev	Date	Rev By	Chkd	Description
F	17.07.20	AF	OAJ	Minor Amendments to Drainage Levels
E	26.06.20	AF	OAJ	Amended to Suit BioConstruct Layout
D	16.06.20	AF	OAJ	Minor amendments to clamp drainage
C	04.05.20	CMH	AF	Amendments to drainage levels
B	20.05.20	CMH	AF	Revised amended following client comments
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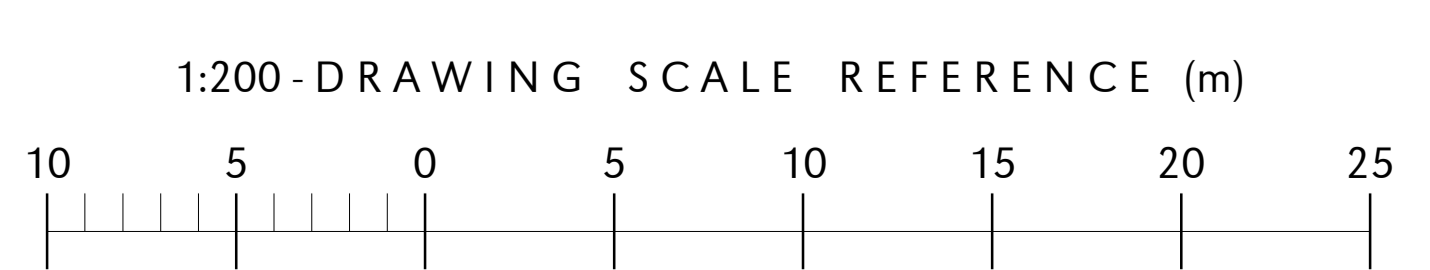
Connaught Road, Attleborough, Norfolk, NR17 2BW  
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civil / structural / environmental / surveying

Client:  
**O'Brien Moran & Co Ltd.**

Project:  
**Proposed AD Plant  
Lower Drayton Farm  
Penkridge, Stafford, ST195RE**

Drawing Title:  
**Proposed Drainage Layout**



Scale	U.N.O.	Date	Drawn By
1:200 (A0)		May 2020	CMH
Drawing No.	25998/007		Rev F

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## **Appendix A – Schedule 1 Listed Activity and Directly Associated Activities**

## Schedule 1 Listed Activities and Directly Associated Activities

Name of DAA	Description of DAA (all serve S5.4 Part A(1)(b)(i))
Storage of waste pending recovery	Storage of feedstocks prior to treatment in the anaerobic digestion process
Raw material storage	Storage of raw materials e.g. sulphuric acid, coagulants and flocculants for digestate concentration process
Physical treatment for the purpose of recycling	Biogas cleaning Separation of digestate (non-routine)
Steam and electrical power supply	Combustion of biogas in a combined heat and power engine with a thermal input power of 1.34mW. Use of heat and electricity in AD process. Export of excess electricity to National Grid.
Emergency flare operation	Use of emergency flare during periods of extended breakdown or maintenance
Gas upgrading	Upgrading of biogas to biomethane (including removal of moisture and other substances such as ammonia, carbon dioxide, hydrogen sulphide and volatile organic compounds) for injection into National Grid.
Gas storage	Storage of biogas above the two fermenters, digestate storage and buffer tanks.
Digestate thickening	Treatment of whole digestate with polymer and concentration in Ekogea concentrator units to produce thickened digestate and grey water
Grey water treatment	Treatment of grey water in Ekogea 'H2E' polishing plant, a single stage anaerobic waste water treatment plant. to produce polished water
Feedstock micronisation	Pre-treatment of feedstocks in the Ekogea micronisation plant which uses polished water from grey water treatment and a BioComplex
Digestate separation	Separation of digestate in a screw press separator (non-routine)
Digestate storage	Storage of thickened digestate and / or whole digestate in storage tank and fibre in concrete storage bay (non-routine)

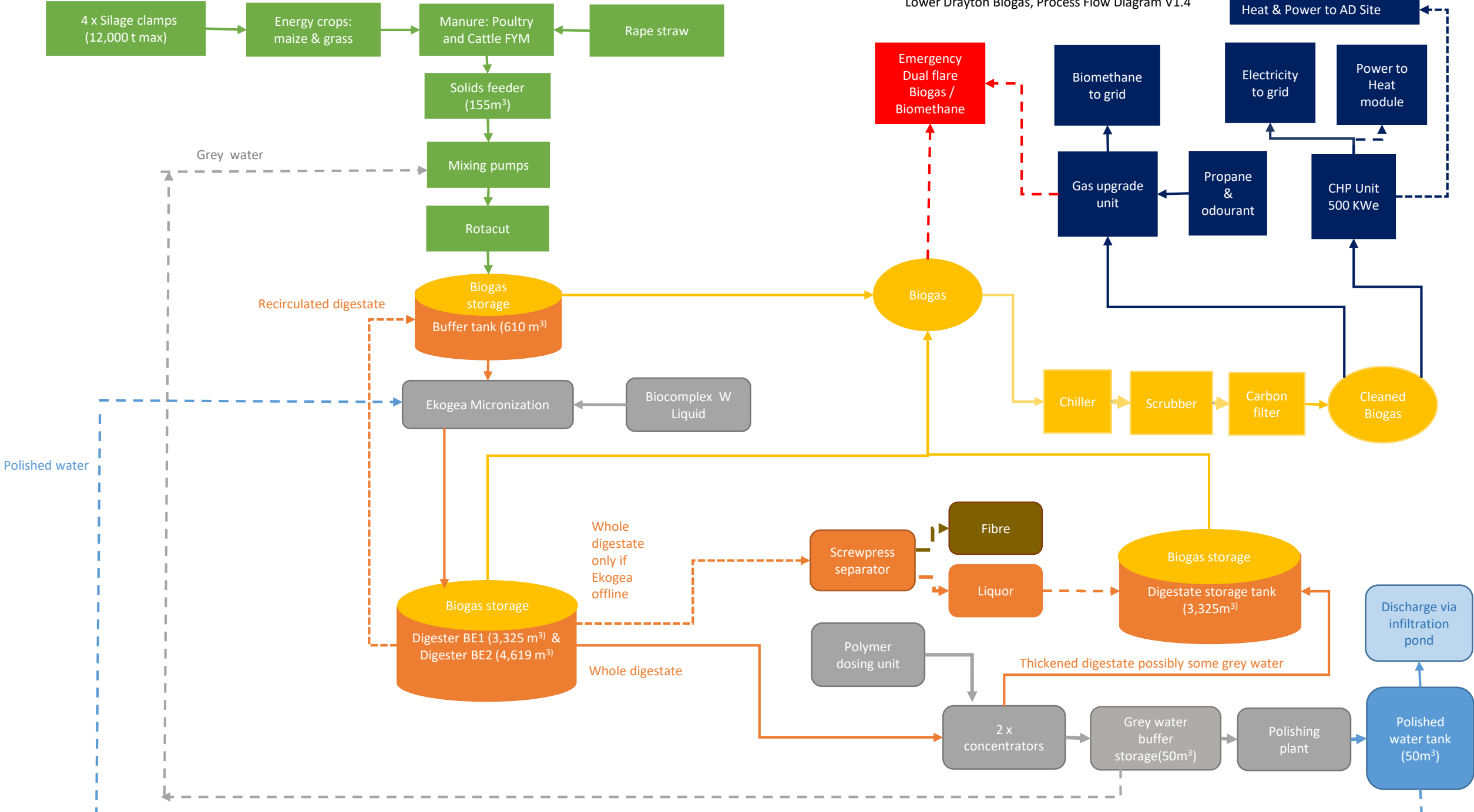


### Schedule 1 Listed Activities and Directly Associated Activities

Surface water collection and storage	Collection of water from sealed drainage areas, treatment in oil separator and storage in infiltration pond
Discharge of polished water	Discharge of excess polished water (and clean surface water) to ground via the infiltration pond and in accordance with specified quality limits
Dirty water collection and storage	Dirty water collection from dirty areas of site, storage in dirty water lagoon and reuse in the process

## **Appendix B – Process Flow Diagram**

Lower Drayton Biogas, Process Flow Diagram V1.4



## **Appendix C – Drainage Design Report**

**Design Strategy and Details of  
Proposed Site Drainage Scheme**

**Job No. 25998**

**Proposed Anaerobic Digestion Plant  
Lower Drayton Farm, Penkridge  
Stafford, ST19 5RE**

**Client: O'Brien Moran & Co Ltd**

**Prepared By: Alex Fitzgerald**

**July 2020**

**Revision B**



<b>CONTENTS.....</b>	<b>3</b>
<b>1.0 BACKGROUND INFORMATION.....</b>	<b>4</b>
<b>2.0 ANAEROBIC DIGESTION SITE LAYOUT, PROCESS &amp; CONCEPT.....</b>	<b>4-5</b>
<b>3.0 DESIGN &amp; METHODOLOGY OF DRAINAGE SYSTEM.....</b>	<b>5-7</b>
<b>4.0 SILAGE CLAMP OVERVIEW.....</b>	<b>7-8</b>
<b>5.0 REVIEW PERIODS DURING CONSTRUCTION.....</b>	<b>9</b>
<b>6.0 MAINTENANCE REGIME.....</b>	<b>9-10</b>
<b>7.0 APPENDIX DETAILS AND DRAWINGS EXPLAINED.....</b>	<b>10-11</b>

**DRAWINGS, CALCULATIONS AND SPECIFICATIONS APPENDIX**  
(Listed in 6.0 APPENDIX DETAILS AND DRAWINGS)

## **1.0 BACKGROUND INFORMATION**

- 1.1 Plandescil Ltd have been commissioned to provide the construction specification and details for the civil engineering elements associated with the Anaerobic Digestion Plant at Lower Drayton Farm in Penkridge, Stafford. This appointment was received from the Civil Engineering Contractor, O'Brien Moran & Co Ltd, as well as the Process Provider, BioConstruct.
- 1.2 This report provides design rationale for the drainage philosophy at Lower Drayton Farm, along with requirements for operation and maintenance. The corresponding drainage design drawings, schedules and construction details accompany this report in the Appendix.

## **2.0 ANAEROBIC DIGESTION LAYOUT, PROCESS & CONCEPT**

- 2.1 O'Brien Moran & Co Ltd instructed Plandescil Ltd to undertake the civil engineering design of the secondary containment bund, silage clamps, hardstanding areas and site drainage for the proposed Anaerobic Digestion Facility located at Lower Drayton Farm, Stafford.
- 2.2 Anaerobic Digestion is the breaking down of organic material, causing the release of heat and the natural gases, carbon dioxide and methane. The aim of the Plant is to use the gas provided by the process, by cleaning the gas and injecting it into the national gas grid and/or using the heat to power combined heat and power unit where it is converted to electricity and fed into the national electricity grid.
- 2.3 This process creates both liquid and solid digestate by-product. The liquid is a stable nutrient rich liquid which can be used as fertiliser or as a soil conditioner. The solid dry digestate can be used in a similar way to manure and spread on fields.
- 2.4 The first stage of the process is the storage of freshly harvested input product (silage), which could be maize, sugar beet, and grass etc. The input product is transported to site typically during the harvest season, where it is unloaded into the 4No. designated silage clamps. The product is then arranged and compacted by farm machinery within the clamp to allow for the most economical use of the space.
- 2.5 Once the product has been delivered and compacted within the concrete wall silage clamps, they are then covered over to protect the ensiled material from moulding and heating, minimising energy wastage. The clamps have a three layer covering system which is anchored to the top of the concrete walls, prohibiting the intrusion of rainwater into the silage and ensuring odour is kept in and the silage remains in an ideal condition to release its energy when it is introduced into the process.
- 2.6 The covering system consists of a thin underlay film which lies tightly against the silage, the film prevents air from penetrating the silage. A secondary silage film is laid over the top to give extra protection to the silage. The films are then smoothed down and secured in place along the edge of the clamp with gravel bags.



- 2.7 The final layer is the silage clamp protection netting. This exposed layer protects the film and silage from any damage. The netting is weighted down using gravel bags to create a secure seal on the clamp.
- 2.8 Regular loads of stored silage are tipped into a nearby feedhopper. The silage is then moved via a screw auger and pumped pipework into the primary fermentation tank where the gas is released within the process; carried out in specifically calculated and monitored doses.
- 2.9 The silage continues to be broken down within the tanks where heat, biogas, solid and liquid digestate are produced from the process.

### **3.0 DESIGN & METHODOLOGY OF DRAINAGE SYSTEM**

- 3.1 The drainage has been designed in accordance with best practice guidelines, using the experience Plandescil has gained from working within the Anaerobic Digestion Industry for more than 10 years.
- 3.2 The aim of the drainage scheme proposed for the Anaerobic Digestion Plant is to remove all clean and dirty water from the sites hardstanding areas as quick as possible; achieved through segregated drainage systems. A dirty water (leachate) system has been designed for the process material storage areas on the site, where vehicle movements are prevalent and surface water contamination is possible. Meanwhile, a separate clean system has been proposed for areas of the site where surface water is to be free from potential contamination.
- 3.3 The leachate water system is comprised of a combination of gullies, sumps and manholes to collect the potentially dirty water run-off from the silage clamps and the dry digestate storage area. These areas are presumed to be dirty water and discharge to the 22,000l below ground leachate tank. The leachate system has been designed without the requirement for valves and remains open all year round. This design consideration mitigates the potential for contamination of surface water through potential errors during the plants operation.
- 3.4 The internal silage clamps floor surfacing levels have been designed to ensure water run-off navigates towards the 1.20m wide surface formed drainage V-formed channel at the north and does not pond on the surface or collect near the wall units. 8No. 1.35mØ sumps are to be installed within the north V-formed channel to collect the leachate water run-off.
- 3.5 A 1.0m wide perimeter asphalt-formed dish channel is proposed to the rear of the L-shaped wall panels, capturing any potential leachate water from silage overspill during operation. Moreover, below ground filter drains have been designed around the entire wall system (internally and externally) to provide a rigorous leak detection system. The perforated filter drains are installed above a sealed 1mm HDPE liner which provides greater environmental protection. The silage clamp construction arrangement is discussed further within 'Section 4.0 – Silage Clamp Overview' and detailed on Plandescil Ltd Drawing No. 25998/103 Rev A in the Appendix.

- 3.6** Installing a combined drainage system between the clamps and adjacent surface apron is justified by the vehicle movements in this area potentially tracking leachate water across the asphalt surface; additional leachate gullies capture dirty water run-off in the area north of the clamps. The system has been designed for the leachate water flow to constantly remain open to eradicate the requirement for valves.
- 3.7** The leachate tank has 2No. pumped outlet connections; one to the fermenter tank for usage within the anaerobic digestion process and another to the lined dirty water lagoon at the north-east of the site, for additional liquid storage if required.
- 3.8** To maximise robustness and longevity of the leachate system, all surface water manholes are to be fully coated internally with bitumen paint, preventing deterioration of the pre-cast concrete rings. Furthermore, UPVC foul water pipe has been specified for all gravity leachate pipework on the site to mitigate the potential for any future leakages at joint locations.
- 3.9** Where leachate contamination is not expected, the asphalt roads and hardstanding areas are to be drained in traditional methods via gully's and manholes. The clean water captured by this system outfalls to the infiltration pond at the south, first passing through a full retention fuel interceptor.
- 3.10** Half-battered kerbs are to be installed around the perimeter of all hardstanding areas to ensure water does not by-pass these proposed systems and the surface levels are designed to ensure the water flows towards the appropriate system.
- 3.11** Percolation tests were undertaken across the site by an external Engineering Consultancy (JNP Group) in accordance with BRE365, enabling a final  $V_p$  (percolation value) to be determined for the site. The  $V_p$  is calculated by recording the depth of water at recommended time intervals to identify the time taken for the water in the trial hole to drain from 75% full to 25% full. A recorded drained depth over a period divided by the time taken to do so provides the average time in seconds ( $V_p$ ) required for the water to drop 1mm. This test information was used to design an infiltration pond. The percolation values obtained from the onsite testing and used in the Micro Drainage calculations are provided within the Appendix to this document. The design is based on a 1-in-100-year event plus 40% for climate change.
- 3.12** A surface water perforated filter drain pipe is installed around the north and east external containment bund perimeters, linked by a series of inspection chambers and discharging to the clean water system for final discharge into the infiltration pond.
- 3.13** The site was assessed to deduce the most suitable and practical location for the proposed soakaway. The assessment conducted by the engineers and designers concluded that the most suitable location for the infiltration pond would be to the south of the site, as shown on Plandescil Ltd Drawing No. 25998/005 Rev E in the Appendix.

- 3.14** The surface water system has been designed with sufficient capacity to allow for the clean containment bund liquid to be pumped into the soakaway at a rate of 2l/sec, instead of fully discharging as per a normal event. This containment bund water first pumps to a manhole chamber at the north-west of the site and flows towards the infiltration pond at the south via gravity, passing through the full retention fuel interceptor before discharging.
- 3.15** The containment structure drainage and construction details of the bund are explained in a separate report prepared by Plandescil. The report confirms that any liquid within the containment bund cannot be discharged until it has been tested and is certified as clean to be released. This information is also summarised below for the reader's convenience.
- 3.16** As part of the operational management of the facility, any containment bund liquid captured within the drainage sumps will be routinely checked and tested prior to being discharged to one of the proposed locations shown on the proposed drainage layout 'Plandescil Ltd Drawing No. 25998/007 Revision E'. If the containment sump water is tested as 'clean', the liquid will be pumped over the containment wall into the surface water system to the west of the site, out-falling to the 365m<sup>3</sup> infiltration pond located to the south of the site. An additional volume of clean water will discharge to the south infiltration pond from the Ekogea system within the containment bund at a maximum rate of 23m<sup>3</sup>. The polished water will first be pumped to the primary containment bund sump before it is tested and discharged.
- 3.17** Should the containment bund sump liquid be tested as 'dirty', the water will be pumped to the 1,140m<sup>3</sup> lined dirty water lagoon located to the east of the site. If required, the dirty water lagoon liquid would be pumped back to the pre-storage (buffer) or fermenter tank within the containment bund, for use within the process. The 2No. smaller sump pits to the south of the containment bund are to be presumed dirty and therefore pumped to the dirty water lagoon. A pumped connection from the south-east sump to the primary sump have also been proposed to allow the option for this area to outfall to the clean system. All options involve manually operated pumped pipework.

#### **4.0 SILAGE CLAMP OVERVIEW**

- 4.1** The silage clamps at Lower Drayton Farm have been designed in accordance with the latest SSAFO regulations. There are four silage clamps, each measuring 22.5m width and 50.0m length. The clamp walls are constructed with interlocking precast concrete L-shaped panels to the sides and rear (east, west and south), whilst T-shaped panels are installed internally. The panels are manufactured by Bosch Beton (supplied by ARK Agriculture, formerly BOCK UK) and have been specifically designed for agriculture material storage such as silage.
- 4.2** The connections between the interlocking wall panels are sealed with approved leachate resistant sealant as specified by the wall supplier ARK Agriculture. The precast panels have been engineered to meet/exceed the silage clamp material loading requirements, in accordance with British Standards and SSAFO regulations.

The SSAFO compliance is further aided by a perimeter drain and monitoring chamber to ensure all dirty water run-off is captured in the leachate water drainage system. The silage clamp details are presented in the appendix.

- 4.3** The soil strata beneath the entire silage clamp floor area has received dynamic compaction stabilisation to a depth of 300mm by a specialist contractor (Independent Stabilisation Company Ltd); ensuring a minimum CBR value of 30% is achieved. The rigorous foundation arrangement proposed for the silage clamps wall panels are shown on Plandescil Ltd Drawing No. 25998/103 Rev A in the Appendix.
- 4.4** The clamp floor consists of asphalt surfacing with designed falls to the centre, preventing leachate water accumulating on the wall panels. The surface levels fall from the back (south) to the front (north), capturing all run-off into 8No. sump pits, situated within a 1200mm wide and 100mm deep V-formed asphalt surface channel. All collected leachate water outfalls to the below ground 22,000l Kingspan Silage/Leachate Effluent Tank through gravity pipes. From this location the leachate water is either pumped back into the process water tank, as discussed in 'Section 3.0 – Design & Methodology of Drainage System'.
- 4.5** Once the pre-cast walls and asphalt floor have been installed, the connection point between the two elements is then sealed with hot poured bitumen. The bottom 0.3m of the clamp walls are then painted with bitumen emulsion to create a water tight seal on this connection point.
- 4.6** Asphalt was the chosen surface for the silage clamps; this was based upon historic testing and detailed discussion with the Environment Agency. This complies with both CIRIA and SSAFO regulations. We have used the chosen specification of asphalt due to the higher binder content and hardstone (granite or similar) material instead of the traditional limestone fillers which react with leachate. If you were to use a traditional jointed concrete mix this would be susceptible to leakage via the joints, also the concrete will be worn away quicker with the potential leachates/acids on the concrete. Experience tells us this will only last for approximately 2 years before the aggregate is exposed within the concrete. Whereas the asphalt will require minimal maintenance for 10 years plus. Asphalt is a continuous lay and is therefore joint free, meaning the potential for leakages through the base/floor is highly unlikely. Furthermore, the designs adhere to the approved DEFRA clamp floor specifications.
- 4.7** Plandescil has been involved with the design of over 30 large silage clamps located across the United Kingdom and have engaged with the Environment Agency on numerous occasions to ensure the most rigorous design solutions are achieved. All silage clamps have resultantly been constructed with a similar design arrangement; installing pre-cast concrete wall panels, surfaced with asphalt (not concrete) and draining into sump pits within V-formed asphalt channels.

## 5.0 REVIEW PERIODS DURING CONSTRUCTION

5.1 The construction of the drainage will be reviewed at numerous stages throughout the construction phase. The Design Engineers, Plandescil, are responsible for visually inspecting the following elements of construction:

- CCTV survey post installation of the drainage prior to occupation.
- 1 year post completion of the site including a CCTV and defects survey.
- Every year post completion should the client request this as a CCTV and defect survey.

## 6.0 AD PLANT MAINTENANCE REGIME- GENERAL OVERVIEW

6.1 Lower Drayton Farm's Anaerobic Digestion Plant proposed maintenance regime consists of daily visual leak inspections within the bund and weekly inspections of the containment bund structure. The daily inspection will be carried out by the Client's site operative who will look for visual signs of leakage coming from the storage tanks or mechanical equipment located within the containment bund. If any tanks are found to be leaking, repair works will be undertaken by trained personnel immediately to prevent any contamination of surface water within the containment bund.

6.2 The weekly inspections will require the site operative to visually inspect the containment bund walls and floor for any signs of cracking within the concrete. If any cracks are found, remedial works will immediately be undertaken using Sikaflex resin injection 'Sikadur 52' to fill and seal the cracks. This process will be carried out by a trained operative or specialist.

6.3 Any liquid which falls within the containment bund will be drained and collected into a sump within the bund. A switch operated pump will be located within the sump which will drain any liquid into the process. Prior to the pump being engaged by the site operative a visual and odour inspection will be carried out to check for any contamination to the liquid.

6.4 If the captured sump water is determined to be clean, a pumped connection to the surface water system to the west at a rate of 2l/s and finally out-falling to the infiltration pond at the south. The drainage system has made an allowance for a pumped connection to the dirty water storage lagoon, so that if needed or determined to be dirty, the liquid could be pumped to the lagoon and then pumped back into the system as required.

6.5 The drainage system on site will be checked yearly. The site operators will check for sediment build up in manholes and pipes.

6.6 The drains will be jetted where required. Manholes will be sludge gulped and checked for any signs of wear and tear, the joints will be resealed and the internal chambers painted with bitumen paint if required.

6.7 The silage clamps will be inspected when empty, the surface should be pressure washed clean and inspected for damage and repaired if required.

The walls should be sheeted with plastic as per the manufacturer's guidance to aid in the life expectancy of the walls. The walls should also be pressure washed clean before refilling. If the bitumen paint to the lower portion of the walls has been worn away this should be reapplied for sheeting, approximately every 3 years.

- 6.8 Refer to the 'Surface Water Maintenance Schedule' in the Appendix for the maintenance details proposed for the clean water system.

## 7.0 APPENDIX DETAILS AND DRAWINGS EXPLAINED

### 7.1 Plandescil Ltd Details

<u>Drawing No.</u>	<u>Title</u>	<u>Comments</u>
25998/005 Rev F	Proposed Site Layout	General site overview with plant items in key
25998/006 Rev F	Proposed Site Levels	General site levels overview for all surfacing
25998/007 Rev F	Proposed Drainage Layout	General site drainage overview with key
25998/054 Rev 0	Leachate Tank Details	Leachate tank reinforced concrete details
25998/101 Rev 0	Typical Hardstanding & Kerb Details	General construction details for hardstanding areas, including kerb specification
25998/102 Rev 0	Typical Drainage Details	General construction details for the surface and leachate water drainage systems
25998/103 Rev A	Silage Clamp Sections & Details	General construction details for the silage clamp walls, floors and perimeter drainage channels

#### Document Title

25998 - Surface Water Maintenance Schedule - Rev 0

25998 - Infiltration Pond Size Micro Drainage Calculations - Rev A

### 7.2 JNP Group Percolation Test Results

<u>Item</u>	<u>Comments</u>
NP - H77020 R001 Soakaway Report	Percolation Test Results for the site

### 7.3 Kingspan Leachate / Silage Effluent Tank Details

<u>Item</u>	<u>Comments</u>
Kingspan 22,000l Single Neck / Silage Tank	Manufacturer product specification

#### 7.4 ARK Agriculture Pre-cast L and T Silage Clamp Wall Panel Specification and Details

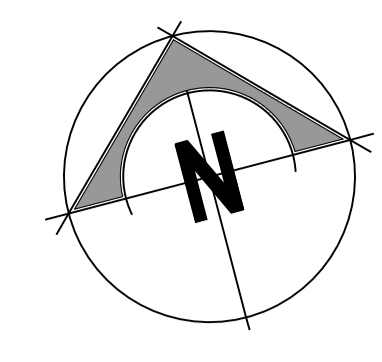
<u>Item</u>	<u>Comments</u>
LA300G – 3m high pre-cast L-wall panels	Manufacturer product specification
TWA300 - 3m high pre-cast T-wall panels	Manufacturer product specification

#### 7.5 Tufflex HD Asphalt Specification and Details

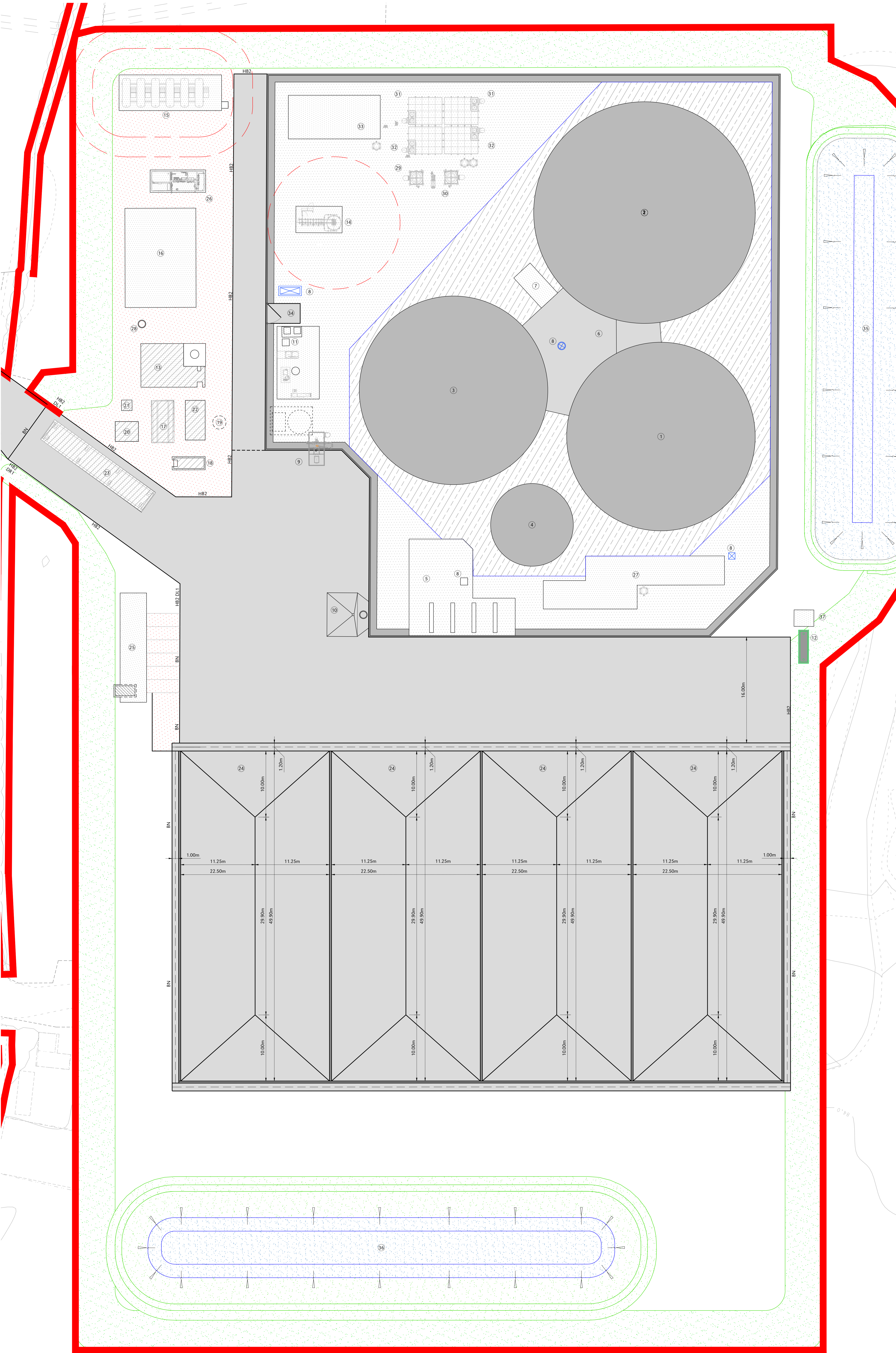
<u>Item</u>	<u>Comments</u>
Tufflex HD Asphalt Data Sheet	Asphalt supplier technical specification

# APPENDIX





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E-mail: pdc@plandescil.co.uk www.plandescil.co.uk

civil / structural / environmental / surveying

Client:  
**O'Brien Moran & Co Ltd.**

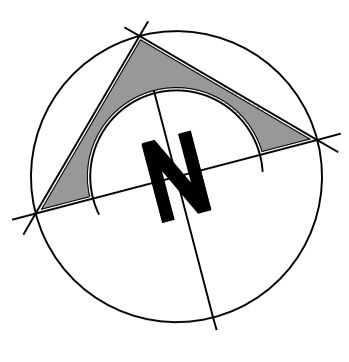
Project:  
**Proposed AD Plant  
Lower Drayton Farm  
Penkridge, Stafford, ST195RE**

Drawing Title:  
**Proposed Site Layout**

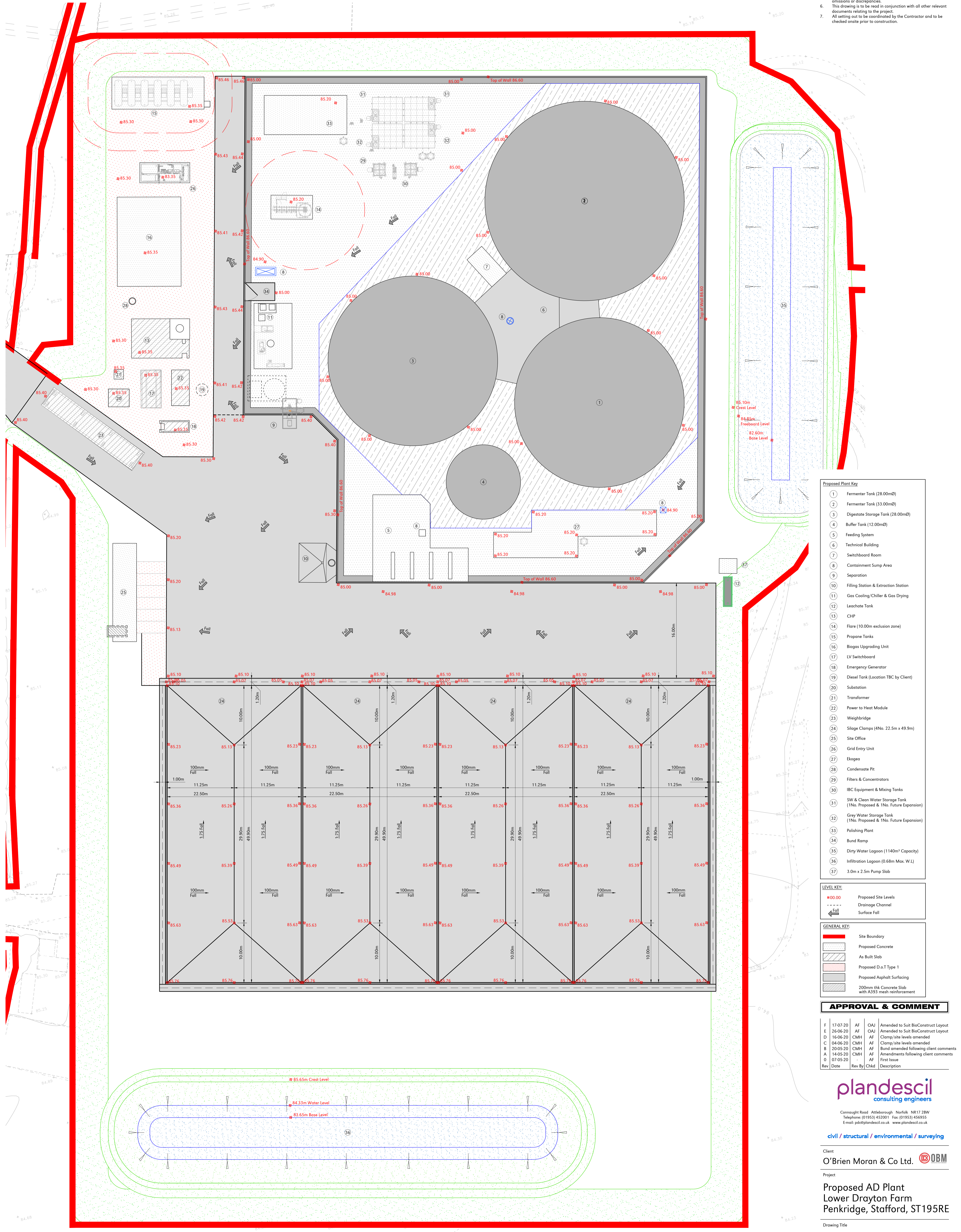


Scale	U.N.O.	Date	Drawn By
1:200 (A0)		April 2020	CMH
Drawing No.	25998/005		Rev
			F





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- Proposed Plant Key**
- 1 Fermenter Tank (28.00m<sup>2</sup>)
  - 2 Fermenter Tank (33.00m<sup>2</sup>)
  - 3 Digestate Storage Tank (28.00m<sup>2</sup>)
  - 4 Buffer Tank (12.00m<sup>2</sup>)
  - 5 Feeding System
  - 6 Technical Building
  - 7 Switchboard Room
  - 8 Containment Sump Area
  - 9 Separation
  - 10 Filling Station & Extraction Station
  - 11 Gas Cooling/Chiller & Gas Drying
  - 12 Leachate Tank
  - 13 CHP
  - 14 Flare (10.00m<sup>2</sup> exclusion zone)
  - 15 Propane Tanks
  - 16 Biogas Upgrading Unit
  - 17 LV Switchboard
  - 18 Emergency Generator
  - 19 Diesel Tank (Location TBC by Client)
  - 20 Substation
  - 21 Transformer
  - 22 Power to Heat Module
  - 23 Weighbridge
  - 24 Silage Clamps (4No. 22.5m x 49.9m)
  - 25 Site Office
  - 26 Grid Entry Unit
  - 27 Ekogas
  - 28 Condensate Pit
  - 29 Filters & Concentrators
  - 30 IBC Equipment & Mixing Tanks
  - 31 SW & Clean Water Storage Tank (1No. Proposed & 1No. Future Expansion)
  - 32 Grey Water Storage Tank (1No. Proposed & 1No. Future Expansion)
  - 33 Polishing Plant
  - 34 Bund Ramp
  - 35 Dirty Water Lagoon (1140m<sup>3</sup> Capacity)
  - 36 Infiltration Lagoon (0.66m Max. W.L)
  - 37 3.0m x 2.5m Pump Slab

- LEVEL KEY:**
- 00.00 Proposed Site Levels
  - Drainage Channel
  - ↘ Fall
  - ↘ Surface Fall

- GENERAL KEY:**
- Site Boundary
  - Proposed Concrete
  - As Built Slab
  - Proposed D.O.T Type 1
  - Proposed Asphalt Surfacing
  - 200mm thk Concrete Slab with A393 mesh reinforcement

**APPROVAL & COMMENT**

Rev	Date	Rev By	Chkd	Description
F	17.07.20	AF	OAJ	Amended to Suit BioConstruct Layout
E	26.06.20	AF	OAJ	Amended to Suit BioConstruct Layout
D	16.06.20	CMH	AF	Clamp/site levels amended
C	04.06.20	CMH	AF	Clamp/site levels amended
B	20.05.20	CMH	AF	Bund amended following client comments
A	14.05.20	CMH	AF	Amendments following client comments
O	07.05.20	-	AF	First Issue

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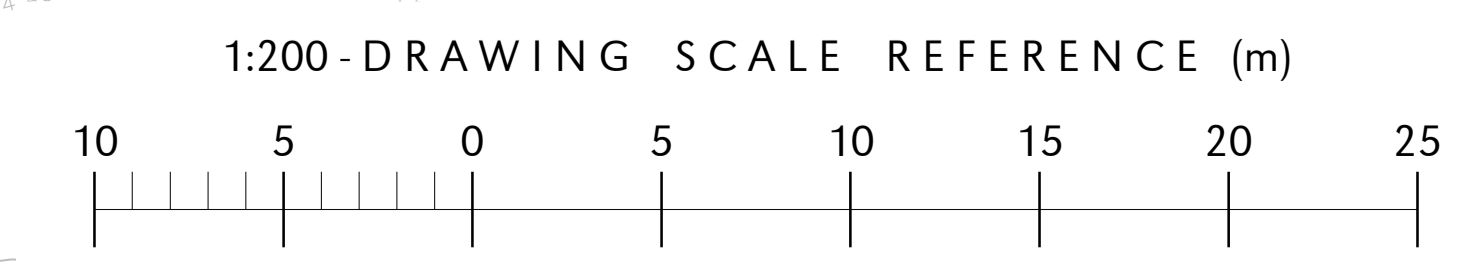
Client:  
**O'Brien Moran & Co Ltd.**

Project:  
**Proposed AD Plant  
Lower Drayton Farm  
Penkridge, Stafford, ST195RE**

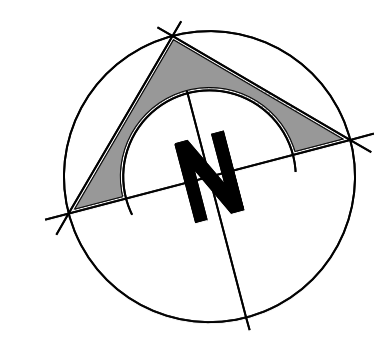
Drawing Title:  
**Proposed Site Levels**

Scale	U.N.O.	Date	Drawn By
1:200 (A0)		April 2020	CMH
Drawing No.	25998/006		Rev F

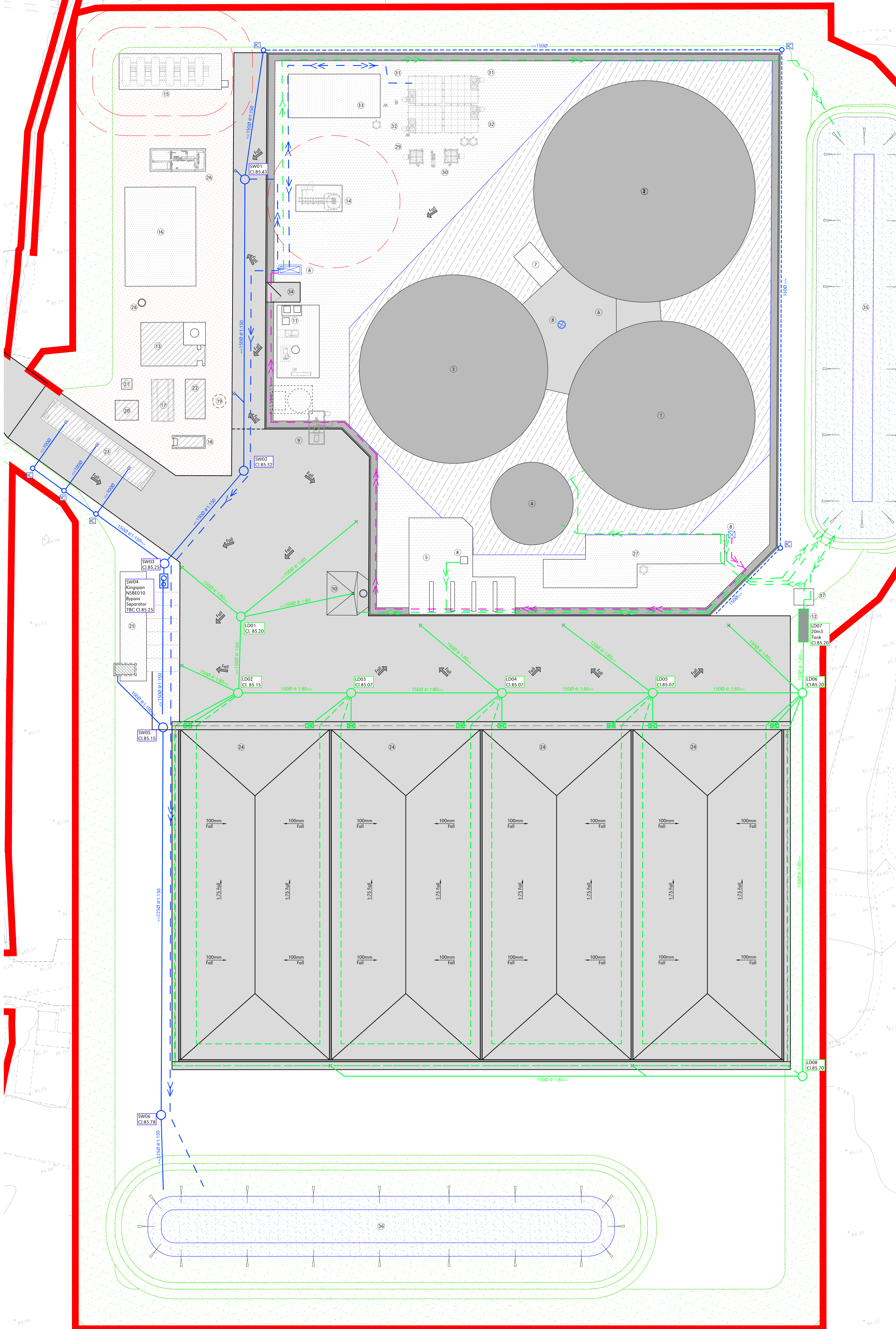
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  - Polishing Plant
  - Bund Ramp
  - Dirty Water Lagoon (1140m³ Capacity)
  - Infiltration Lagoon (0.68m Max. W.L)
  - 3.0m x 2.5m Pump Slab

- PROPOSED DRAINAGE KEY:**
- Leachate Drainage Pumped Pipe (LD)
  - Leachate Drainage (LD)
  - Leachate Gully (LD)
  - Leachate Manhole (LD)
  - Proposed Leachate Sump (LD)
  - Surface Water Drainage (SW)
  - Surface Water Perforated Pipe (SW)
  - Surface Water Pumped Pipe (SW)
  - Surface Water Manhole (SW)
  - Surface Water Gully (SW)
  - Inspection Chamber (SW)
  - Pumped Containment Water Pipe

- GENERAL KEY:**
- Site Boundary
  - Proposed Concrete
  - As Built Slab
  - Proposed D.o.T Type 1
  - Proposed Asphalt Surfacing
  - 200mm thk Concrete Slab with A393 mesh reinforcement

**APPROVAL & COMMENT**

Rev	Date	Rev By	Chkd	Description
F	17.07.20	AF	OAJ	Minor Amendments to Drainage Levels
E	26.06.20	AF	OAJ	Amended to Suit BioConstruct Layout
D	16.06.20	AF	OAJ	Minor amendments to clamp drainage
C	04.05.20	CMH	AF	Amendments to drainage levels
B	20.05.20	CMH	AF	Revised amended following client comments
A	14.05.20	CMH	AF	Amendments following client comments
O	07.05.20	-	AF	First Issue

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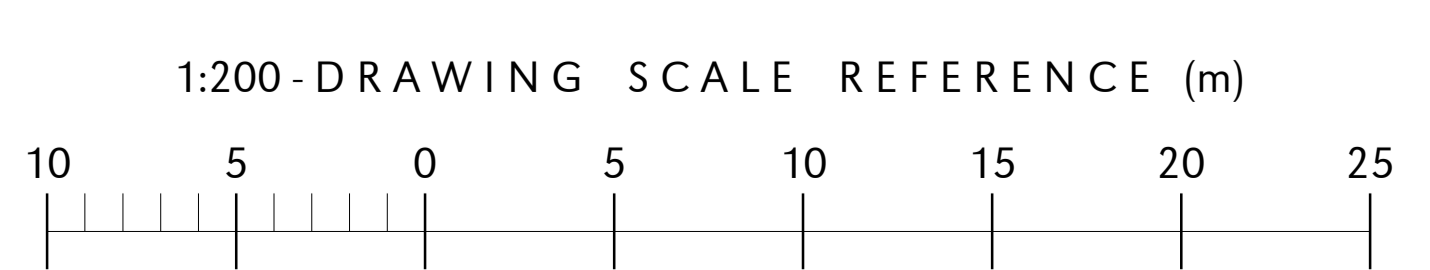
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Project:  
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Penkridge, Stafford, ST195RE**

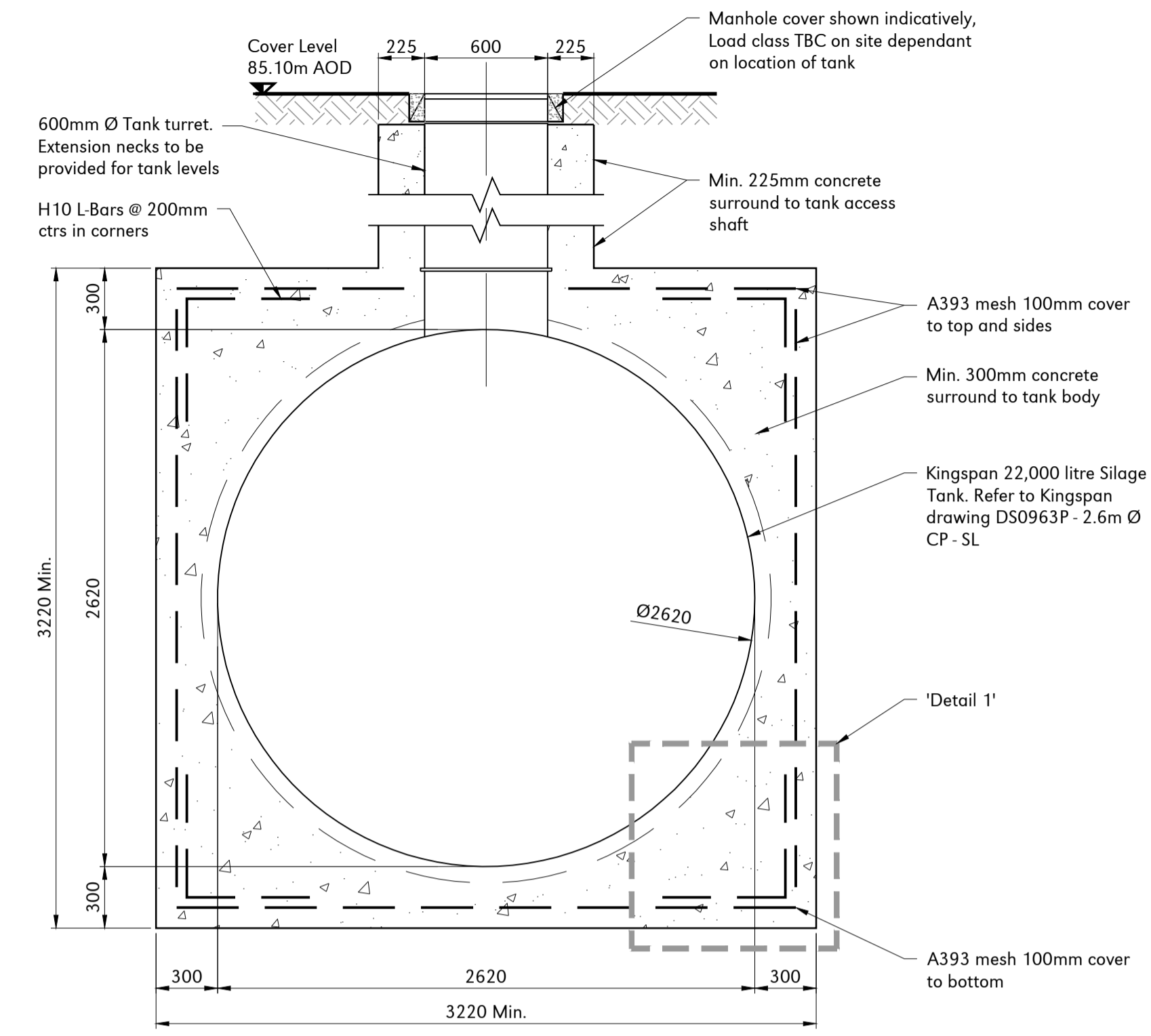
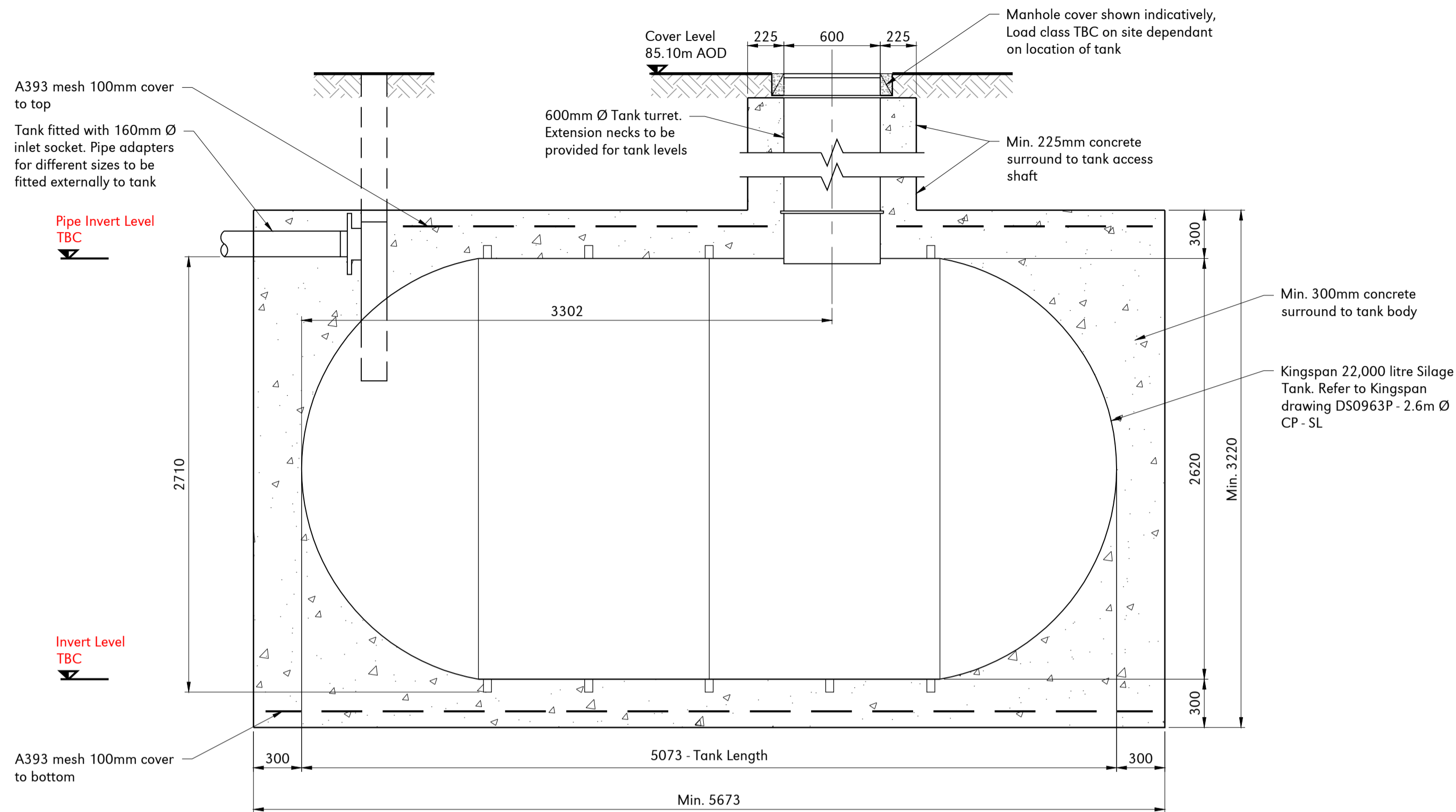
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**Proposed Drainage Layout**



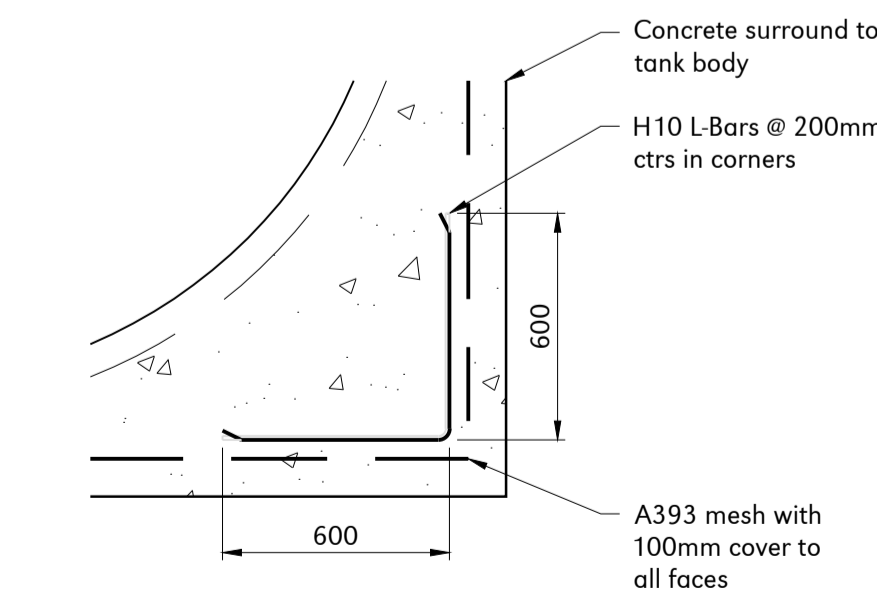
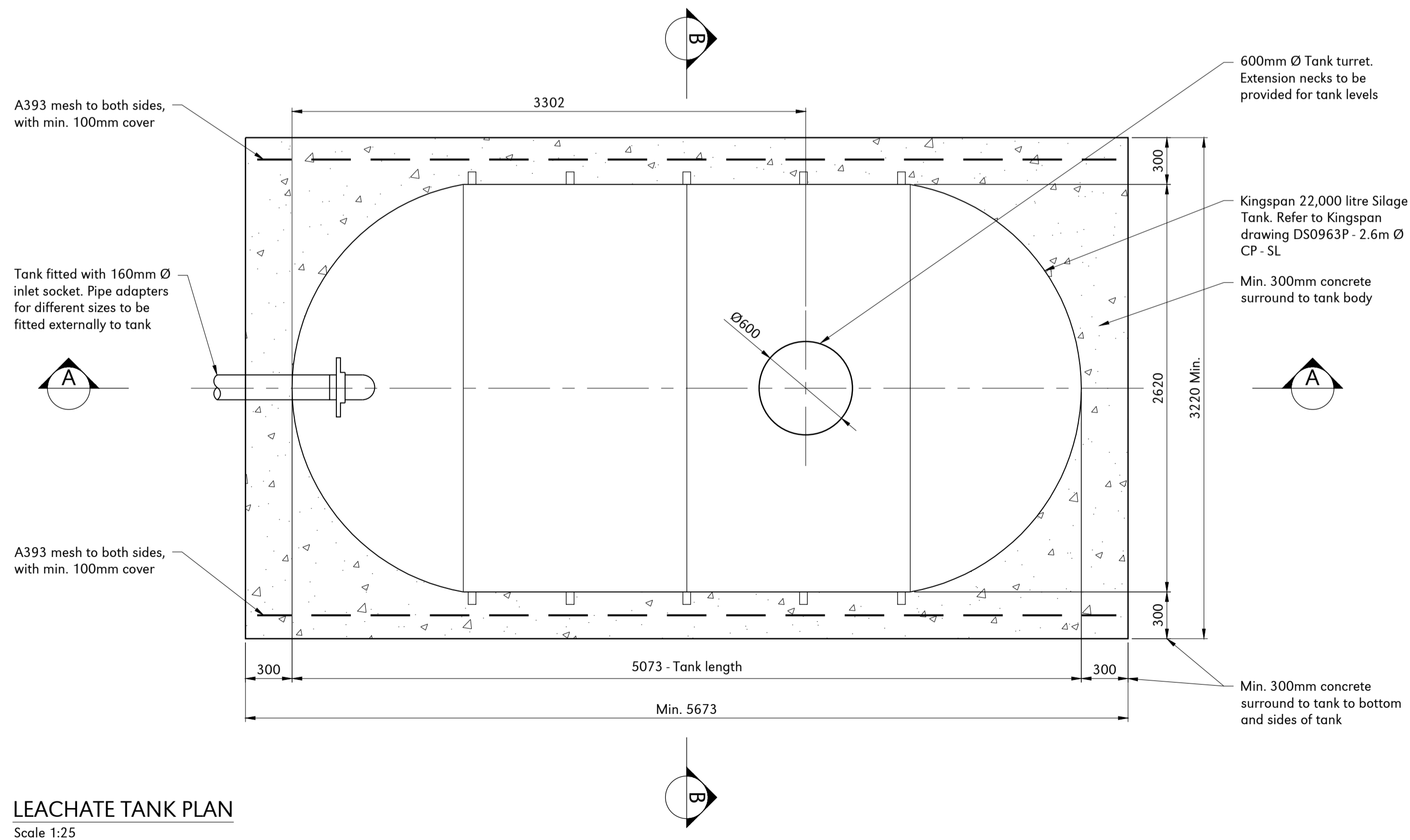
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Scale	U.N.O.	Date	Drawn By
1:200 (A0)		May 2020	CMH
Drawing No.	25998/007	Rev	F





22,000L KINGSPAN SILAGE TANK (DS0963P)  
To be installed in strict accordance with the manufacturer's details and specification, including transport, lifting and concrete surround. Refer to Kingspan 'Installation & Operation Guidelines for Septic, Cesspool, Silage & Settlement Tanks'



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25998/006 - Proposed Site Levels  
25998/007 - Proposed Drainage Layout  
25998/054/01 BS - Leachate Tank Bar Bending Schedule

SILAGE TANK NOTES:

- Silage Tank detailed Kingspan Silage Tank 22,000 litre tank. Refer to Kingspan drawing, DS0963P - 2.6m Ø CP - SL. Single Neck Cesspool / Silage Tank.
- Transportation, lifting and installation of Silage Tank to be in strict accordance with Manufacturer details and specification. Refer to Kingspan 'Installation & Operation Guidelines for Septic, Cesspool, Silage & Settlement Tanks'.
- Invert levels of tank TBC, refer to Proposed Drainage Layout.
- Cover Level to be in accordance with Proposed Site Levels.
- Tank to be surrounded with a minimum of 300mm concrete as noted in Kingspan Installation Guidelines.
- Concrete minimum Strength Class to be C32/40 with max w/c ratio 0.55, 300kg/m<sup>3</sup> cement/combination content (IIB-V), with 20mm max. aggregate.
- In situ Concrete to be in accordance with BS EN 206-1 (BS 8500-1).
- Reinforcement to be Grade H 500N/mm<sup>2</sup> High Yield, Deformed Type 2 Bar detailed in accordance with BS 4449 and BS 8666.

FOUNDATION NOTES:

- Assumed GBP value of 150kN/m<sup>2</sup> has been used. Value provided by the Georisk Management Limited Ground Investigation Report Ref. 18133/LO.001/AMG. Confirmation of minimum GBP of 150kN/m<sup>2</sup> required prior to construction.
- Any soft spots or deleterious material is to be removed & taken down to virgin ground level & replaced with compact D.f.T Type 1 or suitable hogging material.
- Overdig to be made up in compacted D.f.T. Type 1 or lean mix concrete.

APPROVAL & COMMENT

Rev	Date	Rev By	Chkd	Description
0	16-06-20	-	AF	First Issue

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Client

O'Brien Moran & Co Ltd.

Project

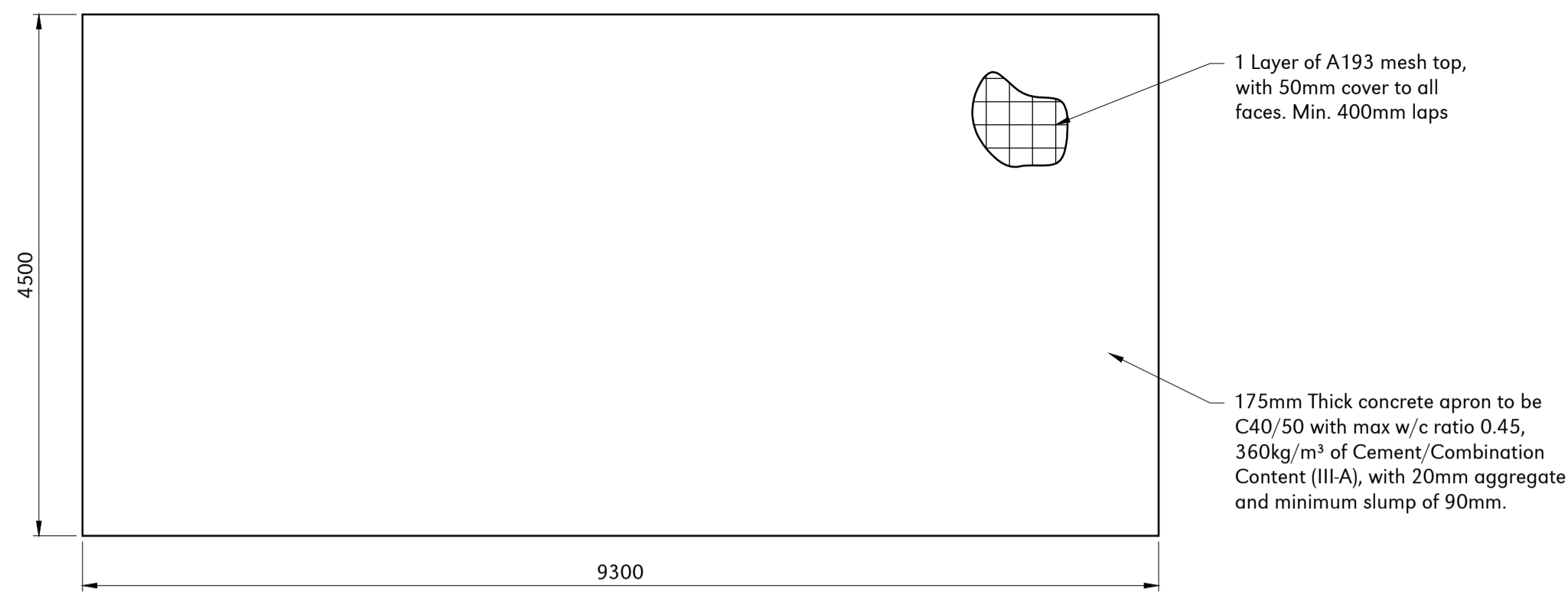
Proposed AD Plant  
Lower Drayton Farm,  
Penkridge, Staffordshire

Drawing Title

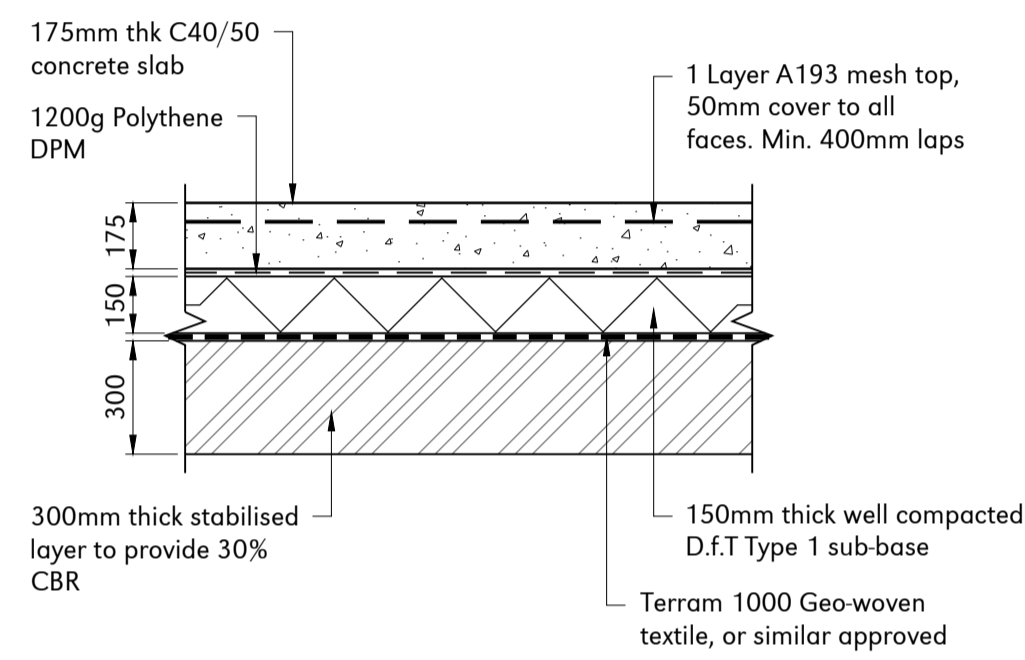
Leachate Tank Details

Scale	U.N.O.	Date	Drawn By
1:20, 1:25 (A1)		May 2020	IGC
Drawing No.	25998/054		Rev
			0



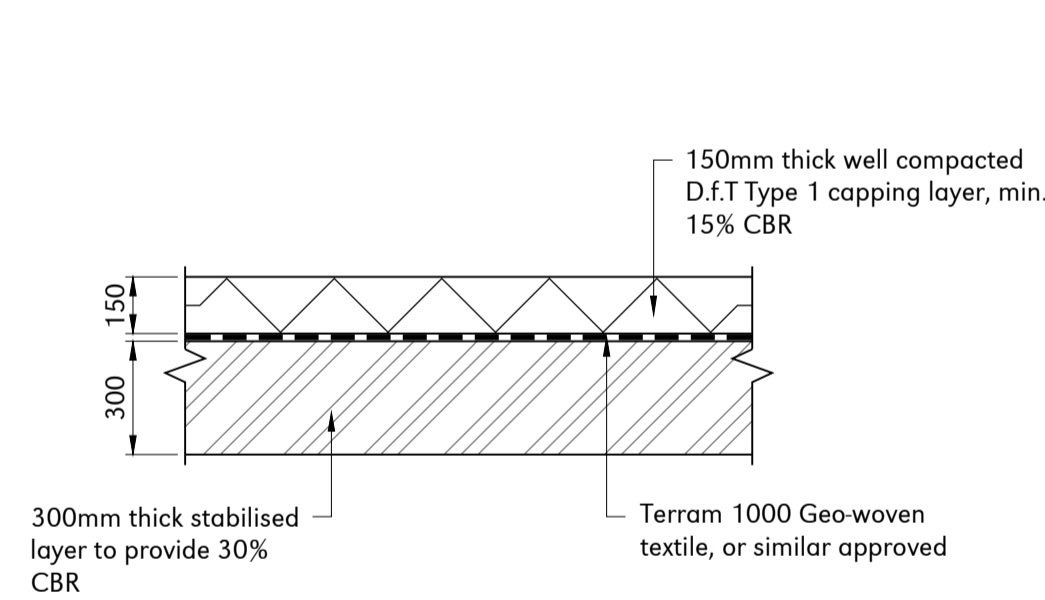


**TYPICAL CONCRETE APRON SLAB PLAN**  
Scale 1:50

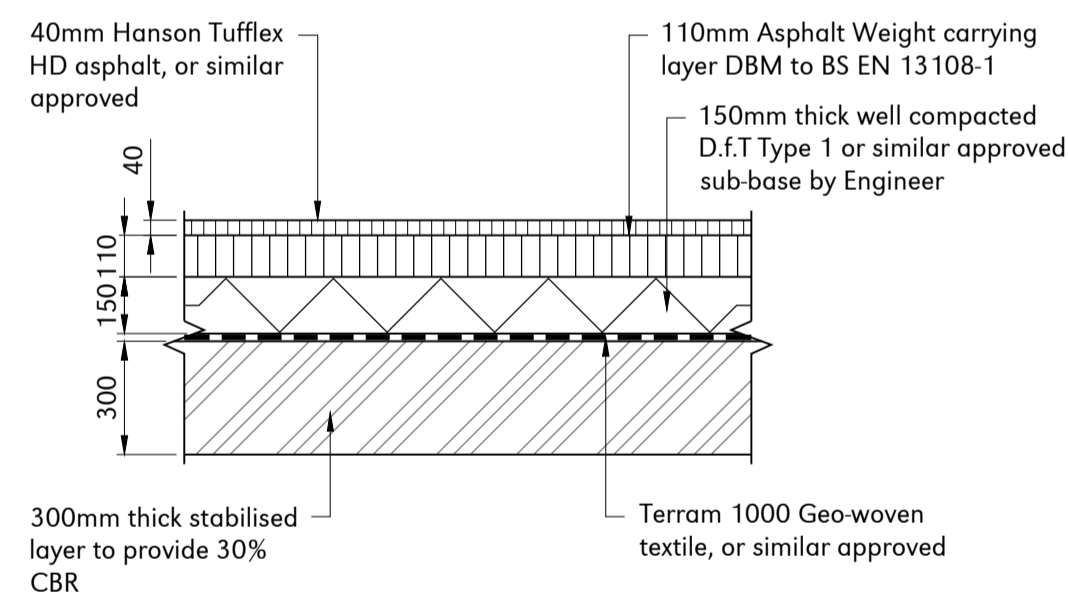


**TYPICAL CONCRETE APRON SLAB CONSTRUCTION**  
Scale 1:20

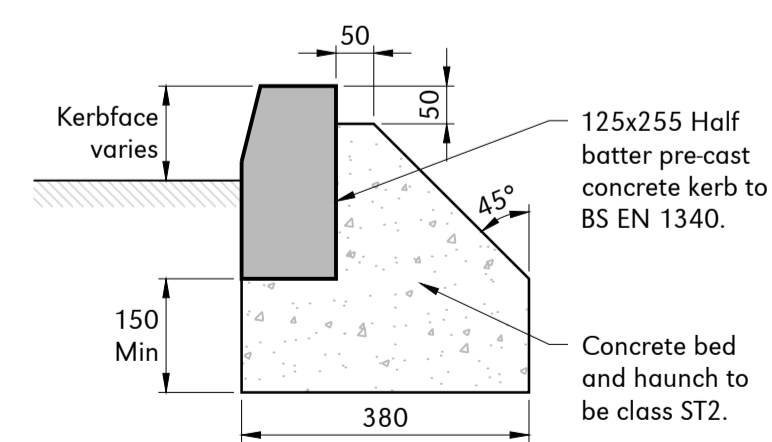
**NOTE:**  
All hard standing areas to be Asphalt specification. Typical concrete details provided in advance of final confirmation for the site access road surfacing.



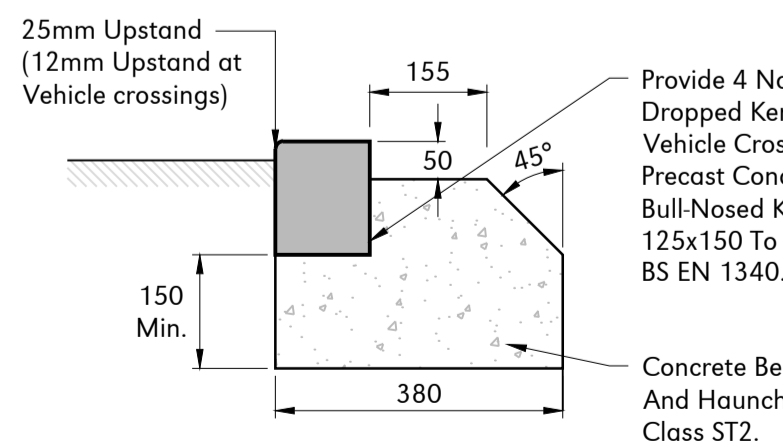
**TYPICAL TYPE 1 CONSTRUCTION**  
Scale 1:20



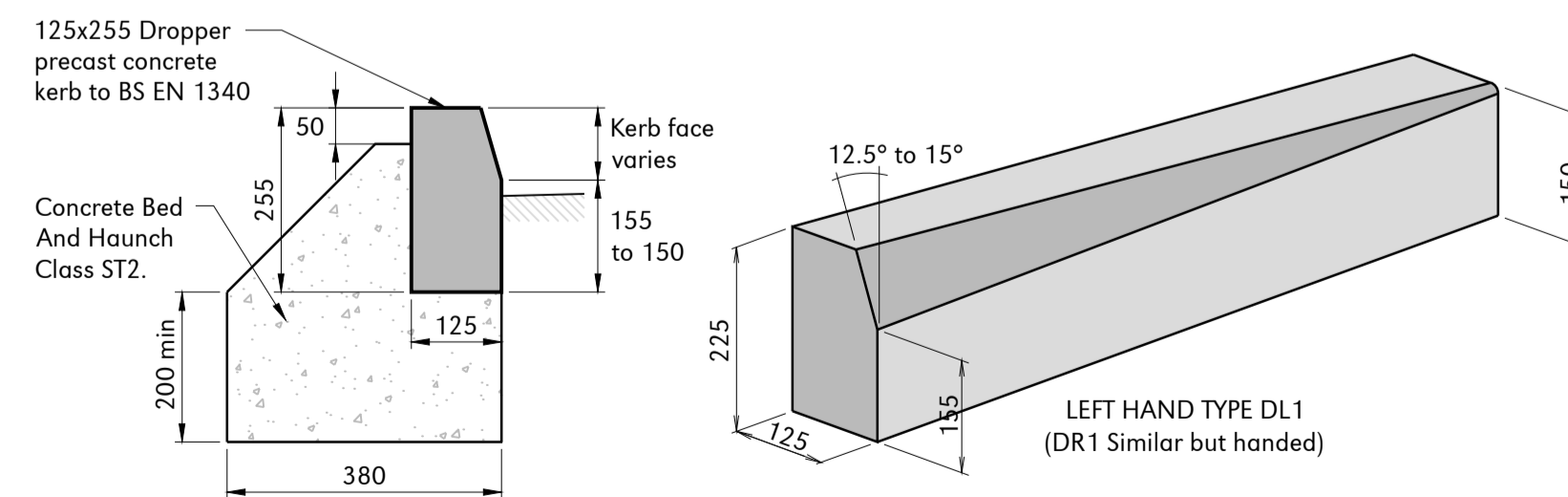
**TYPICAL ASPHALT SURFACE CONSTRUCTION**  
Scale 1:20



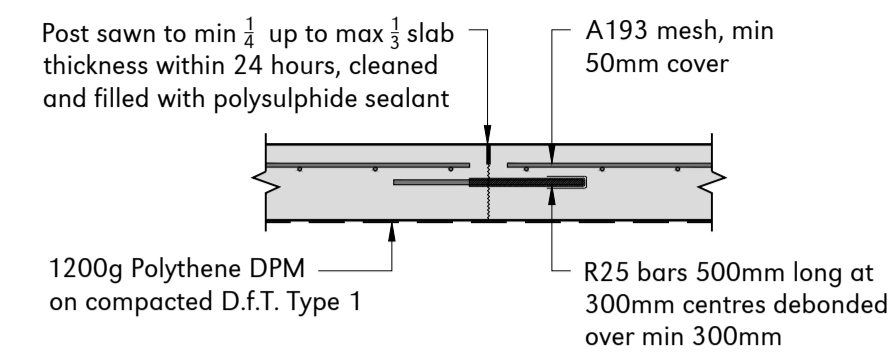
**HALF BATTERED KERB (HB2)**  
Scale 1:10



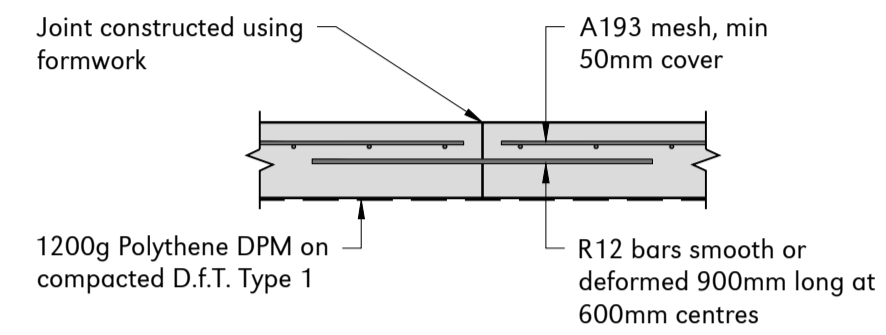
**BULLNOSED KERB (BN)**  
Scale 1:10



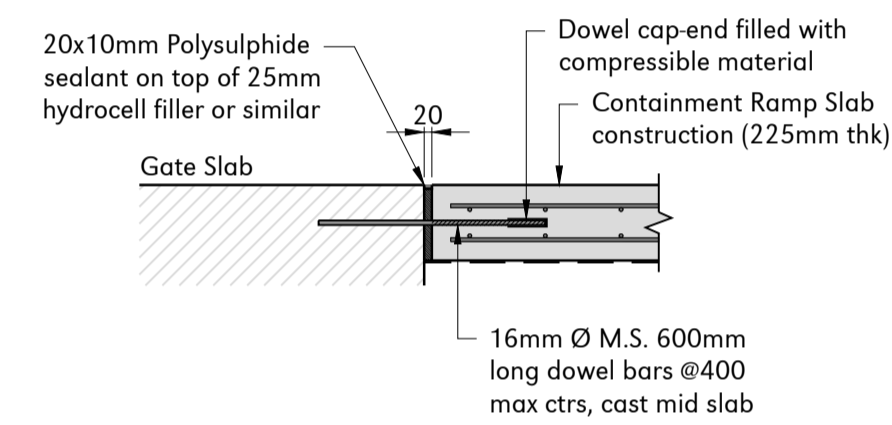
**DROPPER KERB (DL1)**  
DR1 Similar but handed  
(For use with kerb types HB2 and BN)  
Scale 1:10



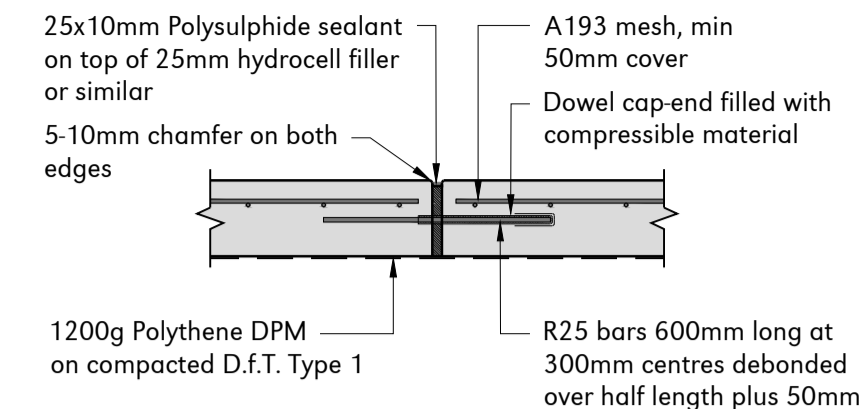
**TYPICAL SAWN FREE-MOVEMENT CONTRACTION JOINT (C.J.)**  
Scale 1:20



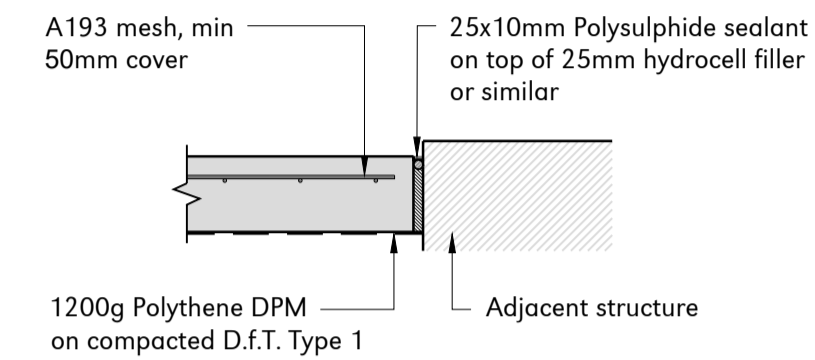
**TYPICAL FORMED RESTRAINED-MOVEMENT LONGITUDINAL JOINT (L.J.)**  
Scale 1:20



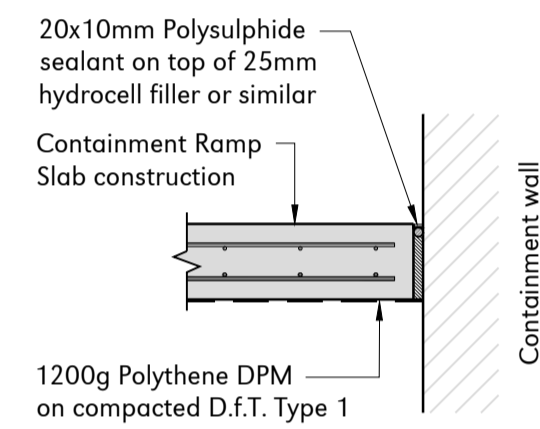
**TYPICAL CONTAINMENT RAMP EXPANSION JOINT DETAIL (E.J.)**  
Scale 1:20



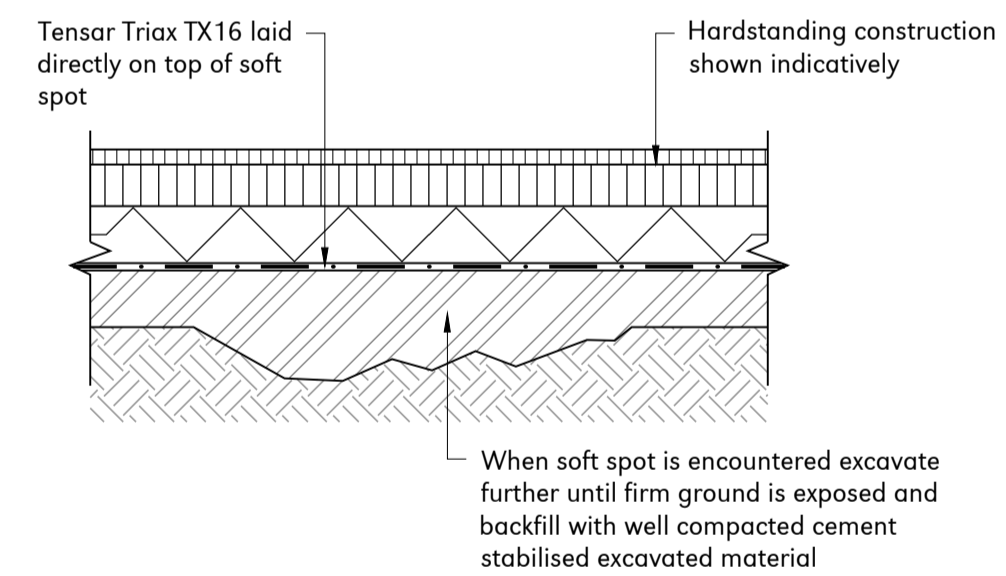
**TYPICAL EXPANSION JOINT (E.J.)**  
Scale 1:20



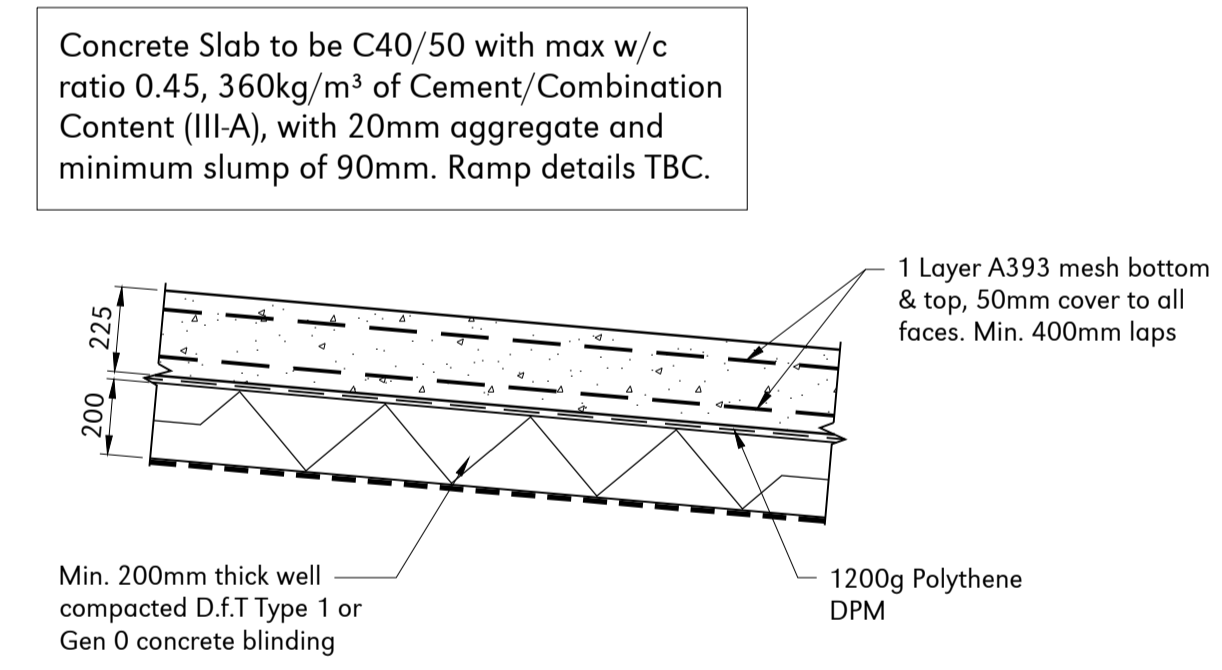
**TYPICAL ISOLATION JOINT (I.J.)**  
Scale 1:20



**TYPICAL CONTAINMENT RAMP ISOLATION JOINT DETAIL (I.J.)**  
Scale 1:20



**TYPICAL SOFT SPOT REMEDIAL DETAIL**  
Scale 1:20



**CONTAINMENT BUND RAMP TYPICAL CONSTRUCTION**  
Scale 1:20

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25998/005 - Proposed Site Layout  
25998/100 - Containment Bund Slab & Joint Details  
25998/102 - Drainage Details
- Asphalt hard standings as requested by Others, not Plandescil Ltd preferred/recommended construction method and practice.

**CONCRETE (ACCESS ROAD TBC):**

- Concrete Slab to be C40/50 with max w/c ratio 0.45, 360kg/m³ of Cement/Combination Content (III-A), with 20mm aggregate (non-limestone) and minimum slump of 90mm.
- Insitu Concrete to be in accordance with BS 8110 & BS 8500-1.
- Reinforcement to be Grade H 500N/mm² High Yield, Deformed Type 2 Bar detailed in accordance with BS 4449 and BS 8666.
- Slab nominal 175mm thick, 50mm cover to top and sides.

**CONCRETE JOINT NOTES (ACCESS ROAD TBC):**

- All joint dowel/reinforcement shall be set level and perpendicular to the joint face prior to casting. Damage or bent dowels are to be re-aligned or replaced prior to casting.
- All formed joints are to be cleaned of concrete overruns to ensure accidental restraint is not created.
- All joints are to be sufficiently cured and cleaned of all contaminations prior to sealing.
- All sealants are to be installed as per manufacturers specification and must be suitable for the joint type.

**ASPHALT HARD STANDINGS:**

- Asphalt surface specification, 40mm Hanson Tufflex HD asphalt, 110mm Asphalt Weight carrying DPM, 150mm D.F.T Type 1 sub-base, 300mm thick stabilised layer.

**MATERIAL NOTES:**

- All D.F.T Type 1 must NOT contain limestone.
- All Asphalt to be made with Granite or other acid resistant aggregate (No Limestone filler allowed).

**FOUNDATION NOTES:**

- Assumed GBP value of 150kN/m² has been used. Value provided by the Independent Stabilisation Company Ltd Interim Operation & Maintenance Manual (June 2020). Confirmation of minimum GBP of 150kN/m² required prior to construction.
- Any soft spots or deleterious material is to be removed & taken down to virgin ground level & replaced with compact D.F.T Type 1 or suitable hogging material.
- Overdig to be made up in compacted D.F.T. Type 1 or lean mix concrete.

**APPROVAL & COMMENT**

Rev	Date	Rev By	Chkd	Description
0	16-06-20	-	AF	First Issue

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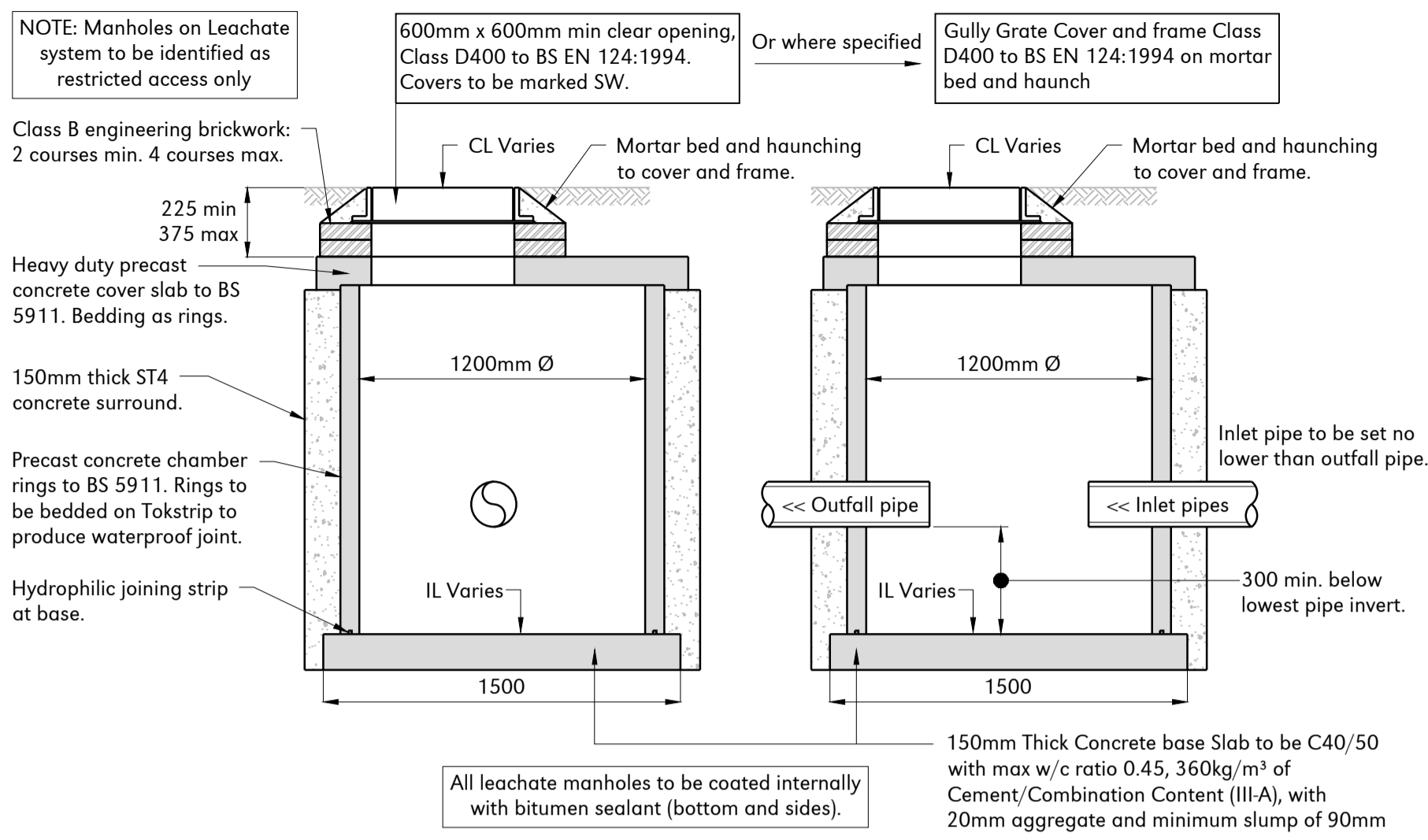
Drawing Title

Typical Hardstanding &  
Kerbing Details

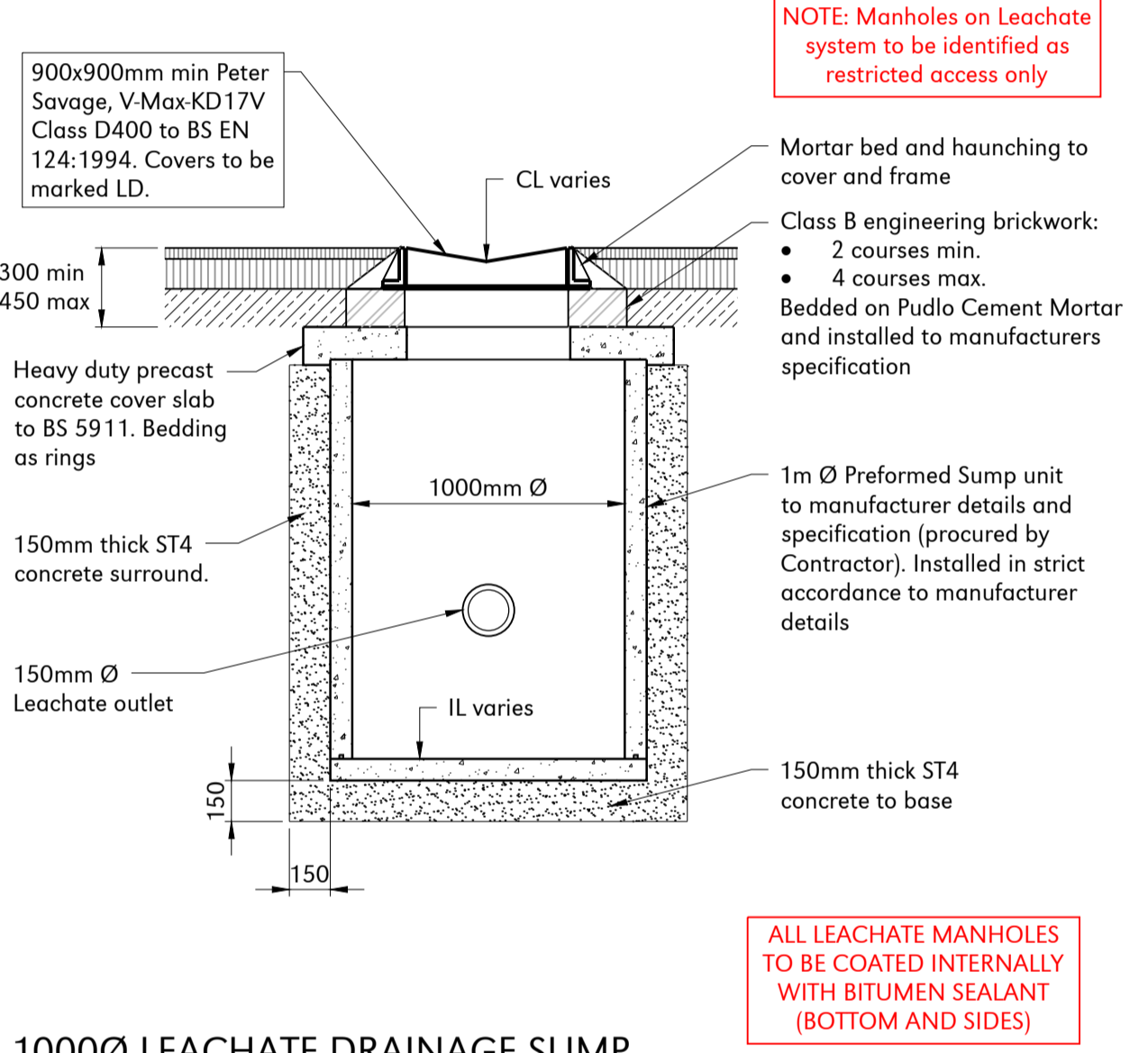
Scale U.N.O. Date May 2020 Drawn By IGC

Drawing No. 25998/101 Rev 0

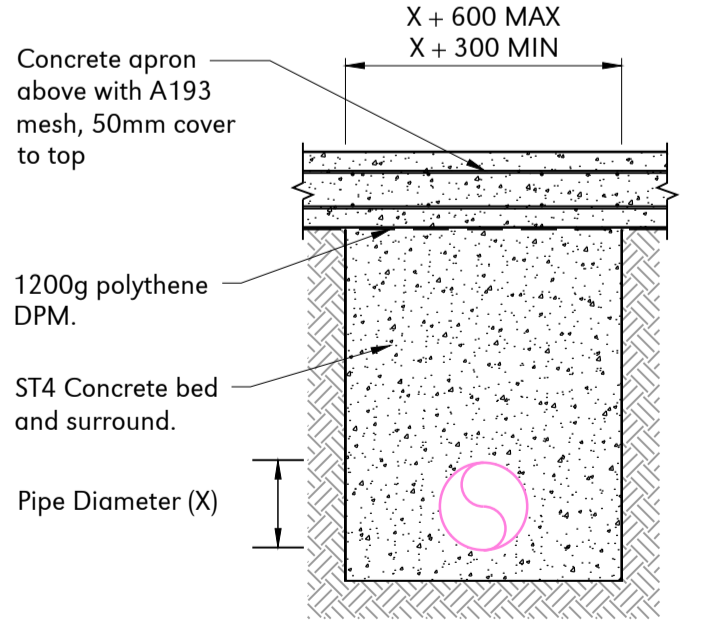




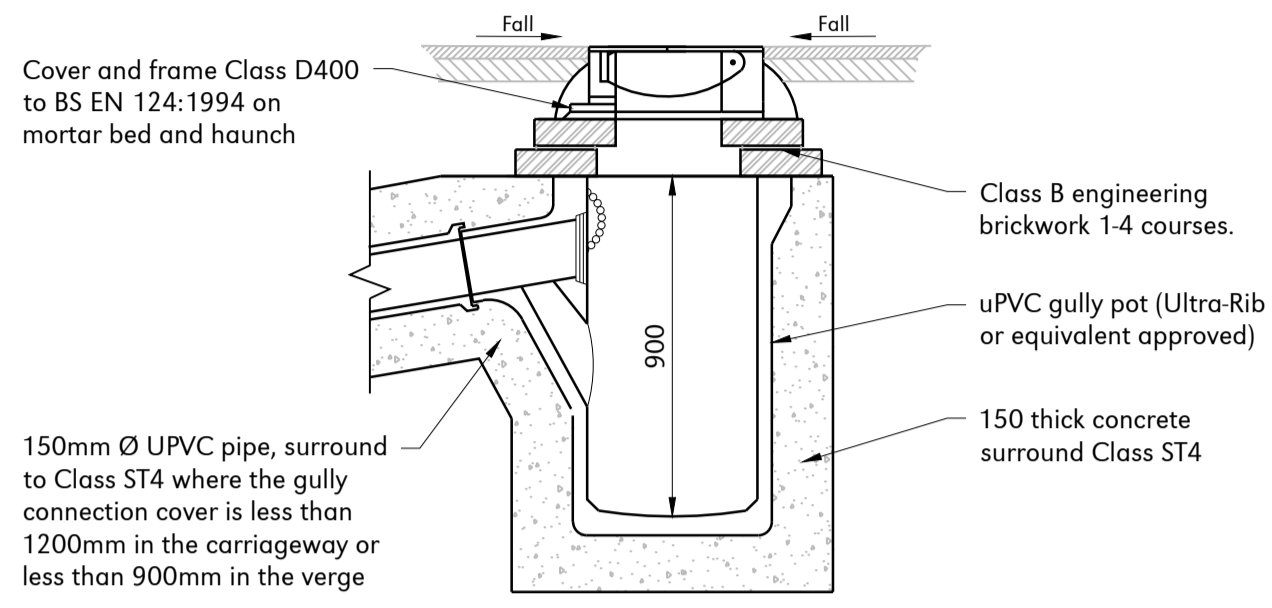
**1200Ø MANHOLE DETAIL**  
Scale 1:25



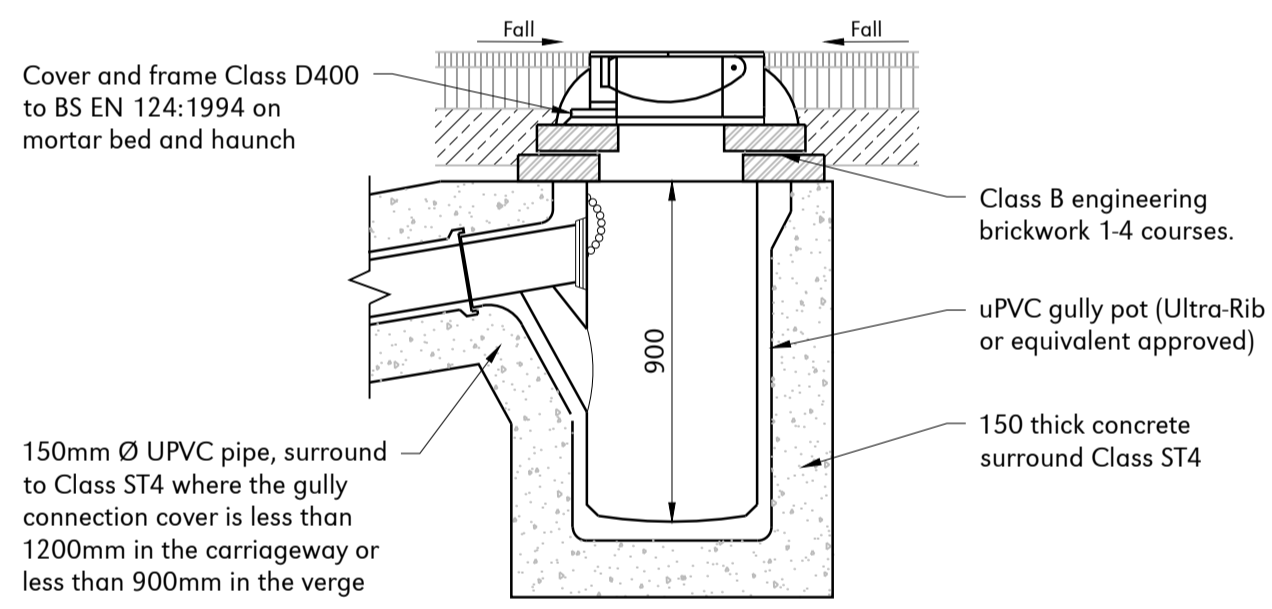
**1000Ø LEACHATE DRAINAGE SUMP**  
Scale 1:25



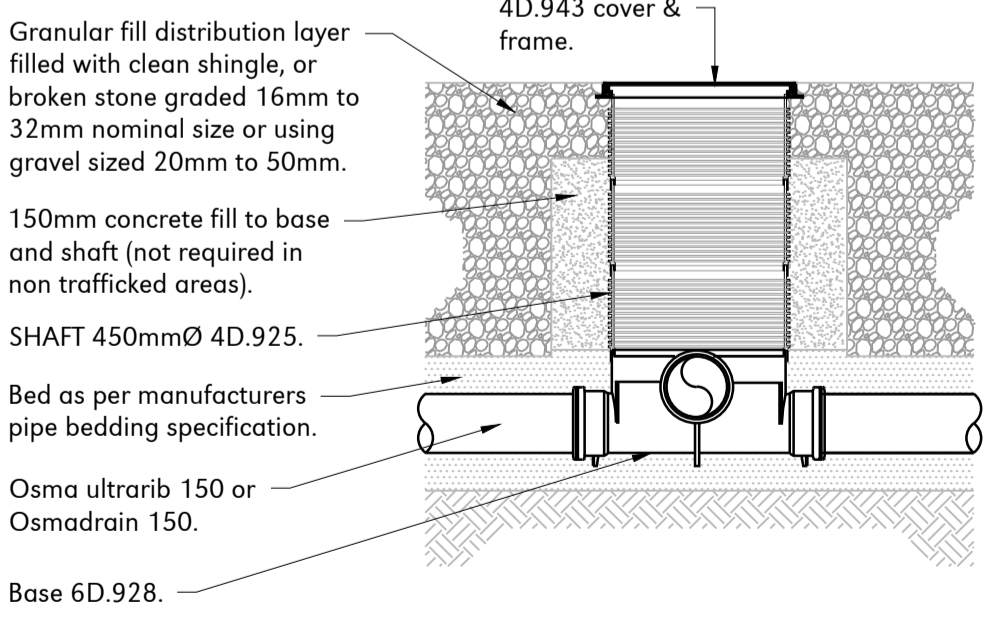
**PIPE BEDDING DETAIL FOR DRAINS WHERE DEPTH TO SOFFIT LESS THAN 0.5M**  
Scale 1:20



**TYPICAL SURFACE WATER GULLY DETAIL**  
Scale 1:20



**TYPICAL LEACHATE GULLY DETAIL**  
Scale 1:20



**450Ø INSPECTION CHAMBER DETAIL**  
Not to Scale

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    - 25998/007 - Proposed Drainage Layout
    - 25998/100 - Containment Bund Slab & Joint Details
    - 25998/101 - Hardstanding & Kerbing Details

- DRAINAGE NOTES:**
- All drainage pipes to be laid invert to invert.
  - All levels are indicative only.
  - All proprietary materials to be fixed strictly in accordance with manufacturer's recommendations using materials approved by the manufacturer.
  - All levels and dimensions should be checked on site by contractors and relevant sub-contractors.
  - Existing public utility services and private apparatus are not necessarily shown on the drawings. The contractor shall liaise with the utility provider to determine precise location of existing services. Existing services to be marked out on site prior to any excavation works. All utility company guidelines & health and safety procedures must be strictly followed.
  - Where surface water drains to ground, the existing ground should be broken up prior to laying the subgrade to aid infiltration.
  - All Leachate manholes to be coated internally with bitumen sealant (bottom and sides).

- MATERIAL NOTE:**
- Materials must NOT contain limestone, including D.F.T Type 1 and concrete aggregate.
  - All Asphalt to be made with Granite or other acid resistant aggregate (No Limestone filler allowed).
  - All Leachate water pipes to be uPVC (Foul Pipe), NOT concrete or Twin Wall.
  - All surface water pipes to be uPVC Twin Wall, NOT concrete.

ALL PROPRIETARY MATERIALS TO BE FIXED STRICTLY IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS USING MATERIALS APPROVED BY THE MANUFACTURER.

**APPROVAL & COMMENT**

Rev	Date	Rev By	Chkd	Description
0	16-06-20	-	AF	First Issue



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civil / structural / environmental / surveying

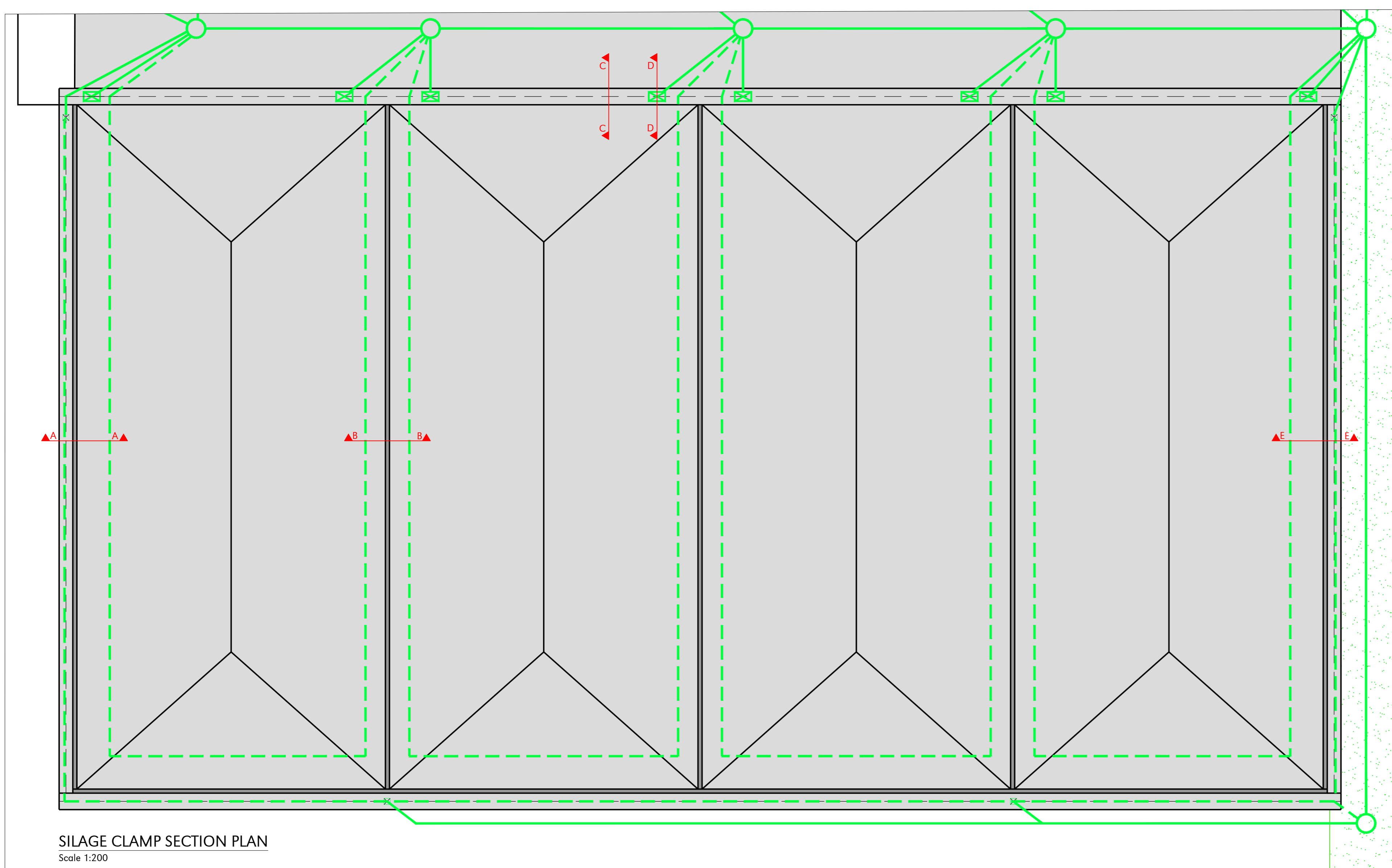
Client  
**O'Brien Moran & Co Ltd.**

Project  
**Proposed AD Plant Lower Drayton Farm, Penkridge, Staffordshire**

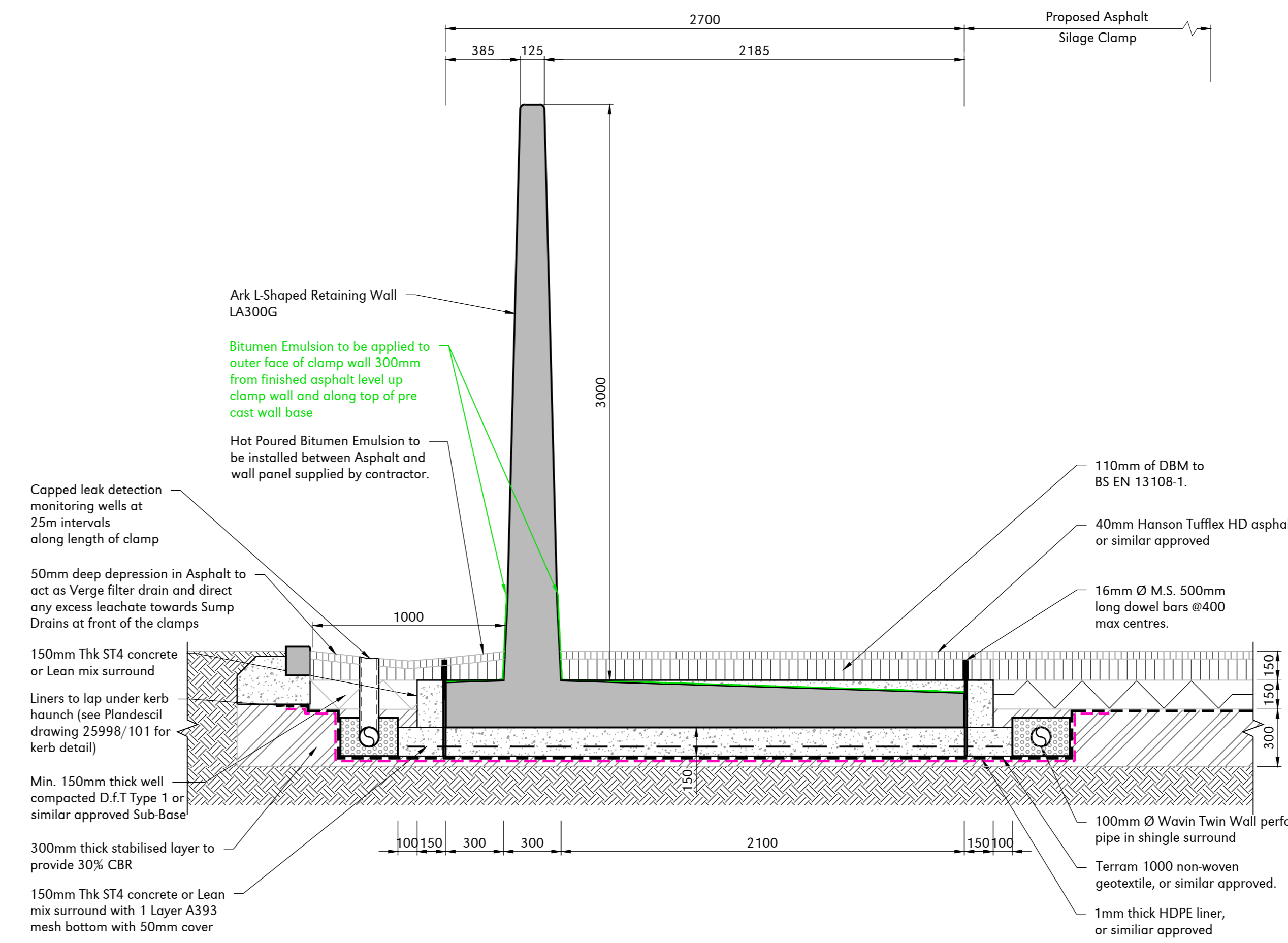
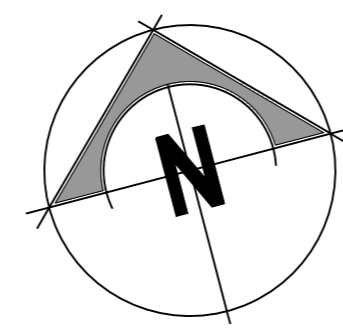
Drawing Title  
**Typical Drainage Details**

Scale	U.N.O.	Date	1:20, 1:25 (A1) May 2020	Drawn By	IGC
Drawing No.	25998/102			Rev	0

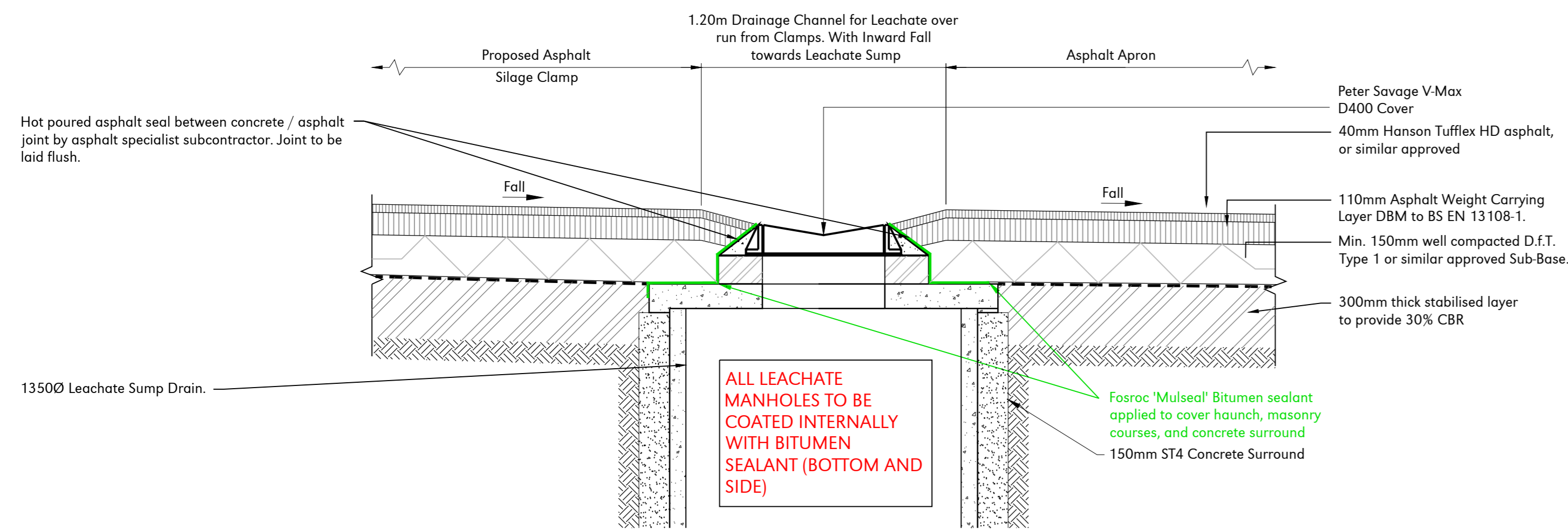




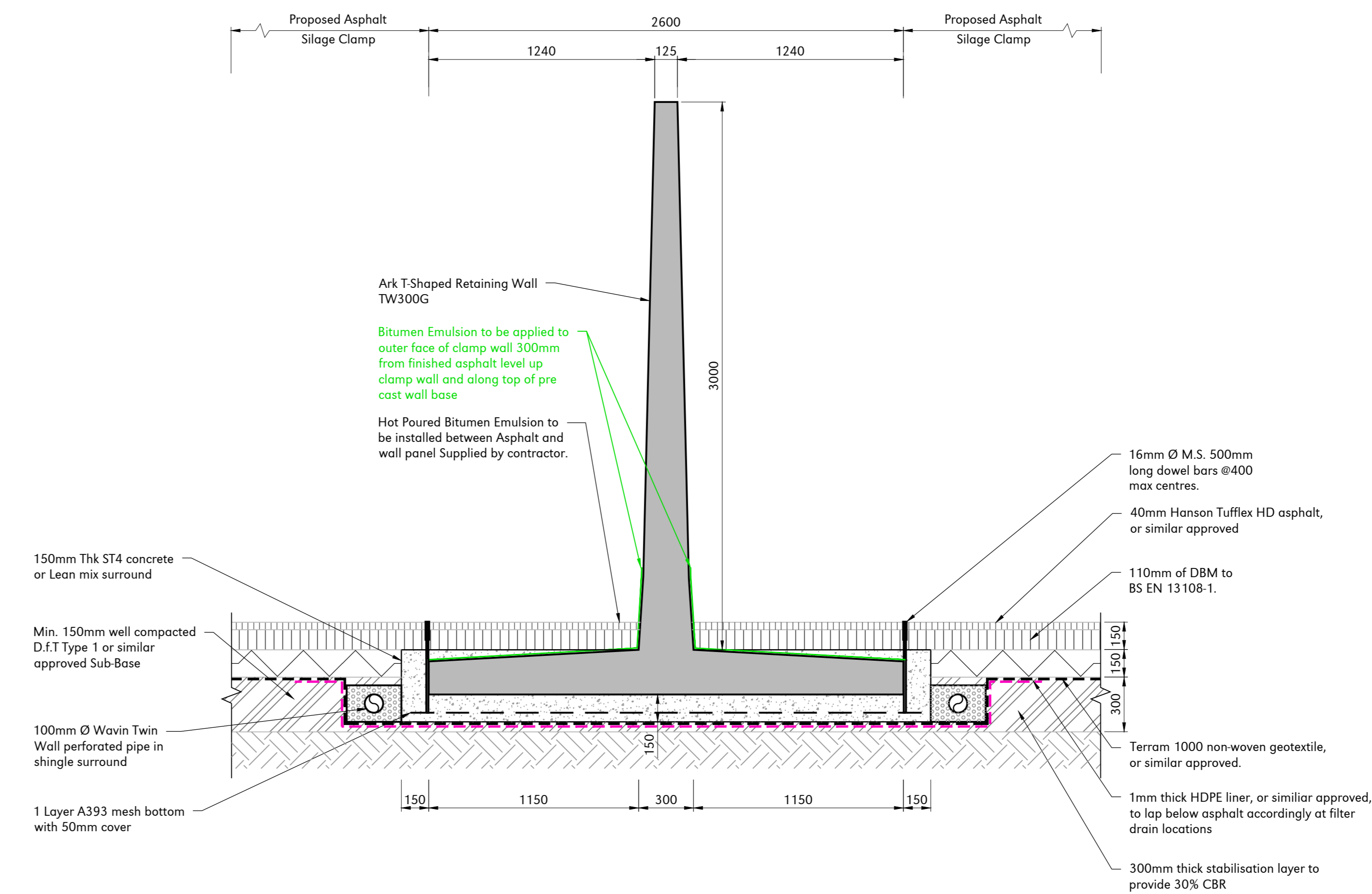
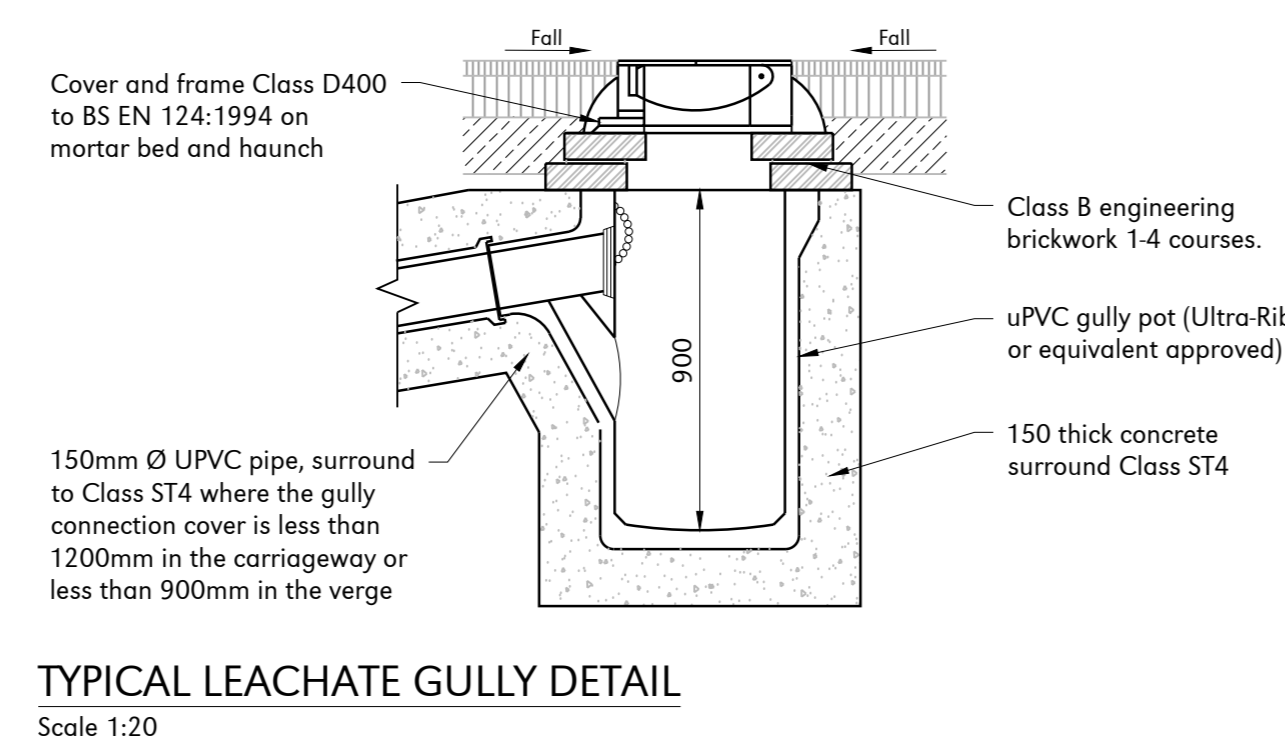
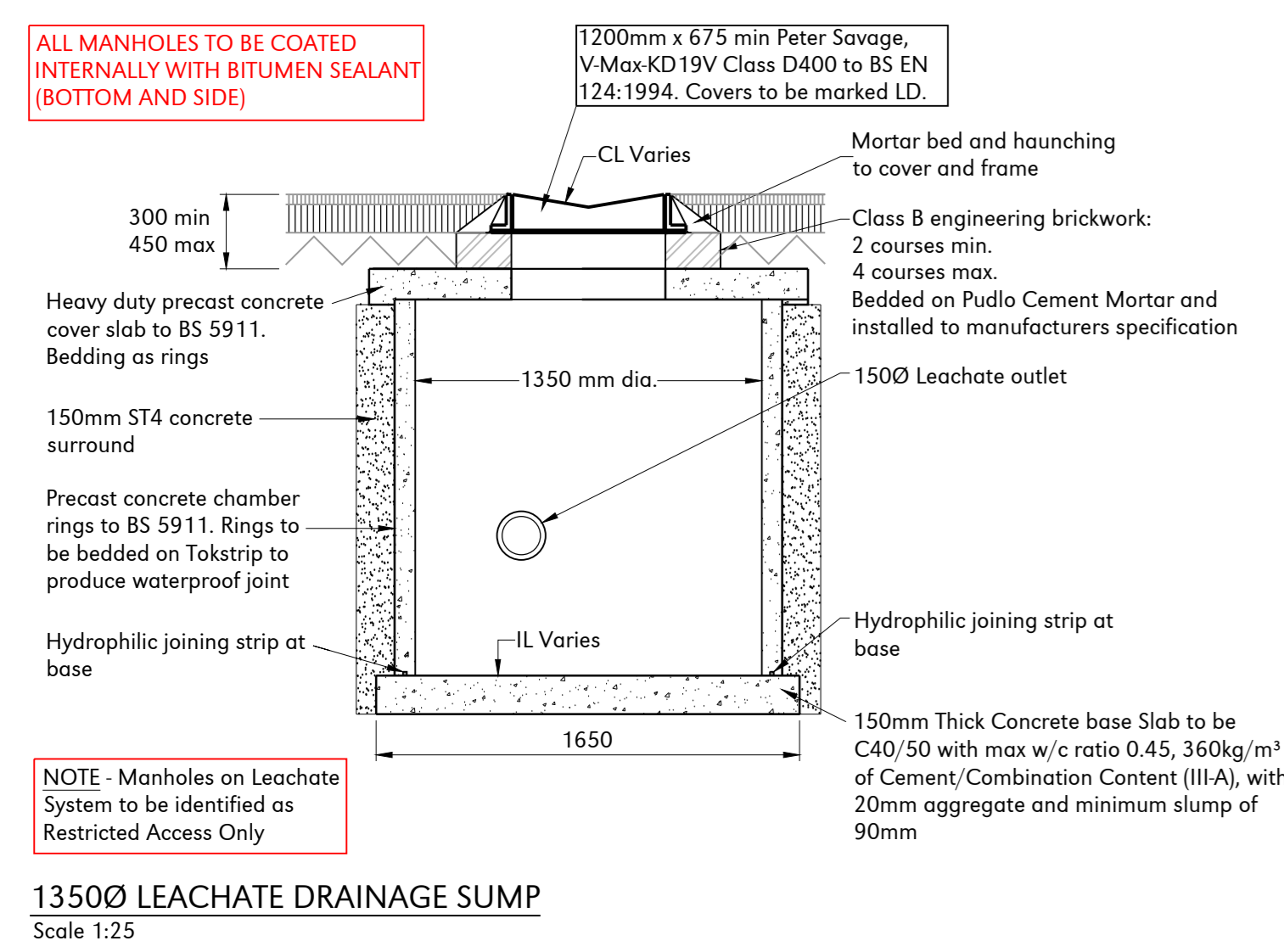
**SILAGE CLAMP SECTION PLAN**  
Scale 1:200



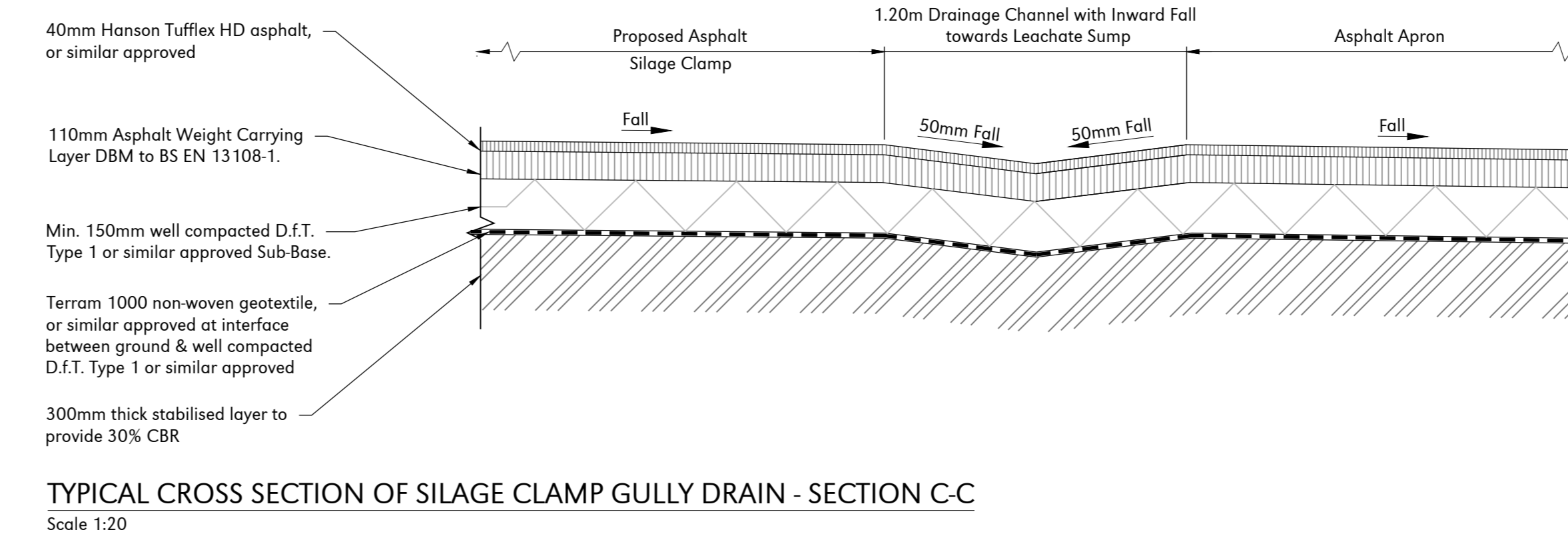
**TYPICAL L-SHAPED WALL PANEL - SECTION AA (E-E HANDED)**  
Scale 1:20



**TYPICAL CROSS SECTION OF SILAGE CLAMP SUMP DRAIN - SECTION D-D**  
Scale 1:20



**TYPICAL T-SHAPED WALL PANEL - SECTION B-B**  
Scale 1:20



**TYPICAL CROSS SECTION OF SILAGE CLAMP GULLY DRAIN - SECTION C-C**  
Scale 1:20

- GENERAL NOTES:**
- All dimensions noted are in millimetres unless stated otherwise.
  - All levels to be above Ordnance Survey Datum defined levels (A.O.D.m) unless noted otherwise.
  - Do not scale from this drawing. If dimensions are not clear ask.
  - This document has been created in accordance with Plandescil Ltd. Terms & Conditions along with the scope of works provided by the client to Plandescil Ltd. Any use of this document other than for its original purpose is prohibited. Plandescil Ltd. accept no liability for any third party uses of this document.
  - Plandescil Ltd. to be immediately notified of any suspected omissions or discrepancies.
  - This drawing is to be read in conjunction with all other relevant documents relating to the project.
  - All setting out to be coordinated by the Contractor and to be checked onsite prior to construction.
  - To be read in conjunction with the following Plandescil Drawings, schedules and documents:  
25998/005 - Proposed Site Layout  
25998/007 - Proposed Drainage Layout  
25998/100 - Containment Bund Slab & Joint Details  
25998/101 - Handstanding & Kerbing Details
  - Should any deviations or changes to specifications be made to the approved Plandescil Ltd silage clamp details during construction, Plandescil Ltd to be notified.
  - Drawing in agreement with the contractor and Silage Clamp Wall supplier (ARK Agriculture)

- SILAGE CLAMP CONSTRUCTION:**
- Materials must NOT contain Limestone, including D.F.T Type 1 and concrete aggregate.
  - All Asphalt to be made with Granite or other acid resistant aggregate (No Limestone filler permitted).
  - All Leachate water pipes to be uPVC (Foul Pipe), NOT Concrete or Twin Wall.
  - All surface water pipes to be uPVC Twin Wall, NOT Concrete.
  - All Leachate Manholes to be coated internally with bitumen sealant (Sides & Bottom).
  - Silage clamps & drainage design to comply with latest SSAFO and CRIA C759 guidance.

ALL PROPRIETARY MATERIALS TO BE FIXED STRICTLY IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS USING MATERIALS APPROVED BY THE MANUFACTURER.

**APPROVAL & COMMENT**

Rev	Date	Rev By	Chk'd	Description
A	17-06-20	CMH	OAJ	Amendments to clamp makeup
0	12-06-20		OAJ	First Issue

**plandescil**  
consulting engineers

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civil / structural / environmental / surveying

Client  
**O'Brien Moran & Co Ltd.**

Project  
**Proposed AD Plant  
Lower Drayton Farm  
Penkridge, Staffordshire**

Drawing Title  
**Silage Clamp Sections  
& Details**


Scale	U.N.O.	Date	Drawn By
	As Noted (A0)	June 2020	CMH
Drawing No.	Rev		
25998/103	A		



## Surface Water Maintenance Schedule

Feature	Schedule	Required Action	Frequency
Drainage (infiltration)	Regular	Inspect and identify any areas that are not operating correctly. If required take remedial action.	Monthly for 3 months then annually
		Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
		Maintain vegetation to designed limits within the vicinity of below ground drainage pipes to avoid damage to system.	Monthly or as required
		Inspect rainwater down pipes, channel drains and road gullies, removing obstructions and silt as necessary. Check there is no physical damage.	Monthly
	Occasional	Remove silt and leaf build up from manholes, gutters etc.	Annually (or as required).
		Remove sediment from pre-treatment inlet structures and inspection chambers.	Annually (or as required).
		Remove inspection covers and inspect, ensuring that the water is flowing freely and that the exit route for water is unobstructed. Remove debris and silt.	Annually
		Removal of sediment, oil, grease and floatables from separator	Half yearly. (or as required).
	Remedial	Replacement of malfunctioning parts.	As required.
		Repair physical damage if necessary	As required
	Monitoring	Inspect inlets and pre-treatment systems for silt accumulation. Establish appropriate silt removal frequencies.	Half yearly.
		Undertake inspection after leaf fall in Autumn	Annually
		Inspect all inlets, outlets and vents to ensure that they are in good condition and operating as designed.	Annually
		Survey inside of pipe runs for sediment build up and remove if necessary.	Every 5 years or as required
		Check manholes, gutters etc. for silt and leaf build up.	Annually



Plandescil Limited		Page 1
42-44 Connaught Road Attleborough Norfolk NR17 2BW	25998	
Date 23/06/2020 File 25998 Pond Size Rev A.SRCX	Designed by MJH Checked by MJH	
Innovyze		Source Control 2019.1

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 187 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m <sup>3</sup> )	Status
15 min Summer	0.416	0.416	14.3	185.6	O K
30 min Summer	0.502	0.502	16.2	237.1	O K
60 min Summer	0.566	0.566	17.7	278.9	O K
120 min Summer	0.593	0.593	18.3	297.5	O K
180 min Summer	0.593	0.593	18.3	297.3	O K
240 min Summer	0.586	0.586	18.1	292.8	O K
360 min Summer	0.565	0.565	17.6	278.0	O K
480 min Summer	0.539	0.539	17.0	260.7	O K
600 min Summer	0.513	0.513	16.4	243.9	O K
720 min Summer	0.488	0.488	15.9	228.5	O K
960 min Summer	0.444	0.444	14.9	201.5	O K
1440 min Summer	0.370	0.370	13.3	159.8	O K
2160 min Summer	0.287	0.287	11.5	116.8	O K
2880 min Summer	0.226	0.226	10.2	88.3	O K
4320 min Summer	0.143	0.143	8.5	52.5	O K
5760 min Summer	0.092	0.092	7.4	32.4	O K
7200 min Summer	0.062	0.062	6.8	21.5	O K
8640 min Summer	0.049	0.049	6.5	16.8	O K
10080 min Summer	0.045	0.045	5.9	15.4	O K
15 min Winter	0.456	0.456	15.2	208.6	O K
30 min Winter	0.549	0.549	17.3	267.4	O K
60 min Winter	0.619	0.619	18.9	316.0	O K
120 min Winter	0.654	0.654	19.7	341.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m <sup>3</sup> )	Time-Peak (mins)
15 min Summer	156.894	0.0	18
30 min Summer	103.367	0.0	33
60 min Summer	64.564	0.0	62
120 min Summer	38.694	0.0	116
180 min Summer	28.314	0.0	144
240 min Summer	22.550	0.0	176
360 min Summer	16.211	0.0	244
480 min Summer	12.743	0.0	314
600 min Summer	10.539	0.0	382
720 min Summer	9.009	0.0	450
960 min Summer	7.011	0.0	580
1440 min Summer	4.907	0.0	838
2160 min Summer	3.427	0.0	1212
2880 min Summer	2.665	0.0	1584
4320 min Summer	1.893	0.0	2292
5760 min Summer	1.504	0.0	3000
7200 min Summer	1.279	0.0	3680
8640 min Summer	1.133	0.0	4400
10080 min Summer	1.032	0.0	5088
15 min Winter	156.894	0.0	18
30 min Winter	103.367	0.0	32
60 min Winter	64.564	0.0	60
120 min Winter	38.694	0.0	116

42-44 Connaught Road  
 Attleborough  
 Norfolk NR17 2BW

25998



Date 23/06/2020

Designed by MJH

File 25998 Pond Size Rev A.SRCX

Checked by MJH


Innovyze

Source Control 2019.1

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m <sup>3</sup> )	Status
180 min Winter	0.651	0.651	19.7	339.0	O K
240 min Winter	0.643	0.643	19.5	333.5	O K
360 min Winter	0.616	0.616	18.8	313.7	O K
480 min Winter	0.583	0.583	18.1	290.3	O K
600 min Winter	0.548	0.548	17.3	267.2	O K
720 min Winter	0.516	0.516	16.5	246.0	O K
960 min Winter	0.457	0.457	15.2	209.2	O K
1440 min Winter	0.360	0.360	13.0	154.2	O K
2160 min Winter	0.253	0.253	10.7	100.8	O K
2880 min Winter	0.179	0.179	9.2	67.5	O K
4320 min Winter	0.083	0.083	7.3	29.3	O K
5760 min Winter	0.047	0.047	6.2	16.1	O K
7200 min Winter	0.041	0.041	5.4	14.0	O K
8640 min Winter	0.037	0.037	4.7	12.5	O K
10080 min Winter	0.034	0.034	4.4	11.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m <sup>3</sup> )	Time-Peak (mins)
180 min Winter	28.314	0.0	154
240 min Winter	22.550	0.0	186
360 min Winter	16.211	0.0	264
480 min Winter	12.743	0.0	338
600 min Winter	10.539	0.0	412
720 min Winter	9.009	0.0	484
960 min Winter	7.011	0.0	624
1440 min Winter	4.907	0.0	882
2160 min Winter	3.427	0.0	1272
2880 min Winter	2.665	0.0	1640
4320 min Winter	1.893	0.0	2332
5760 min Winter	1.504	0.0	2936
7200 min Winter	1.279	0.0	3664
8640 min Winter	1.133	0.0	4408
10080 min Winter	1.032	0.0	5128

Plandescil Limited		Page 3
42-44 Connaught Road Attleborough Norfolk NR17 2BW	25998	
Date 23/06/2020 File 25998 Pond Size Rev A.SRCX	Designed by MJH Checked by MJH	

Innovyze Source Control 2019.1


Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 393098 315400 SJ 93098 15400
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.665

<b>Time (mins) Area</b>		
<b>From:</b>	<b>To:</b>	<b>(ha)</b>
0	4	0.665

Plandescil Limited		Page 4
42-44 Connaught Road Attleborough Norfolk NR17 2BW	25998	
Date 23/06/2020 File 25998 Pond Size Rev A.SRCX	Designed by MJH Checked by MJH	

Innovyze Source Control 2019.1


Model Details

Storage is Online Cover Level (m) 1.700

Infiltration Basin Structure

Invert Level (m) 0.000 Safety Factor 2.0  
 Infiltration Coefficient Base (m/hr) 0.12240 Porosity 1.00  
 Infiltration Coefficient Side (m/hr) 0.12240

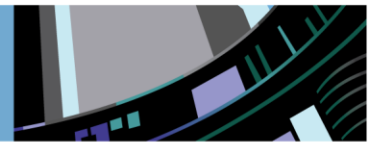
Depth (m)	Area (m <sup>2</sup> )	Depth (m)	Area (m <sup>2</sup> )	Depth (m)	Area (m <sup>2</sup> )
0.000	330.0	0.700	776.0	1.700	1105.0

Plandescil Limited		Page 5
42-44 Connaught Road Attleborough Norfolk NR17 2BW	25998	
Date 23/06/2020 File 25998 Pond Size Rev A.SRCX	Designed by MJH Checked by MJH	

Innovyze Source Control 2019.1

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
1440	0.3	2880	0.3	4320	0.3	5760	0.3	7200	0.3	8640	0.3	10080	0.3



Our Ref: H77020

Your Ref:

Chkd: CDW

14 November 2019

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 Middlesbrough  
 TS2 1PS

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 Venture Court  
 Queens Meadow Business Park  
 Hartlepool  
 TS25 5TG

**telephone**

01429 239539

**email**

hartlepool@jnpgroup.co.uk

**For the attention of Paul Hetherington**

Dear Paul,

**Re: Proposed Biogas Plant, Penkrige**

Further to your recent instruction, an engineer from **jnp**group attended site on 22<sup>nd</sup> October 2019 in order to undertake repeatable soakaway tests in accordance with BRE 365 at three locations P1, S2C and S3. A fourth location, S1, was also attempted however a significant depth of Made Ground was encountered, deeming the location unsuitable to use for infiltration testing. Two other locations were attempted at S2 and S2B, however these were abandoned due to shallow instability of the ground and groundwater seepage at depths below 1.75 m below ground level (bgl).

The site is a currently a vacant area of land south of the main farmyard buildings for Low Drayton Farm which can be accessed off a single-track road that runs to the western edge of the site. The site was bounded by hedgerows at all boundaries with significant foliage located along the eastern boundary. Open fields, most likely used for grazing surround the site. General photographs of the site are included as Appendix A to this letter.

The site was generally flat, with a small southern facing slope that crested just north of the locations of the trial holes that were excavated. In the east of the site there is a dirt track used for racing, along with fencing which is associated with this. A number of small bushes are present across the site and localised areas of fly tipping also noted.

The soakaways pits were excavated utilising a JCB 3cx with a two-foot bucket. A one-foot bucket was used for excavating the small trial hole at P1. Logs are included as Appendix B. For locations S2, S2B, S2C, S3 and P1 grass overlying between 0.05 m – 0.10 m of brown sandy topsoil, which in turn was underlain by light brown, slightly orange very silty sand with occasional rounded medium to coarse quartzite gravel and very sandy silty clay to a maximum proven depth of 2.20 m bgl. Location S1 encountered grass overlain by brown sandy clay and black / brown gravelly sandy clay with the gravel fraction comprising brick, clinker, charred wood and other debris most likely from a previous building on-site.

Soakaways were undertaken at locations S2C and S3, as shown on the attached site location plan. The depths of the soakaways excavated ranged from 1.55 m – 1.70 m. All excavations were terminated due to difficulty excavating the Chalk.

- Civil Engineering
- Consulting
- Flood Risk
- Geo-Environmental
- Green Energy
- Rail
- Structural Engineering
- Transport Planning

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10234789 England

**JNP Group** is the trading name of JNP Group Consulting Engineers Ltd.



Each soakaway location was charged with water on two consecutive occasions. The reduction in water level was recorded until the soakaways were empty and this data was used to calculate infiltration rates as detailed in the table below.

Table 1 – Infiltration Rates

Soakaway Location	Test 1	Test 2
S2C	3.6x10 <sup>-5</sup> m/sec	3.8x10 <sup>-5</sup> m/sec
SA3	4.3x10 <sup>-5</sup> m/sec	3.4x10 <sup>-5</sup> m/sec

It is recommended that the lowest recorded infiltration rate for each test location should be utilised for design purposes. The full soakaway results are included as Appendix C.

Location P1 was used to undertake a percolation test. The proposed hole was excavated to 1.00 m bgl with a two-foot bucket, before using a one-foot bucket to excavate a 0.30 m deep excavation at the proposed invert level of the drainage design. This hole was then filled in accordance with 'TDS0005P Drainage Fields also known as Sub-Surface Irrigation Systems' from Kingspan Environmental. The excavation was filled a total of six times. This was limited due to the finite amount of water that was ordered to site. Table 2 below summarises the findings.

Table 2 – Percolation test results

Test	Time for full drainage (seconds)	Time for reduction from 25% - 75% effective depth (seconds)	Vp (percolation value)
P1 test 1	600	300	2.000
P1 test 2	590	325	2.167
P1 test 3	585	310	2.067
P1 test 4	660	400	2.667
P1 test 5	575	330	2.334
P1 test 6	550	335	2.334

We trust that the above and attached are sufficient for your current needs, however, should you require anything further please do not hesitate in contacting the undersigned.

Yours sincerely



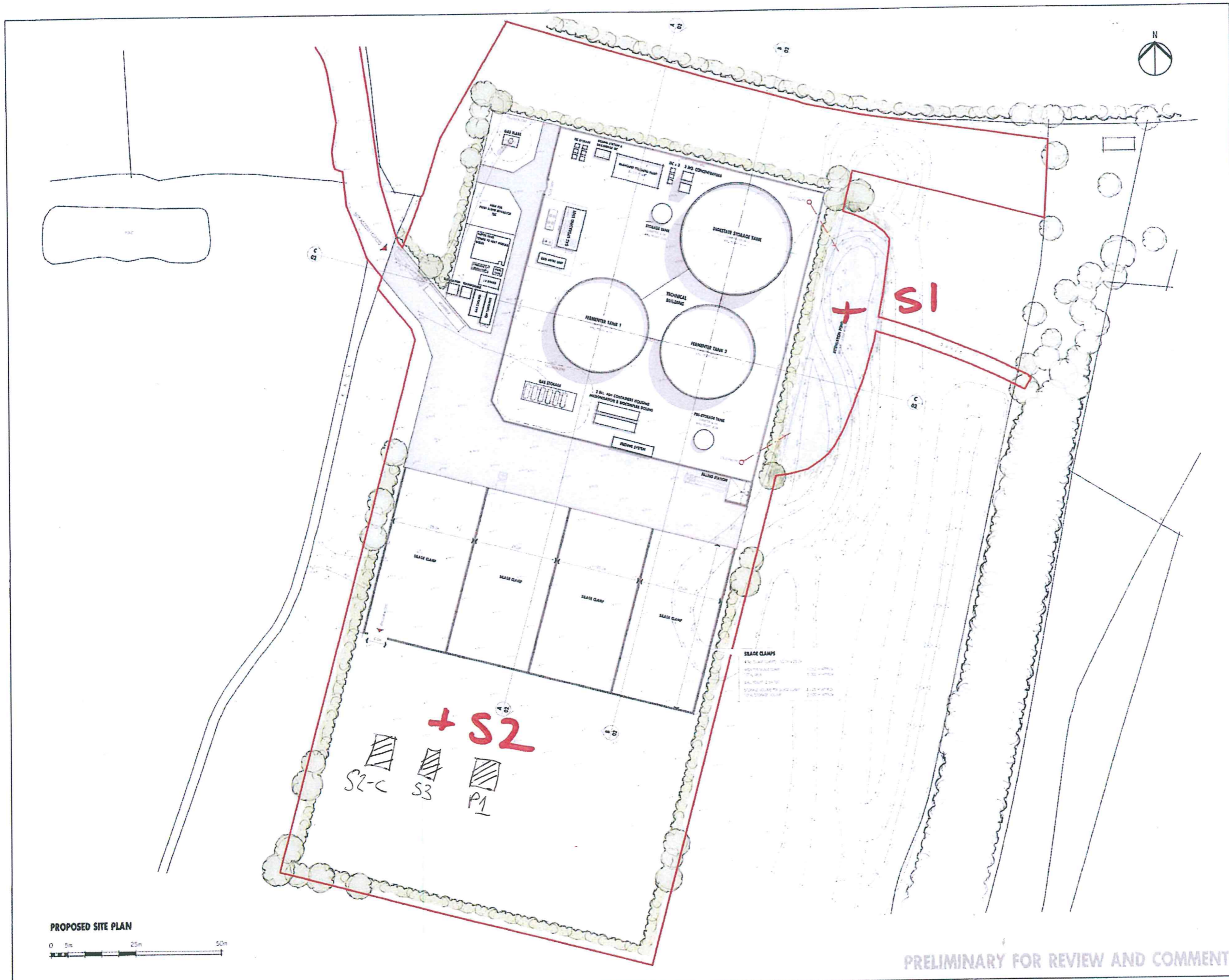
**Edward Tainsh**  
**BSc**  
**Assistant Geo-environmental Engineer**

# Drawings





DO NOT SCALE. All dimensions must be checked/verified on site.



C 23 JULY 19 REVISED FOLLOWING CLIENT COMMENTS  
 B 18 JULY 19 REVISED FOLLOWING CLIENT MEETING  
 A 18 JULY 19 ISSUED FOR REVIEW AND COMMENT

**HarkinAssociates**  
 Design | Architecture

BRITAINIA HOUSE, SUITE 15, BRIGGATE ROAD,  
 RIVERSIDE PARK, WIDLESBROUGH, LEICESTERSHIRE, LE19 1RQ  
 TEL: 01534 24 890  
 EMAIL: [info@harkinassociates.net](mailto:info@harkinassociates.net)

Client: **BIOCONSTRUCT**

Job Title:  
 PROPOSED BIOGAS PLANT  
 LOWER DRAYTON FARM  
 FENRIDGE  
 STAFFORD ST19 5RZ

Drawing Title:  
**PROPOSED SITE PLAN**

Scale.	Date.	Drawn.	Checked.
1:500 @ A1	18 JULY 19	NLN	MJM

Drawing No.	Rev.
<b>19-1469-01</b>	C

PRELIMINARY FOR REVIEW AND COMMENT

# Appendix A

## Site Photographs





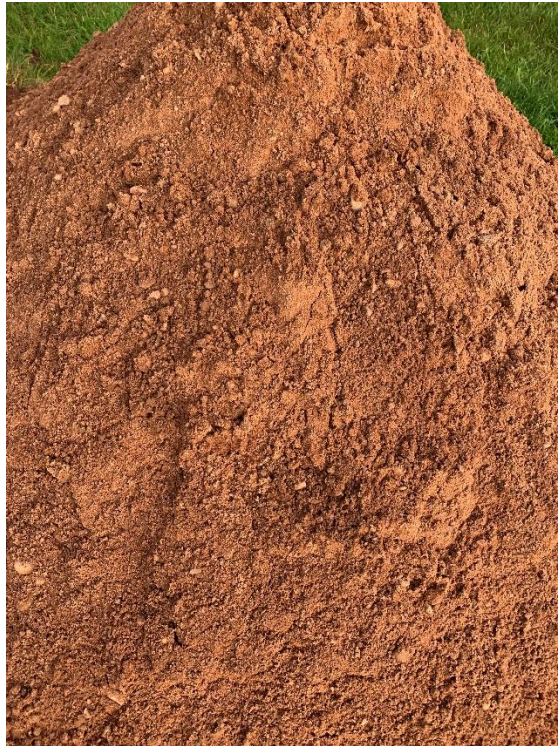


Photograph 1 - location S2, evidence of seepage at base of excavation



Photograph 2 - location S1, arisings with evidence of Made Ground





Photograph 3 – location S2C, arisings



Photograph 4 – location S2B, sidewall collapse

# Appendix B

## Soakaway Test Pit Logs



# Trial Pit Log

Trialpit No

**P1**

Sheet 1 of 1

Project Name: Proposed Biogas plant at Penkridge

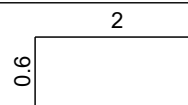
Project No.  
H77020

Co-ords: 393060.00 - 315300.00  
Level:

Date  
24/10/2019

Location: Penkridge

Dimensions (m):

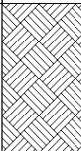
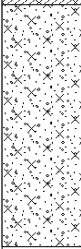


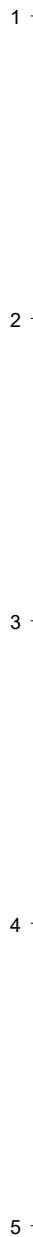
Scale  
1:25

Client: Harkin Associates

Depth  
1.30

Logged  
ET

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.50			Grass overlying brown sandy gravelly TOPSOIL TOPSOIL
				1.30			Brown slightly silty SAND with occasional quartzite gravel GLACIOFLUVIAL DEPOSITS
							End of pit at 1.30 m



Remarks: 0.30 m wide from 1.00 - 1.30 m

Stability:



# Trial Pit Log

Trialpit No

**S1**

Sheet 1 of 1

Project Name: Proposed Biogas plant at Penkridge

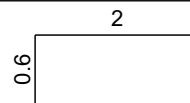
Project No.  
H77020

Co-ords: 393133.00 - 315423.00  
Level:

Date  
24/10/2019

Location: Penkridge

Dimensions (m):



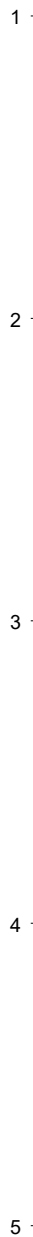
Scale  
1:25

Client: Harkin Associates

Depth  
2.00

Logged  
ET

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.30			Grass overlying brown sandy gravelly TOPSOIL. MADE GROUND
							Black / dark brown slightly sandy gravelly CLAY. Gravel is brick, wood, concrete, burnt wood with occasional clinker. MADE GROUND
				2.00			End of pit at 2.00 m



Remarks:

Stability:



# Trial Pit Log

Trialpit No

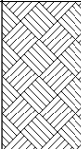
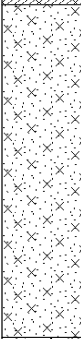
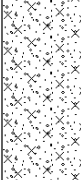
**S2**

Sheet 1 of 1

Project Name: Proposed Biogas plant at Penkridge	Project No. H77020	Co-ords: 393044.00 - 315313.00 Level:	Date 24/10/2019
--	--------------------	--	--------------------

Location: Penkridge	Dimensions (m): Depth 2.20	2 	Scale 1:25 Logged ET
---------------------	-------------------------------	--	-------------------------------

Client: Harkin Associates

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
				0.50			Grass overlying brown sandy gravelly TOPSOIL. TOPSOIL	
				1.60			Brown silty SAND with occasional quartzite gravel. GLACIOFLUVIAL DEPOSITS	1
				2.20			Brown slightly gravelly silty SAND. Gravel is fine to medium sized rounded quartzite. GLACIOFLUVIAL DEPOSITS	2
							----- End of pit at 2.20 m	3
								4
								5

Remarks:

Stability:





# Trial Pit Log

Trialpit No

**S2B**

Sheet 1 of 1

Project Name: Proposed Biogas plant at Penkridge

Project No.  
H77020

Co-ords: 393039.00 - 315308.00  
Level:

Date  
24/10/2019

Location: Penkridge

Dimensions (m):

2

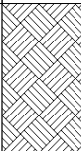
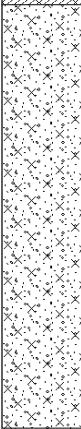
Depth  
1.90

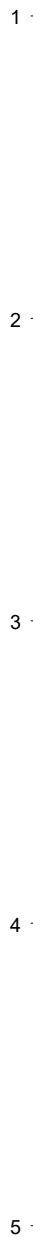
0.9

Scale  
1:25

Logged  
ET

Client: Harkin Associates

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.50			Grass overlying brown sandy gravelly TOPSOIL. TOPSOIL
				1.90			Brown slightly gravelly silty SAND. Gravel is fine to medium sized rounded quartzite. GLACIOFLUVIAL DEPOSITS
							End of pit at 1.90 m



Remarks: Side wall collapse at 1.80 m

Stability:



# Trial Pit Log

Trialpit No

**S2C**

Sheet 1 of 1

Project Name: Proposed Biogas plant at Penkridge

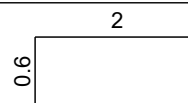
Project No.  
H77020

Co-ords: 393039.00 - 315300.00  
Level:

Date  
24/10/2019

Location: Penkridge

Dimensions (m):

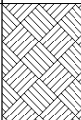
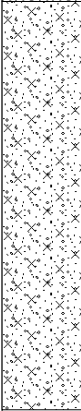


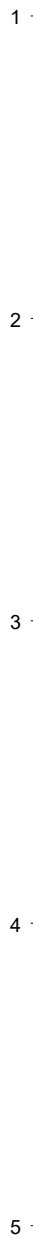
Scale  
1:25

Client: Harkin Associates

Depth  
1.60

Logged  
ET

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.40			Grass overlying brown sandy gravelly TOPSOIL. TOPSOIL
				1.75			Brown silty SAND with occasional quartzite gravel. GLACIOFLUVIAL DEPOSITS
							End of pit at 1.60 m



Remarks:

Stability:



# Trial Pit Log

Trialpit No

**S3**

Sheet 1 of 1

Project Name: Proposed Biogas plant at Penkridge

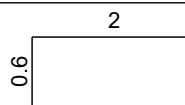
Project No.  
H77020

Co-ords: 393050.00 - 315300.00  
Level:

Date  
24/10/2019

Location: Penkridge

Dimensions (m):

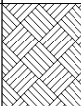
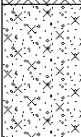
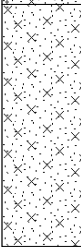


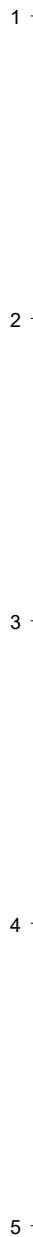
Scale  
1:25

Client: Harkin Associates

Depth  
1.75

Logged  
ET

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.35			Grass overlying brown sandy gravelly TOPSOIL. TOPSOIL
				0.80			Brown silty SAND with occasional quartzite gravel. GLACIOFLUVIAL DEPOSITS
				1.60			Brown silty SAND. GLACIOFLUVIAL DEPOSITS
							End of pit at 1.75 m



Remarks:

Stability:



# Appendix C

## Soakaway Test Results





**SOIL INFILTRATION TEST**

Project:  
Penkridge Biogas

Project No:  
H77020

Test Location: S2-C

Test No: 1

Date: 22 Oct 2019

Water level during test

Time mins	Depth m bgl
0	1.100
6	1.150
20	1.200
30	1.250
40	1.300
50	1.330
60	1.400
70	1.480
80	1.520
90	1.550
100	1.600
120	1.650
130	1.700

Trial pit dimensions

depth (m)	1.70
length (m)	2.00
width (m)	0.60

$$f = \frac{V_{p75-25}}{a_{s50} \times t_{p75-25}}$$

*f* = soil infiltration rate

*V*<sub>p75-25</sub> = volume of water from 75% to 25% effective depth

*a*<sub>s50</sub> = internal surface area at 50% effective depth

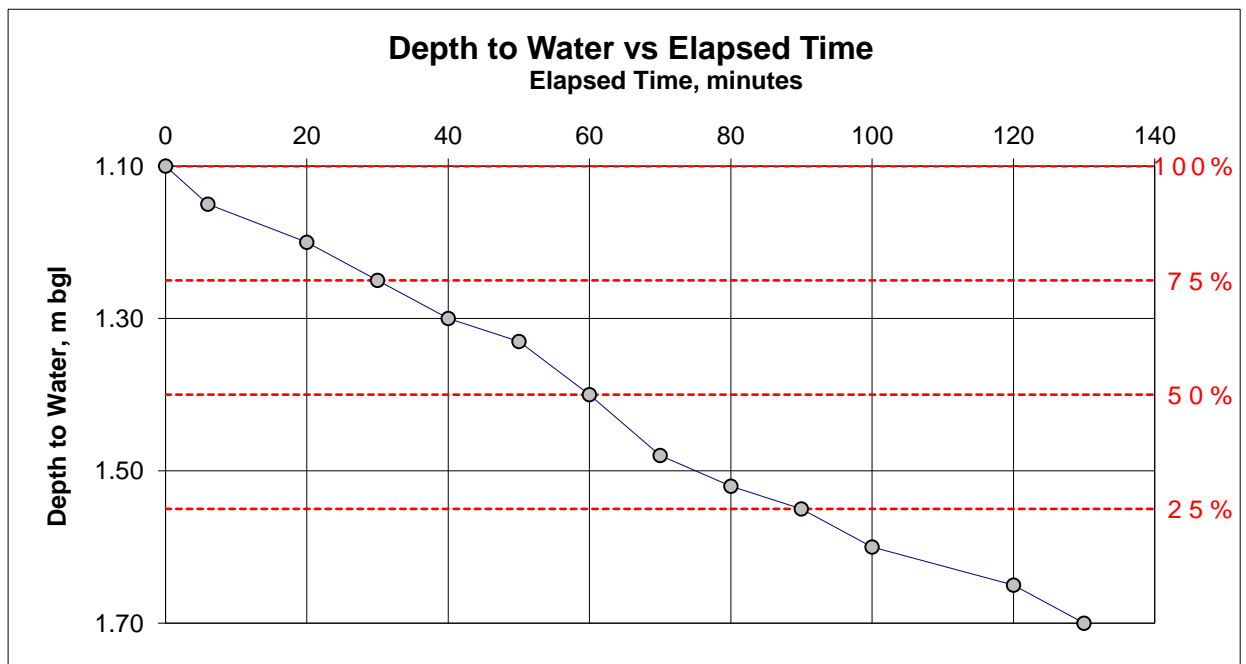
*t*<sub>p75-25</sub> = time for the water level to fall from 75% to 25% effective depth

time at 75% effective depth (mins) 30

time at 25% effective depth (mins) 90

(from graph)

**Calculated Soil Infiltration Rate = 3.6E-05 m/sec**





Test Location: S2-C

Test No: 2

Date: 22 Oct 2019

Water level during test

Time mins	Depth m bgl
0	1.100
10	1.150
20	1.200
30	1.330
40	1.380
50	1.400
60	1.420
70	1.450
80	1.520
90	1.550
100	1.580
110	1.600
120	1.650

Trial pit dimensions

depth (m)	1.65
length (m)	2.00
width (m)	0.60

$$f = \frac{V_{p75-25}}{a_{s50} \times t_{p75-25}}$$

*f* = soil infiltration rate

*V<sub>p75-25</sub>* = volume of water from 75% to 25% effective depth

*a<sub>s50</sub>* = internal surface area at 50% effective depth

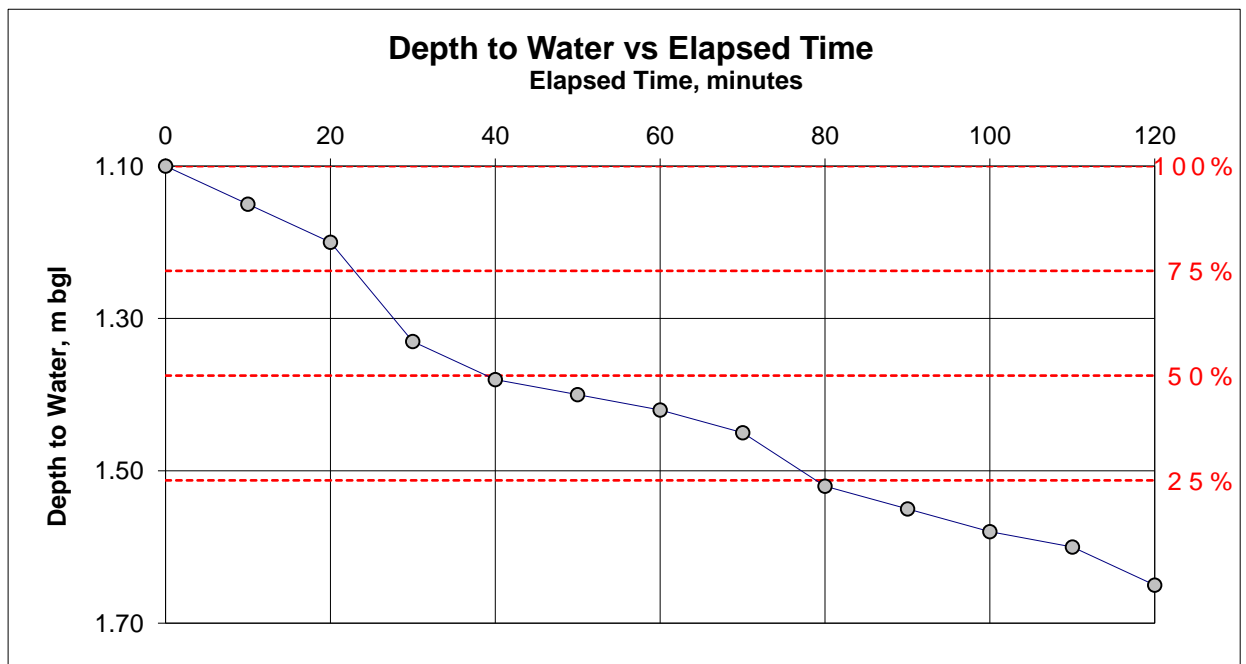
*t<sub>p75-25</sub>* = time for the water level to fall from 75% to 25% effective depth

time at 75% effective depth (mins) 25

time at 25% effective depth (mins) 80

(from graph)

**Calculated Soil Infiltration Rate = 3.8E-05 m/sec**





**SOIL INFILTRATION TEST**

**Project:**  
Penkridge Biogas

**Project No:**  
H77020

Test Location: S3

Test No: 1

Date: 22 Oct 2019

Water level during test

Time mins	Depth m bgl
0	1.000
10	1.200
20	1.300
30	1.350
40	1.380
50	1.410
60	1.450
70	1.480
80	1.500
90	1.520
100	1.550
110	1.580
120	1.600

Trial pit dimensions

depth (m)	1.60
length (m)	2.00
width (m)	0.60

$$f = \frac{V_{p75-25}}{a_{s50} \times t_{p75-25}}$$

*f* = soil infiltration rate

*V*<sub>p75-25</sub> = volume of water from 75% to 25% effective depth

*a*<sub>s50</sub> = internal surface area at 50% effective depth

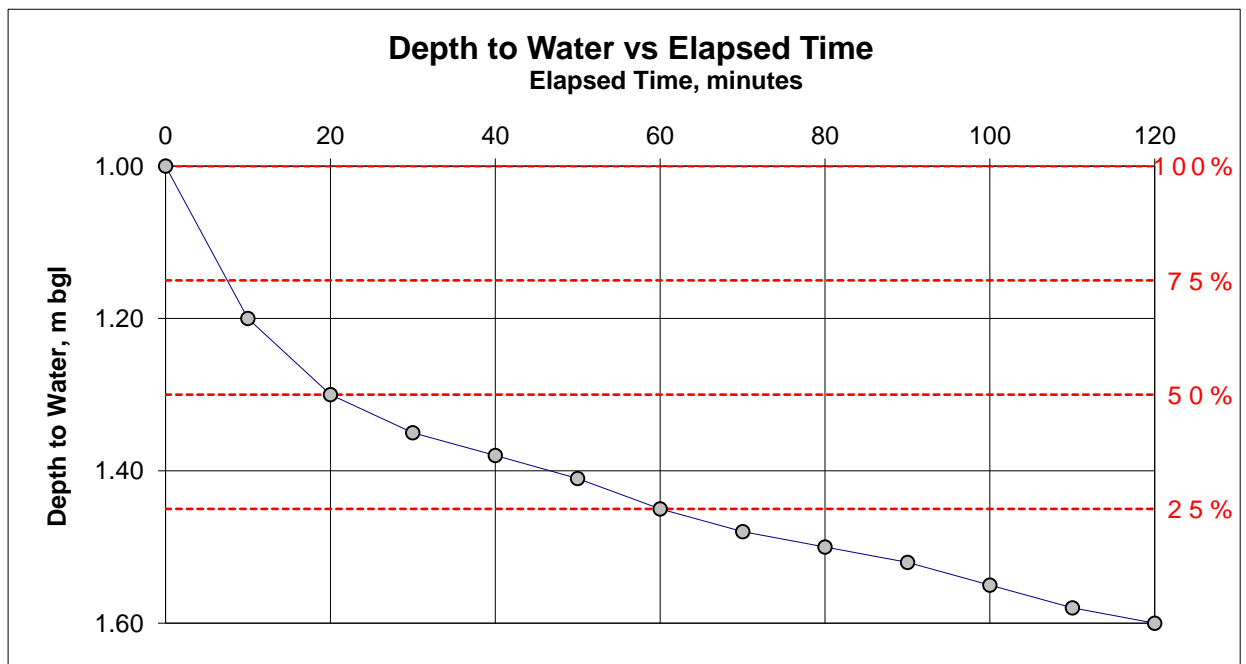
*t*<sub>p75-25</sub> = time for the water level to fall from 75% to 25% effective depth

time at 75% effective depth (mins) 9

time at 25% effective depth (mins) 60

(from graph)

**Calculated Soil Infiltration Rate = 4.3E-05 m/sec**





**SOIL INFILTRATION TEST**

Project:  
Penkridge Biogas

Project No:  
H77020

Test Location: S3

Test No: 2

Date: 22 Oct 2019

Water level during test

Time mins	Depth m bgl
0	1.000
10	1.080
20	1.120
30	1.150
40	1.200
50	1.260
60	1.300
70	1.360
80	1.400
90	1.410
100	1.430
110	1.450
120	1.480
130	1.510
140	1.520
150	1.550

Trial pit dimensions

depth (m)	1.55
length (m)	2.00
width (m)	0.60

$$f = \frac{V_{p75-25}}{a_{s50} \times t_{p75-25}}$$

*f* = soil infiltration rate

*V*<sub>p75-25</sub> = volume of water from 75% to 25% effective depth

*a*<sub>s50</sub> = internal surface area at 50% effective depth

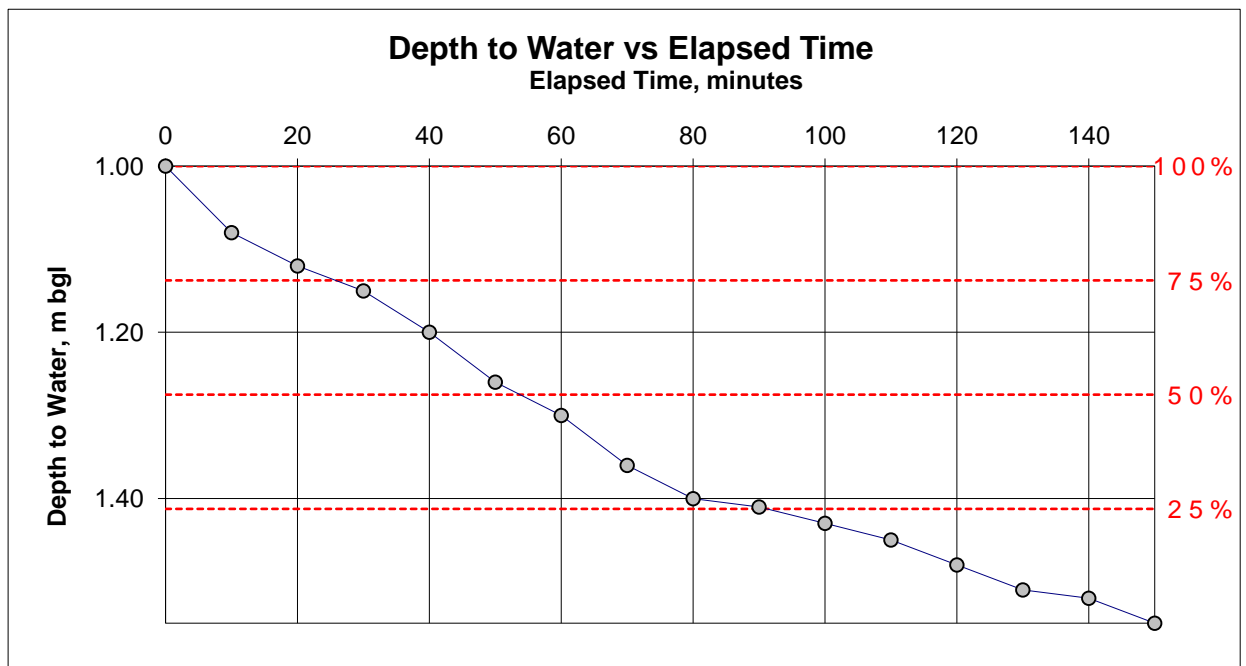
*t*<sub>p75-25</sub> = time for the water level to fall from 75% to 25% effective depth

time at 75% effective depth (mins) 29

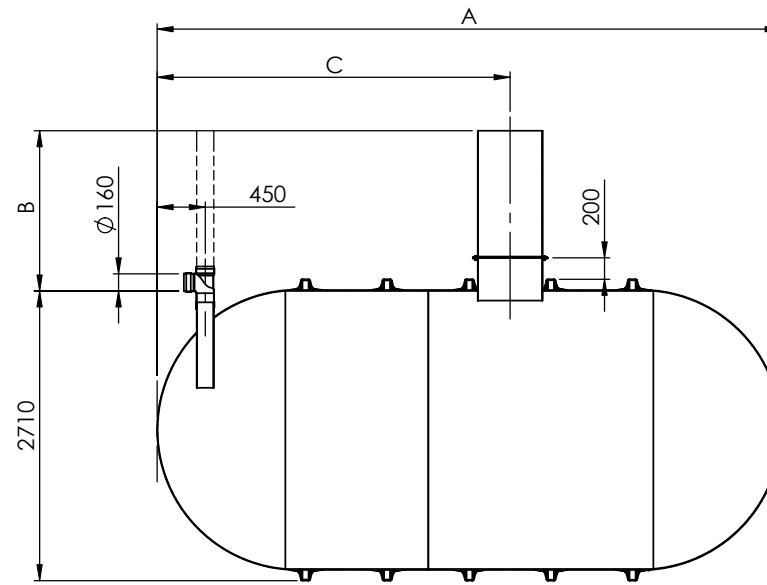
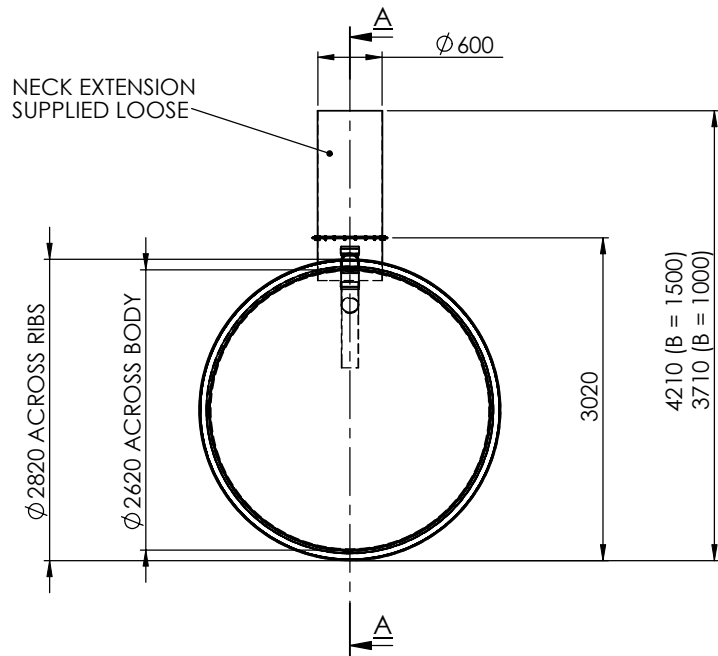
time at 25% effective depth (mins) 90

(from graph)

**Calculated Soil Infiltration Rate = 3.4E-05 m/sec**







SECTION A-A

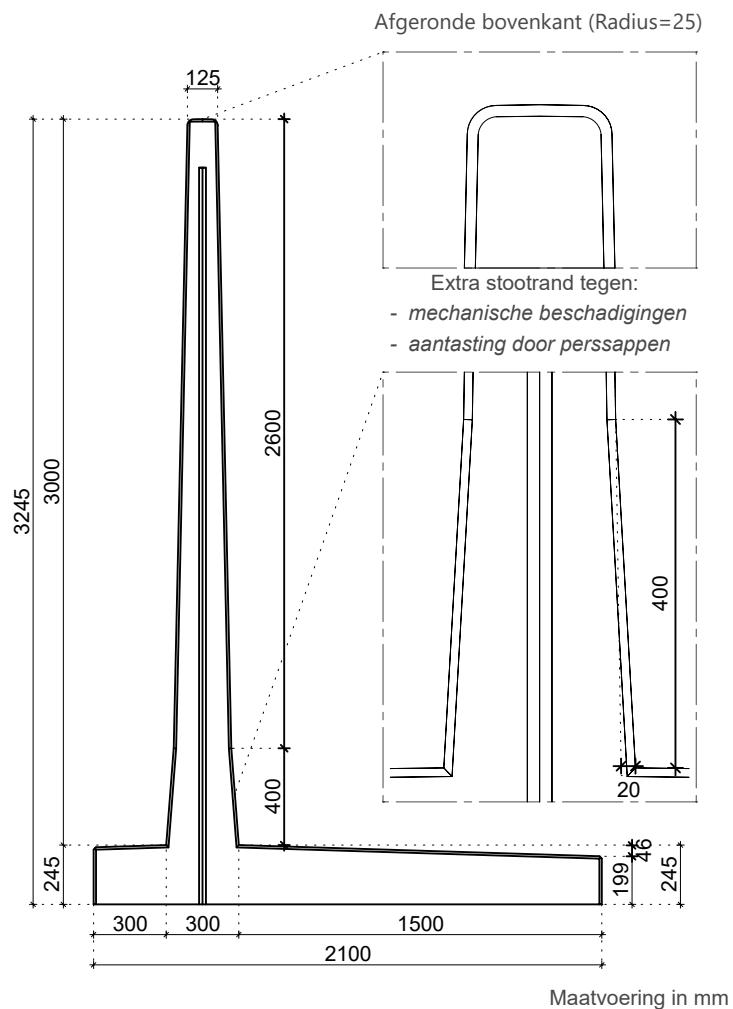
Nominal Volume (Litres)	Nominal Volume (Gallons)	Weight (Kg)	Overall Length A	Inlet invert B = 1.5 Metres	Inlet Invert B = 1.0 Metres	Dimension to neck C
18,000	3,960	646	4,317	1,500	1,000	2,547
22,000	4,889	828	5,073	1,500	1,000	3,302
26,000	5,720	981	5,837	1,500	1,000	3,302

NOTES:-

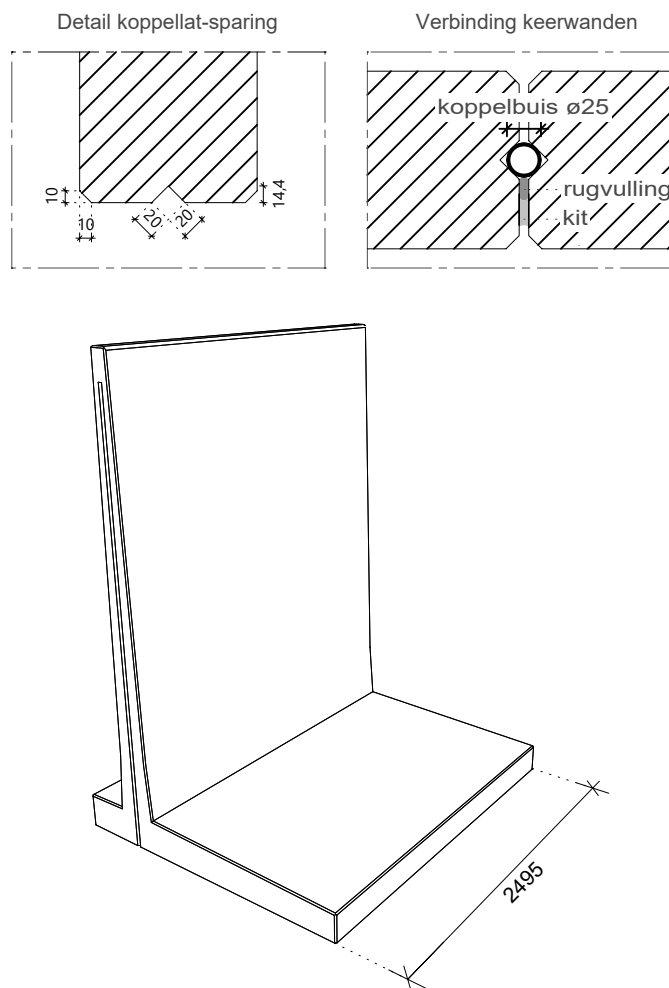
- CESSPOOLS AND SILAGE TANKS MUST NOT DISCHARGE IN TO THE ENVIRONMENT AND MUST BE EMPTIED WHEN FULL.
- THE TANK IS FITTED WITH A 160MM INLET SOCKET. PIPE ADAPTORS CAN BE PROVIDED FOR AN ALTERNATIVE SIZE OF 110mm. THESE ARE FITTED EXTERNALLY TO THE TANK.
- THIS DRAWING IS PROVIDED TO SUPPLY DIMENSIONAL INFORMATION ONLY.
- THE UNIT MUST BE INSTALLED WITH A CONCRETE SURROUND. PLEASE SEE THE DETAILED INSTALLATION PROCEDURE SUPPLIED WITH EACH UNIT.
- THE UNIT IS SUPPLIED WITH LOOSE, BOLT ON TANK SHAFTS TO SUIT EITHER 1 OR 1.5 METRE INVERT (SPECIFY WITH ORDER). THEY MUST BE FITTED ON SITE AS PART OF THE INSTALLATION AND CAN BE TRIMMED TO SUIT THE EXACT SIZE OF INVERT.
- THE UNIT IS PROVIDED WITH 1, 2 OR 3 SHAFTS, DEPENDING ON IT'S VOLUME. TO AID DE-SLUDGING IT IS RECOMMENDED THAT 2 SHAFTS ARE SELECTED FOR TANKS WITH CAPACITIES OF 34m<sup>3</sup> AND ABOVE. 3 SHAFTS SHOULD BE FITTED TO UNITS OF ABOVE 54m<sup>3</sup> (SPECIFY WITH ORDER). ADDITIONAL SHAFTS CAN BE FITTED. UNITS SHOULD NOT BE INSTALLED DEEPER THAN NECESSARY, NOR DEEPER THAN THE INVERT SPECIFIED FOR THE UNIT SUPPLIED.
- PEDESTRIAN DUTY COVER AND FRAMES TO FIT DIAMETER 600mm NECKS, ARE AVAILABLE FOR PURCHASE.
- THE WEIGHTS GIVEN ARE FOR HANDLING PURPOSES ONLY AND EXCLUDE THE BOLT ON SHAFTS.
- THE INLET PIPE SHOULD BE EXTENDED TO GROUND LEVEL. DIAMETER 450mm ACCESS COVERS ARE FOR PURCHASE TO ALLOW FOR RODDING ACCESS.
- SINGLE NECK TANKS SERVING SINGLE PROPERTIES SHOULD BE VENTED, USING THE SOIL STACK. LARGER TANKS SERVING MULTIPLE PROPERTIES SHOULD HAVE A VENT FITTED TO THE NECK TO ENABLE LOCALISED HIGH LEVEL VENTING.
- WE RECOMMEND THE PURCHASE AND USE OF A HIGH LEVEL ALARM WITH THESE TANKS.

Please Check with Environmental Treatment Systems Limited For The Latest Issue Of This Drawing				Material : Various	Tolerance (unless stated) :	Drawing : DS0963P - Ø2.6 CP - SL	Page 1 of 3	
Issue	Date	Drawn by	Approved by	Finish :	Thickness : n/a			
001	04.11.08	M.H.		Weight : 980.96 Kg	Surface Area : m <sup>2</sup>	SINGLE NECK CESSPOOL / SILAGE TANK		
002	27.02.09	M.H.		Modelled By : Name				
All Dimensions In mm				Scale: Do Not Scale	 Third Angle Projection		Kingspan Environmental reserve the right to alter the details of this drawing without prior notice. This drawing is copyright and may not be reproduced or used without the written permission of Kingspan Environmental	
R:\Engineering\Drawing Data\02 - Sales Drawings\DS\DS - 09\DS0963P - Ø2.6 CP - SL								

## Afmetingen



## 3D-model



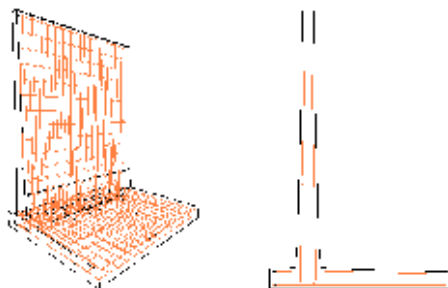
## Specificaties

- Betonkwaliteit: C 60/75 (Hogesterkebeton)
- Milieuklasse: XC4; XF3; XD3
- Gewicht: 6330 kg
- Wapeningstaal: B500A
- Standaardlengte: 2495 mm
- Betondekking: 30 mm
- Alle zichtzijdes zichtbetonklasse; A

## Kwaliteiten

- KOMO-certificering volgens agrarische betonproducten
- CE-certificering *zeer dichte en gladde betonstructuur*
- Volledig gecertificeerd geproduceerd met hogesterktebeton (C60/75)
- Kiwa gecontroleerde drukbankproeven voor beste productgarantie
- Veilig en vast aanrijden tot 20 ton aslast zonder randafstand
- Ontwerplevensduur 50 jaar
- Levering uit voorraad
- 15 jaar productgarantie

## Wapening



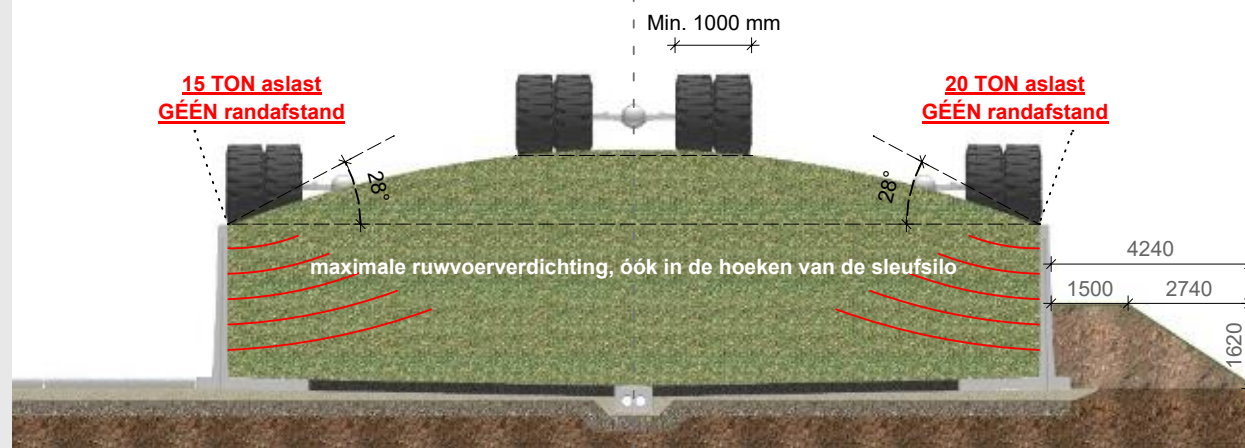
Wapening conform de nieuwste Eurocode.

## Belastingschema Vrijstaand

- Maximale voertuigbelasting zonder grondwal: 15 ton aslast, geen randafstand
- De LA-keerwand dient achter de hak ingeklemd te worden door verharding
- Afwijkende belastingen/toepassingen op aanvraag

## Belastingschema Grondwal

- Maximale voertuigbelasting met grondwal: 20 ton aslast, geen randafstand
- Grondwal conform tekening aanbrengen
- De grondwal mag niet mechanisch verdicht worden



## Volgens voorschriften

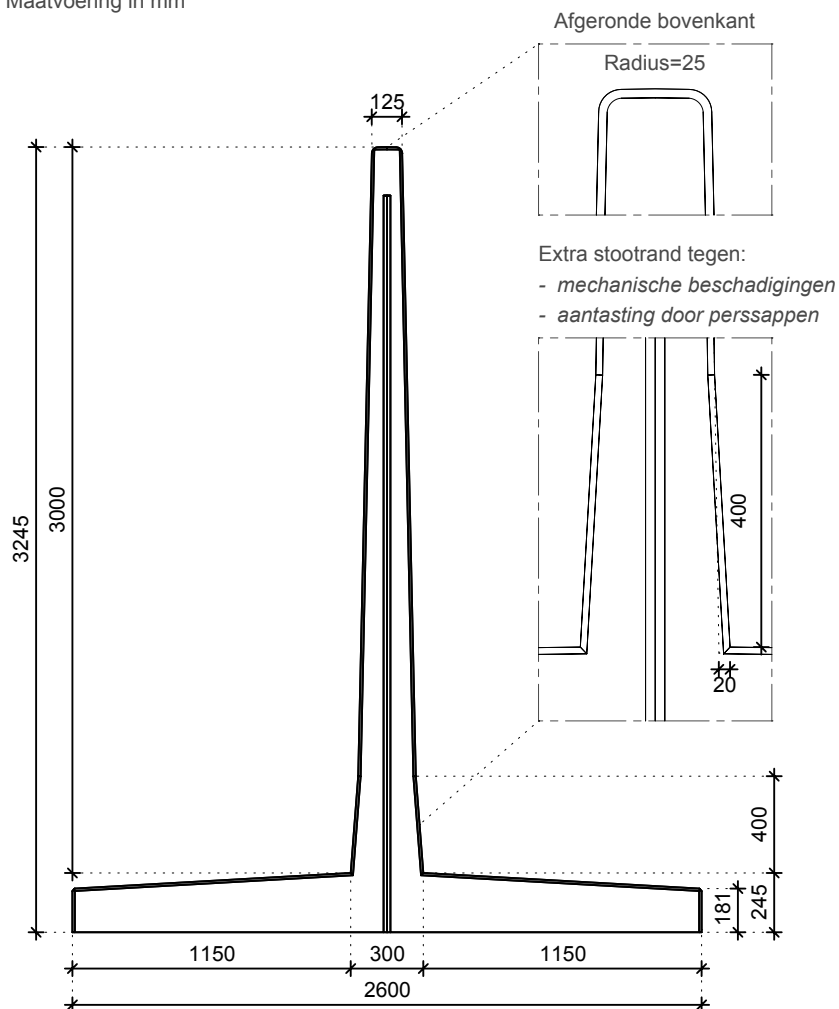
NEN-EN 1990 Eurocode 0  
 NEN-EN 1991 Eurocode 1  
 NEN-EN 1992 Eurocode 2  
 NEN-EN 1997 Eurocode 7

NEN-EN 206-1  
 NEN 8005  
 NEN 9997-2  
 Incl. nationale bijlagen

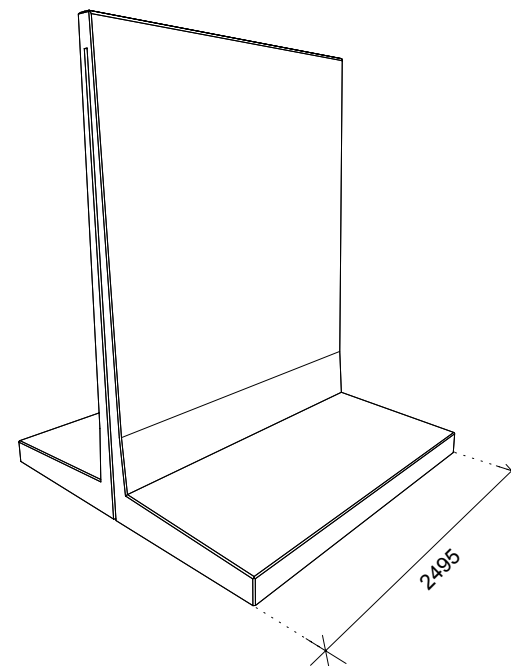


## Afmetingen

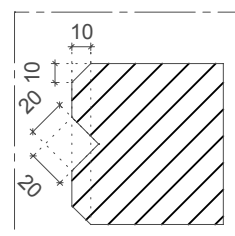
Maatvoering in mm



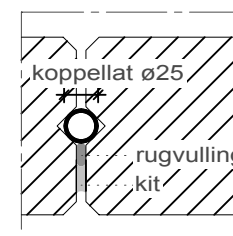
## 3D-model



Detail koppellat-sparing



Verbinding keerwanden



## Specificaties

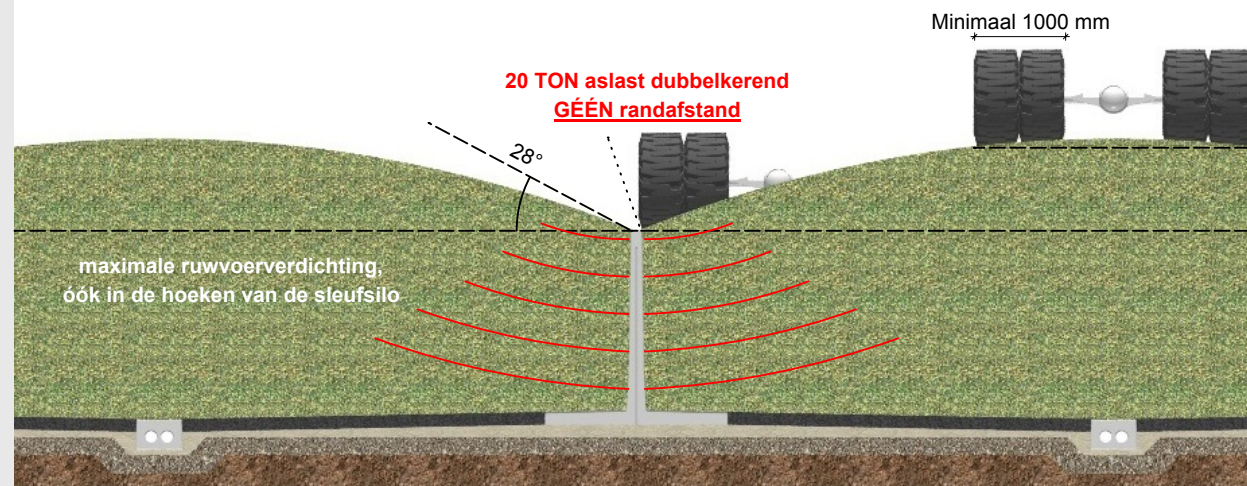
- Betonkwaliteit: C60/75 hogesterktebeton
- Gewicht: 6850 kg
- Milieuklasse: XA3, XC4, XF3
- Wapeningsstaal: B500A
- Standaardlengte: 2495 mm
- Betondekking: 30 mm
- Zichtklasse AVB1

## Kwaliteiten

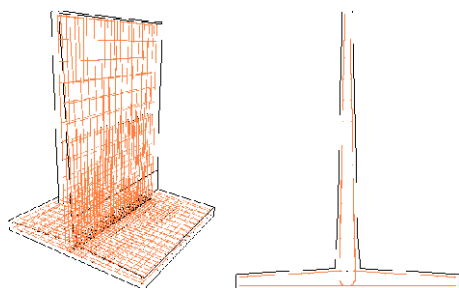
- KOMO-certificering volgens agrarische betonproducten
- CE-certificering  
*zeer dichte en gladde betonstructuur*
- Volledig gecertificeerd geproduceerd met hogesterktebeton (C60/75)
- Kiwa gecontroleerde drukbankproeven voor beste productgarantie
- Veilig en vast aanrijden tot 20 ton aslast zonder randafstand
- Ontwerplevensduur 50 jaar
- Levering uit voorraad
- 20 jaar productgarantie

## Belastingschema

- Maximale voertuigbelasting: 20 ton aslast, geen randafstand
- De wanden zijn vrijdragend en dubbelkerend
- De voet van de TWA/wand moet worden ingesloten door verharding
- Afwijkende belastingen/ toepassingen op aanvraag



## Wapening



Wapening conform de nieuwste Eurocode.

## Volgens voorschriften

NEN-EN 1990 Eurocode 0  
NEN-EN 1991 Eurocode 1  
NEN-EN 1992 Eurocode 2  
NEN-EN 1997 Eurocode 7

NEN-EN 206-1  
NEN 8005  
NEN 9997-2  
Incl. nationale bijlagen





# Tufflex® HD / HD+

Technical data sheet



**Tufflex® HD / HD+ is a unique asphalt surfacing solution designed for very heavy, slow moving traffic. It contains a Polymer Modified Binder (PMB) with an exceptionally high softening point.**

A PMB is at the heart of a unique solution that offers good protection against damage caused by heavy, slow moving traffic. The product also contains fuel resisting properties.

## **Benefits**

The main advantages of Tufflex® HD are:

- Cost-effective over the whole life
- Very high deformation resistance
- Low air void which prevents water ingress
- Fuel resisting properties
- Good workability
- Has a resistance to elevated temperatures from chemical attacks from leachates
- Good load spreading ability from very heavy, slow moving traffic at higher temperatures to prevent wheel track deformation
- Increased stiffness

The main advantages of Tufflex® HD+ are:

- Increased stiffness over Tufflex HD
- Enhanced fuel resisting properties

**Please note:** 7 days' notice required to stock specialist binder.

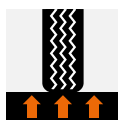
**Tufflex® HD / HD+ technical data**

Material property	Typical result	Spec limits	Report reference
Maximum density (Mg/m <sup>3</sup> )	2.499	-	MXD81-16
Bulk density – reference (Mg/m <sup>3</sup> )	2.399	-	BD150-16
Air void content – reference (%)	4.0	≤5	
Stiffness (MPa)	8,883	-	SM41-16
ITFT* (cycles to failure @ 100µstrain)	TBC	-	FT5-16
Duriez	0.92	≥0.80	DT7-16
Bulk density (Proc. D) – WT slabs (Mg/m <sup>3</sup> )	2.384	-	BD183-16
Air void content – WT slabs (%)	4.6	-	
Mean proportional rut depth (30,000 cycles) – % (large device WT)	4.7	-	WT51-16
Refusal density (Mg/m <sup>3</sup> )	2.449	-	RD15-16
Voids at refusal (%)	2.0	≥0.5	

\*Please contact the asphalt technical team at [asphaltsales@hanson.com](mailto:asphaltsales@hanson.com) for ITFT data.

**Use this product for**

- ✓ Carriageways
- ✓ Farm floors/composting areas
- ✓ Industrial areas
- ✓ Lorry parks and bus stations



RESISTANCE TO DEFORMATION



FUEL RESISTING PROPERTIES



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- Industrial, Commercial, Agricultural and Domestic building design
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- Anaerobic Digestion and Waste to Energy Project design and detail

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- Contaminated Land investigations (intrusive & non-intrusive)
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- Environmental impact assessments (EIA)
- Flood Risk Assessments
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- 1D & 2D flood modelling
- Hydraulic river modelling
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- Consent to discharge applications
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- Structural failure studies
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- Engineering Setting out
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- Volumetric analysis
- Site area computations
- Flood risk surveys using GPS active network
- Measured building floor plans and elevation surveys
- Land transfer plans to Land Registry requirements
- Drainage network surveys
- Assistance/Expert witness in land boundary disputes
- Deterioration monitoring
- Preparation of asset plans
- As built record surveys



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## **Appendix D – Containment Bund Design Report**

## **Containment Bund Design Report**

**Job No. 25998**

**Proposed Anaerobic Digestion Plant  
Lower Drayton Farm, Penkridge  
Stafford, ST19 5RE**

**Client: O'Brien Moran & Co Ltd**

**Prepared By: Alex Fitzgerald**

**July 2020**

**Revision B**



## CONTENTS

<b>CONTENTS.....</b>	<b>3</b>
<b>1.0 BACKGROUND INFORMATION.....</b>	<b>4</b>
<b>2.0 ANAEROBIC DIGESTION SITE LAYOUT, PROCESS &amp; CONCEPT.....</b>	<b>4-5</b>
<b>3.0 DESIGN &amp; METHODOLOGY OF CONTAINMENT BUND.....</b>	<b>5-7</b>
<b>4.0 REVIEW PERIODS DURING CONSTRUCTION.....</b>	<b>7</b>
<b>5.0 MAINTENANCE REGIME.....</b>	<b>7-8</b>
<b>6.0 APPENDIX DETAILS AND DRAWINGS EXPLAINED.....</b>	<b>8-9</b>

**DRAWINGS, CALCULATIONS AND SPECIFICATIONS APPENDIX**  
(Listed in 6.0 APPENDIX DETAILS AND DRAWINGS)

## 1.0 BACKGROUND INFORMATION

- 1.1 Plandescil Ltd have been commissioned to provide the construction specification and details for the civil engineering elements associated with the Anaerobic Digestion Plant at Lower Drayton Farm in Penkridge, Stafford. This appointment was received from the Civil Engineering Contractor, O'Brien Moran & Co Ltd, as well as the Process Provider, BioConstruct. The package of works consisted of a containment bund and drainage design philosophy.
- 1.2 The intention of this report is to clarify any outstanding details for the Environment Agency.

## 2.0 ANAEROBIC DIGESTION LAYOUT, PROCESS & CONCEPT

- 2.1 O'Brien Moran & Co Ltd instructed Plandescil Ltd to undertake the civil engineering design of the secondary containment bund, hardstanding areas and site drainage for the proposed Anaerobic Digestion Facility located at Lower Drayton Farm, Stafford.
- 2.2 The bund has been designed and constructed in accordance with the latest Environment Agency (EA) guidance document, CIRIA C736 - *Containment Systems for the Prevention of Pollution*. Following approval of the design by the Process Provider, O'Brien Moran & Co Ltd have been instructed to construct the containment bund in accordance with Plandescil designs. Plandescil have also been tasked with reviewing the construction of the containment bund throughout the build.
- 2.3 Upon finalisation of the site's mechanical and electrical process equipment, the size and capacity of the containment bund was established. A number of liquid-retaining structures were to be located within the secondary containment bund and had been accounted for within the capacity calculations, including:
- 1No. 33.00m diameter and 6m high fermenter tank
  - 2No. 28.00m diameter and 6m high fermenter tank
  - 1No. 12.00m diameter and 6m high input tank
- 2.4 The containment capacity is designed in accordance with CIRIA C736, with the calculations demonstrating 110% of the largest tank volume to be a greater volume than 25% of the combined volume (displayed on the attached calculation spreadsheet). The proposed footprint of the containment area allowed for the walls to be constructed to a minimum height of 1.6m, which included 250mm freeboard capacity as per page 85 of CIRIA C736. The containment bund occupies a footprint area of 6,050m<sup>2</sup>.
- 2.5 Minor reductions in level had been allowed for in the bund floor slab to enable rainfall to flow towards the designated sump collection pits. The regional specific rainfall data had been obtained and accounted for within the containment capacity checks.

- 2.6 To comply with the CIRIA C736 secondary containment requirements for the tank installations, it was agreed that all storage tanks would be constructed with their concrete bases constructed on top of the secondary containment bund floor slab. This allows for a more accurate visual integrity inspection of the storage tanks during the operation phase of the Anaerobic Digestion Facility and provides an additional level of protection to the ground below.
- 2.7 The containment bund floor slab has been designed with surface falls to allow for the drainage of liquid towards 3No. sump pits of varying size. The primary sump is to be constructed at 3.00m length, 1.00m width and 1.60m depth. Pre-formed 1.20mØ MDPE chambers with reinforced concrete surrounds are to be used for the remaining sump pits. Shallow formed channels within the containment bund concrete floor will be cast by the contractor to direct the surface water flow towards sump locations.
- 2.8 As part of the operational management of the facility, any containment bund liquid captured within the drainage sumps will be routinely checked and tested prior to being discharged to one of the proposed locations shown on the proposed drainage layout 'Plandescil Ltd Drawing No. 25998/007 Revision E'. If the containment sump water is tested as 'clean', the liquid will be pumped over the containment wall into the surface water system to the west of the site, out-falling to the 365m<sup>3</sup> infiltration pond located to the south of the site. An additional volume of clean water will discharge to the south infiltration pond from the Ekogea system within the containment bund at a maximum rate of 23m<sup>3</sup>. The polished water will first be pumped to the primary containment bund sump before it is tested and discharged.
- 2.9 Should the containment bund sump liquid be tested as 'dirty', the water will be pumped to the 1,140m<sup>3</sup> lined dirty water lagoon located to the east of the site. If required, the dirty water lagoon liquid would be pumped back to the pre-storage (buffer) or fermenter tank within the containment bund, for use within the process. The 2No. smaller sump pits to the south of the containment bund are to be presumed dirty and therefore pumped to the dirty water lagoon. A pumped connection from the south-east sump to the primary sump have also been proposed to allow the option for this area to outfall to the clean system. All options involve manually operated pumped pipework.

### **3.0 DESIGN & METHODOLOGY OF CONTAINMENT BUND**

- 3.1 Following the design approval of the containment bund wall height, footprint area and internal arrangement, Plandescil completed the base slab detailing and wall reinforcement designs. It was agreed that the bund floor would be constructed from a jointed fibre reinforced concrete mix.
- 3.2 The fibre reinforced concrete mix was designed by fibre concrete specialists, Sika. This was the preferred supplier from the local concrete batching plant used by the contractor.

The fibre mix design specification document provided by Sika's designers can be found in the Appendix, outlining the proposed static loading and design details. Sika proposed a single fibre mix specification for the concrete located under the fermenter tanks and surrounding areas, comprised of 175mm construction thickness. A layer of A393 steel mesh had been specified in the bottom of the slab to provide additional structural capacity in heavily loaded areas such as beneath fermenter tanks. A provision of 50mm cover is specified this reinforcement.

- 3.3** The containment walls are designed to water retaining concrete specification in accordance with CIRIA C736.
- 3.4** The walls are designed with a concrete toe which joins to the fibre reinforced concrete containment bund floor, creating a fully water retaining structure. The joint formed between the wall and the toe (noted as the kicker joint) during construction is waterproofed through the installation of 'Premcrete HydroStop BR' and is positioned centrally to the wall and runs along the entire perimeter of the containment bund. The joints between each six metre construction section of wall are waterproofed through the installation of 'Premcrete HydroBar PVC Rearstop' at the base of the toe and 'Premcrete HydroBar PVC Centrestop' through the centre of the wall.
- 3.5** The interaction point between the retaining wall toe and the fibre reinforced concrete containment bund floor is formed into an expansion joint. The expansion joint consists of a connecting reinforcement bar between the two slabs that allows for differential movement. Between the two slabs 'Premcrete Exafoam' is installed and 20mm thick layer of 'Premcrete Intumescent Sealant' applied to the top. At the base of the joint, 'Premcrete 240mm HydroBar PVC Rearstop' is also installed. The waterproofing details described are shown on all drawings detailing the wall section as noted in the Appendix. These include Plandescil Ltd Drawing No. 25998/080 Revision A and 25998/100 Revision B.
- 3.6** In addition to all of this, the contractor has also laid a Bentomat liner product below the jointed concrete layer to allow for an additional containment system below the entire containment bund system. This is installed in between 2No. 1200g DPM layers and sealed to the external side of the containment bund wall, 100mm above the kicker, forming a fully sealed structure. Details as presented in the Appendix.
- 3.7** The walls have been designed in accordance with CIRIA C736 and are designed to withstand the hydraulic load from a catastrophic failure and the typical operational static loads shown on the following calculation sheets in the Appendix.
- 3.8** Any post cut saw joints within the fibre reinforced concrete slab or containment wall toe will be filled with an intumescent sealant no more than twenty four hours after cutting to assure water proofing capability. The saw cut joints are to be minimum 1/4 depth and maximum 1/3 depth of the total slab thickness. Details can be found on the drawings in the Appendix.



3.9 All pipes, ducts and cables are fixed on cable trays and stanchions positioned above the concrete containment, so as to not penetrate the containment floor or walls. This has been designed in accordance with CIRIA C736 to ensure any potential leakages are visible to on-site, operational staff whilst carrying out daily inspections of the containment bund structure.

#### 4.0 REVIEW PERIODS DURING CONSTRUCTION

4.1 The construction of the containment bund will be reviewed at numerous stages throughout the construction phase. The Design Engineers, Plandescil, are responsible for visually inspecting the following elements of construction:

- Concrete surfacing finish
- Installation of waterproofing components
- Installation of joint waterproofing materials
- Defect remedial procedure and final finish

#### 5.0 AD PLANT MAINTENANCE REGIME

5.1 Lower Drayton Farm's proposed maintenance regime consists of daily visual leak inspections within the bund and weekly inspections of the containment bund structure. The daily inspection will be carried out by the Client's site operative who will look for visual signs of leakage coming from the storage tanks or mechanical equipment located within the containment bund. If any tanks are found to be leaking, repair works will be undertaken by trained personnel immediately to halt the contamination of liquid within the containment bund.

5.2 The weekly inspections will require the site operative to visually inspect the containment bund walls and floor for any signs of cracking within the concrete. If any cracks are found remedial works will immediately be undertaken, using Sikaflex resin injection 'Sikadur 52' to fill and seal the cracks. This process will be carried out by a trained operative or specialist.

5.3 Any liquid which falls within the containment bund will be drained and collected into a sump within the bund. A switch operated pump will be located within the sump which will drain any liquid into the process. Prior to the pump being engaged by the site operative a visual and odour inspection will be carried out to check for any contamination to the liquid. The drainage system has made an allowance for a pumped connection to the lagoon, so that if needed liquid could be pumped to the lagoon and then pumped back into the system as required.

5.4 The drainage system on site will be checked yearly. The site operators will check for sediment build up in manholes and pipes. The drains will be jetted where required. Manholes will be sludge gulped and checked for any signs of wear and tear, the joints will be resealed and the internals painted with bitumen paint if required.

## 6.0 APPENDIX DETAILS AND DRAWINGS EXPLAINED

### 6.1 Plandescil Ltd Details

<u>Drawing No.</u>	<u>Title</u>	<u>Comments</u>
25998/005 Rev F	Proposed Site Layout	General site overview with plant items in key
25998/007 Rev F	Proposed Drainage Layout	General site drainage overview with key
25998/008 Rev C	Concrete Jointing Layout	Construction drawing showing areas of concrete and how they would be jointed
25998/080 Rev A	1.60m Containment Bund Wall RC Details (6m Bay)	Containment bund wall reinforced concreted and waterproofing design
25998/100 Rev C	Typical Containment Bund Slab & Joint Details	Containment bund floor reinforced concrete and waterproofing design

#### Comments

25998 – Containment Capacity Calculations Rev B	Calculation for bund capacity with finalised site layout
25998 – Scenario 1 ( Generic Loading Case) Summary - Retaining wall analysis & design (EN1992)	Containment bund wall structural design calculations – Generic design loading scenario
25998 – Scenario 2 ( Hydraulic Loading Case) Summary - Retaining wall analysis & design (EN1992)	Containment bund wall structural design calculations – Catastrophic failure design loading scenario

### 6.2 Premcrete Water Bar Details for the Containment Bund

<u>Item</u>	<u>Comments</u>
Hydrobar PVC Specification	Water Bar Details used in containment
Hydrostop WSM Specification	
Hydrostop BR Safety Data Sheet	

### 6.3 Sika Fibre Reinforced Concrete Design Specification for the Containment Bund Floor

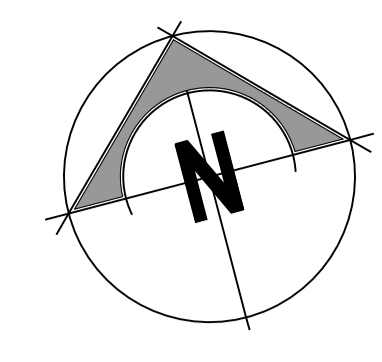
<u>Item</u>	<u>Comments</u>
SIKAFIBER® Product Proposal	Fibre reinforced concrete mix design specification for slabs on ground - Designed/approved by Sika

#### 6.4 Bentonite Liner Specification for the Containment Bund

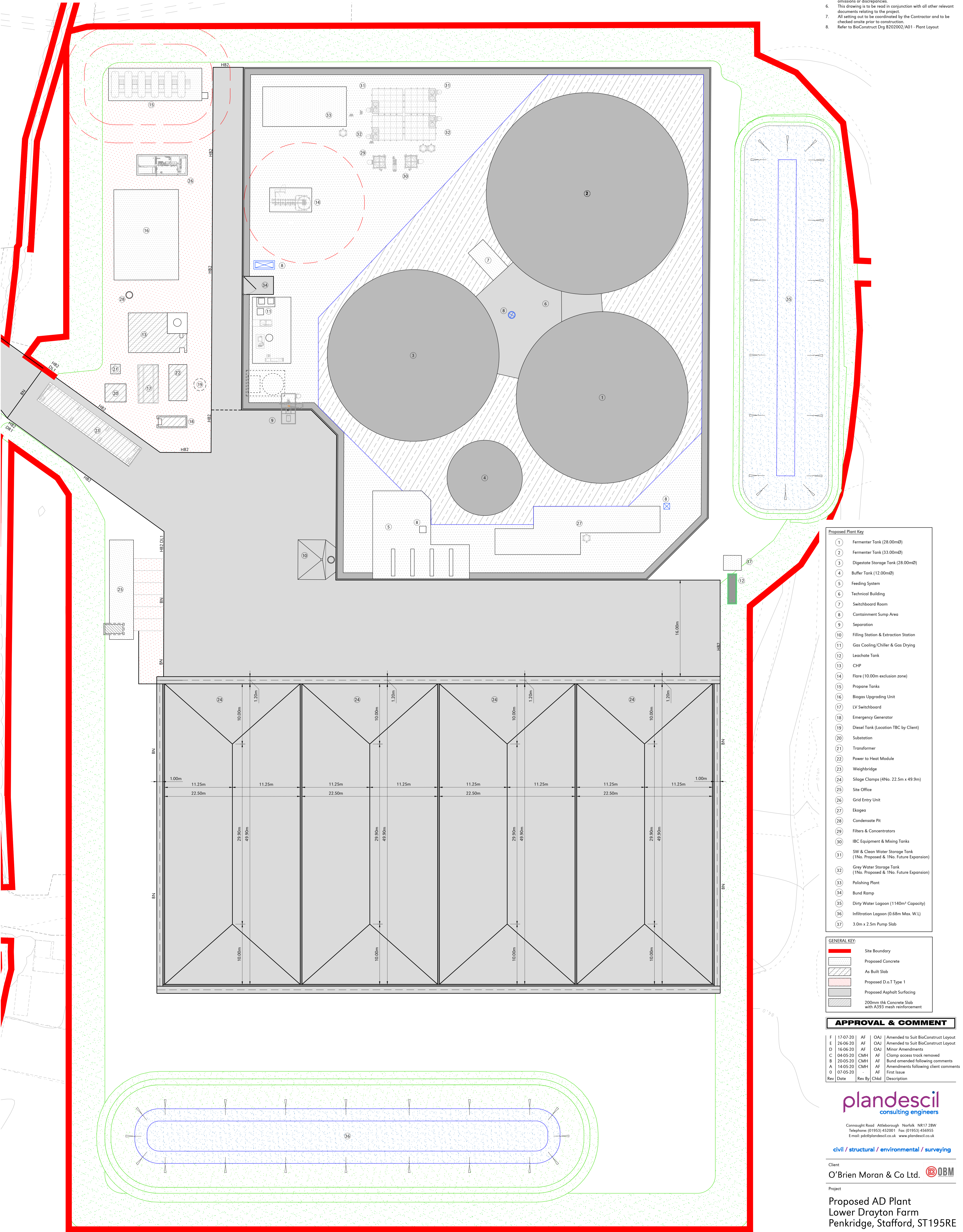
<u>Item</u>	<u>Comments</u>
BENTOMAT AS5000-1 Self	Bentonite liner sealed between 2No. 1200g DPM liners

# APPENDIX





- GENERAL NOTES:**
- All dimensions noted are in metres unless stated otherwise.
  - All levels to be above Ordnance Survey Datum defined levels (A.O.D.m) unless noted otherwise.
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  - This drawing is to be read in conjunction with all other relevant documents relating to the project.
  - All setting out to be coordinated by the Contractor and to be checked onsite prior to construction.
  - Refer to BioConstruct Drg B202002/A01 - Plant Layout



- Proposed Plant Key**
- 1 Fermenter Tank (28.00mØ)
  - 2 Fermenter Tank (33.00mØ)
  - 3 Digestate Storage Tank (28.00mØ)
  - 4 Buffer Tank (12.00mØ)
  - 5 Feeding System
  - 6 Technical Building
  - 7 Switchboard Room
  - 8 Containment Sump Area
  - 9 Separation
  - 10 Filling Station & Extraction Station
  - 11 Gas Cooling/Chiller & Gas Drying
  - 12 Leachate Tank
  - 13 CHP
  - 14 Flare (10.00m exclusion zone)
  - 15 Propane Tanks
  - 16 Biogas Upgrading Unit
  - 17 LV Switchboard
  - 18 Emergency Generator
  - 19 Diesel Tank (Location TBC by Client)
  - 20 Substation
  - 21 Transformer
  - 22 Power to Heat Module
  - 23 Weighbridge
  - 24 Silage Clamps (4No. 22.5m x 49.9m)
  - 25 Site Office
  - 26 Grid Entry Unit
  - 27 Ekogea
  - 28 Condensate Pit
  - 29 Filters & Concentrators
  - 30 IBC Equipment & Mixing Tanks
  - 31 SW & Clean Water Storage Tank (1No. Proposed & 1No. Future Expansion)
  - 32 Grey Water Storage Tank (1No. Proposed & 1No. Future Expansion)
  - 33 Polishing Plant
  - 34 Bund Ramp
  - 35 Dirty Water Lagoon (1140m³ Capacity)
  - 36 Infiltration Lagoon (0.68m Max. W.L.)
  - 37 3.0m x 2.5m Pump Slab

- GENERAL KEY:**
- Site Boundary
  - Proposed Concrete
  - As Built Slab
  - Proposed D.o.T Type 1
  - Proposed Asphalt Surfacing
  - 200mm thick Concrete Slab with A393 mesh reinforcement

**APPROVAL & COMMENT**

Rev	Date	Rev By	Chkd	Description
F	17.07.20	AF	OAJ	Amended to Suit BioConstruct Layout
E	26.06.20	AF	OAJ	Amended to Suit BioConstruct Layout
D	16.06.20	AF	OAJ	Minor Amendments
C	04.05.20	CMH	AF	Clamp access track removed
B	20.05.20	CMH	AF	Bund amended following comments
A	14.05.20	CMH	AF	Amendments following client comments
O	07.05.20	-	AF	First Issue

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Client:  
**O'Brien Moran & Co Ltd.**

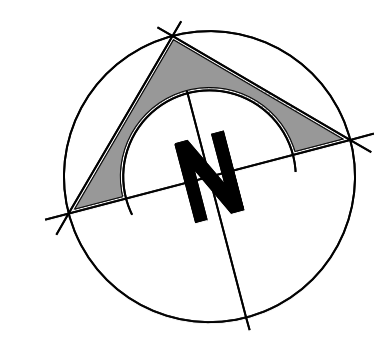
Project:  
**Proposed AD Plant  
Lower Drayton Farm  
Penkridge, Stafford, ST195RE**

Drawing Title:  
**Proposed Site Layout**

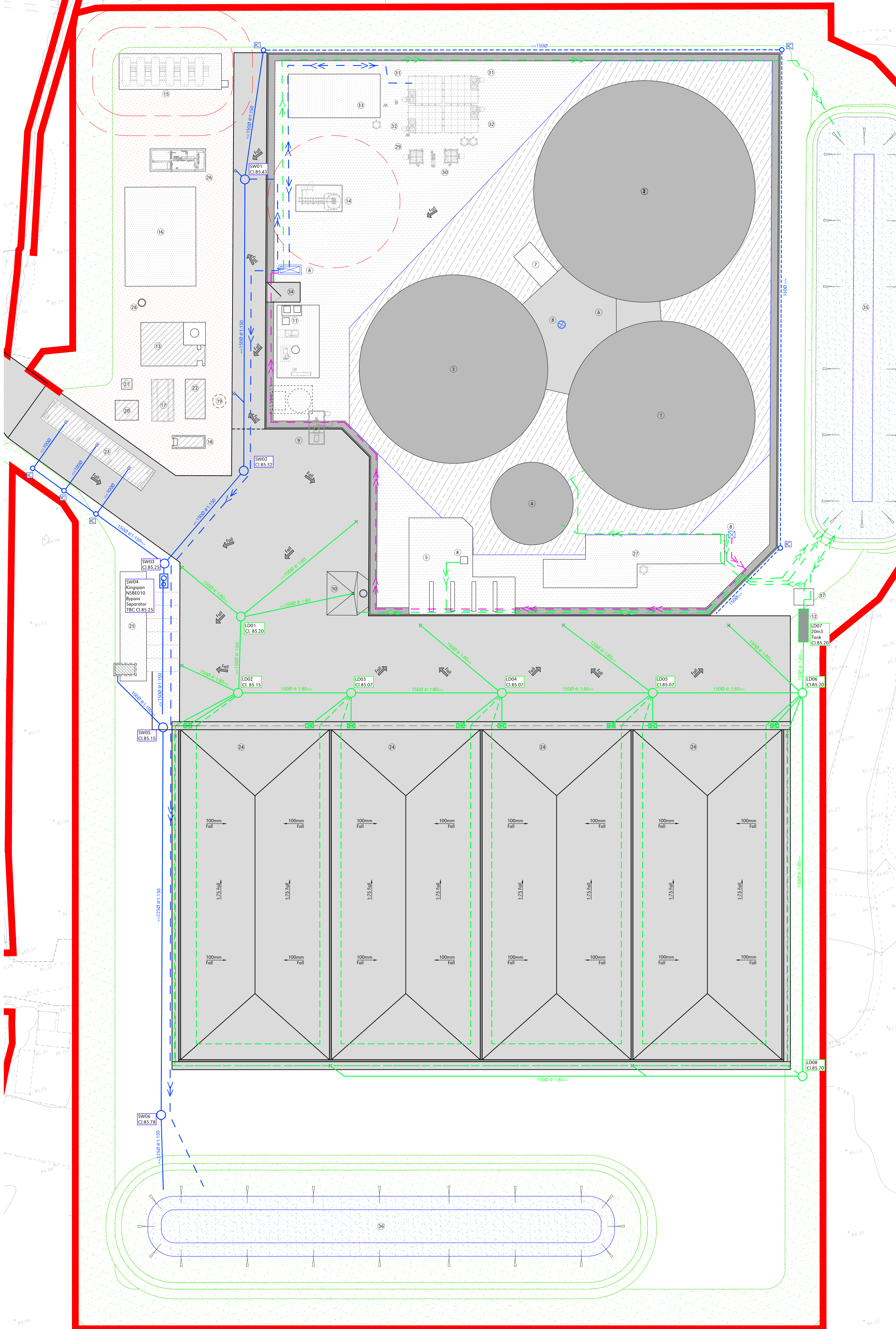


Scale	U.N.O.	Date	Drawn By
1:200 (A0)		April 2020	CMH
Drawing No.	25998/005	Rev	F





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- Proposed Plant Key**
- Fermenter Tank (28.00mØ)
  - Fermenter Tank (33.00mØ)
  - Digestate Storage Tank (28.00mØ)
  - Buffer Tank (12.00mØ)
  - Feeding System
  - Technical Building
  - Switchboard Room
  - Containment Sump Area
  - Separation
  - Filling Station & Extraction Station
  - Gas Cooling/Chiller & Gas Drying
  - Leachate Tank
  - CHP
  - Flare (10.00m exclusion zone)
  - Propane Tanks
  - Biogas Upgrading Unit
  - LV Switchboard
  - Emergency Generator
  - Diesel Tank (Location TBC by Client)
  - Substation
  - Transformer
  - Power to Heat Module
  - Weightbridge
  - Silage Clamps (4No. 22.5m x 49.9m)
  - Site Office
  - Grid Entry Unit
  - Ekogea
  - Condensate Pit
  - Filters & Concentrators
  - IBC Equipment & Mixing Tanks
  - SW & Clean Water Storage Tank (1No. Proposed & 1No. Future Expansion)
  - Grey Water Storage Tank (1No. Proposed & 1No. Future Expansion)
  - Polishing Plant
  - Bund Ramp
  - Dirty Water Lagoon (1140m³ Capacity)
  - Infiltration Lagoon (0.68m Max. W.L)
  - 3.0m x 2.5m Pump Slab

- PROPOSED DRAINAGE KEY:**
- Leachate Drainage Pumped Pipe (LD)
  - Leachate Drainage (LD)
  - Leachate Gully (LD)
  - Leachate Manhole (LD)
  - Proposed Leachate Sump (LD)
  - Surface Water Drainage (SW)
  - Surface Water Perforated Pipe (SW)
  - Surface Water Pumped Pipe (SW)
  - Surface Water Manhole (SW)
  - Surface Water Gully (SW)
  - Inspection Chamber (SW)
  - Pumped Containment Water Pipe

- GENERAL KEY:**
- Site Boundary
  - Proposed Concrete
  - As Built Slab
  - Proposed D.o.T Type 1
  - Proposed Asphalt Surfacing
  - 200mm thk Concrete Slab with A393 mesh reinforcement

**APPROVAL & COMMENT**

Rev	Date	Rev By	Chkd	Description
F	17.07.20	AF	OAJ	Minor Amendments to Drainage Levels
E	26.06.20	AF	OAJ	Amended to Suit BioConstruct Layout
D	16.06.20	AF	OAJ	Minor amendments to clamp drainage
C	04.05.20	CMH	AF	Amendments to drainage levels
B	20.05.20	CMH	AF	Revised amended following client comments
A	14.05.20	CMH	AF	Amendments following client comments
O	07.05.20	-	AF	First Issue

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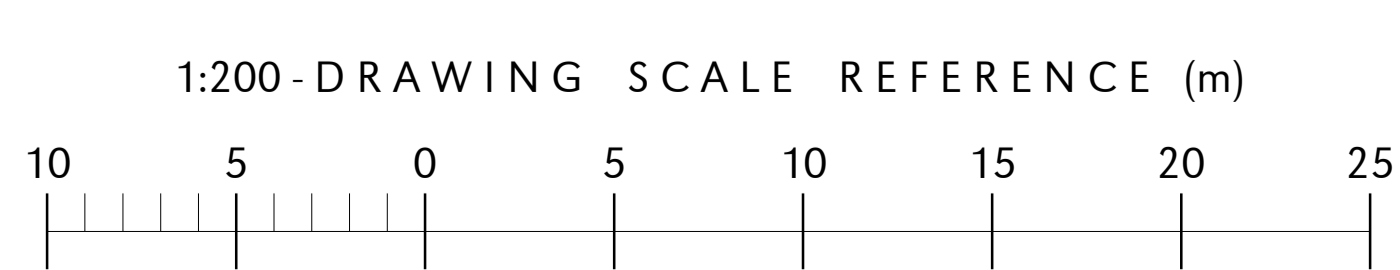
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Client:  
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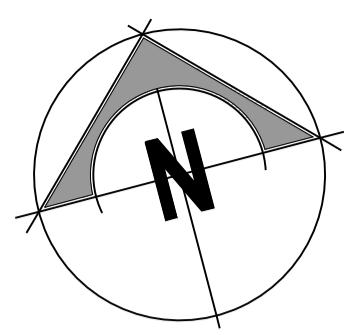
Project:  
**Proposed AD Plant  
Lower Drayton Farm  
Penkridge, Stafford, ST195RE**

Drawing Title:  
**Proposed Drainage Layout**



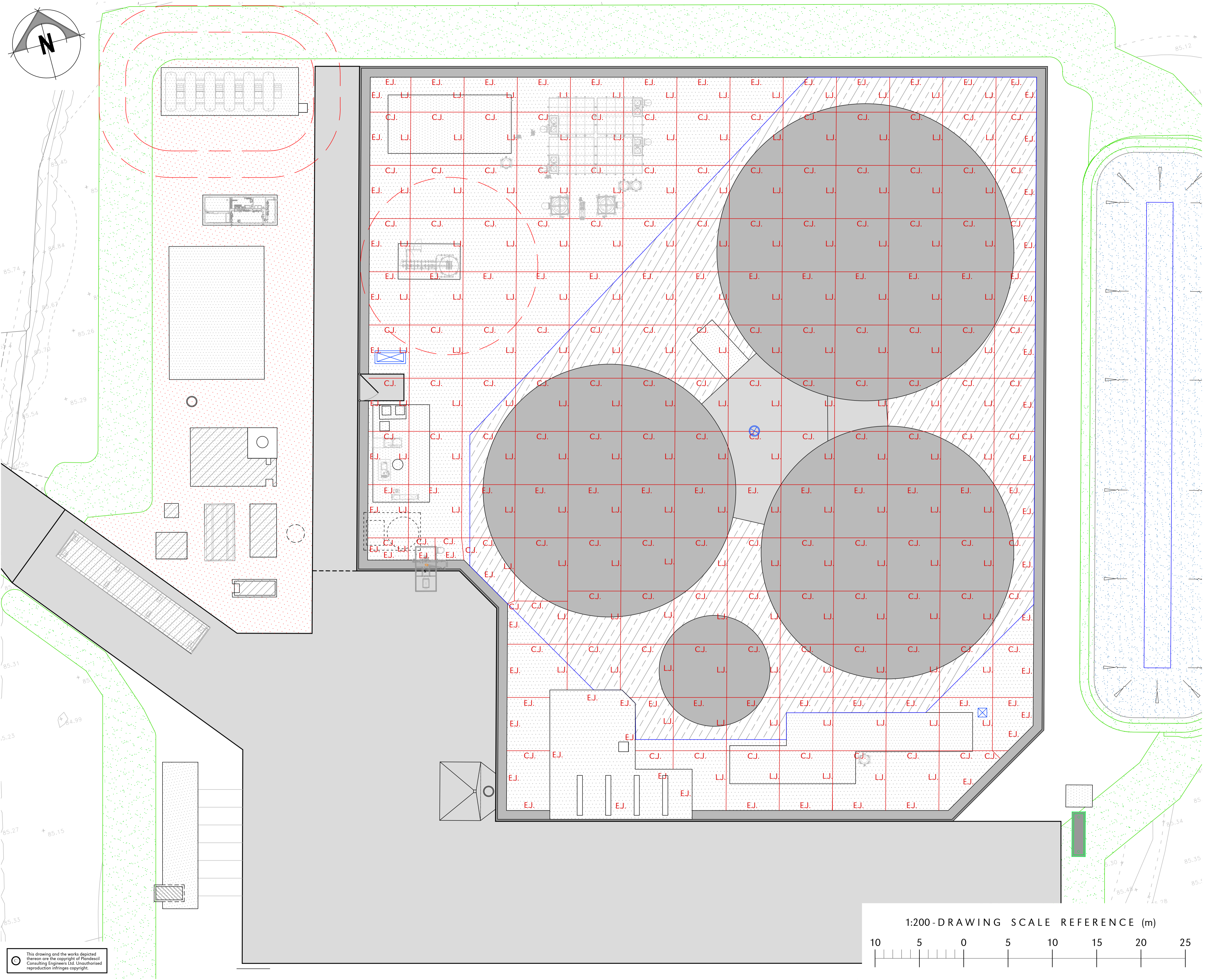
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Drawing No.	25998/007		Rev F





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**CONCRETE JOINTING KEY:**

	L.J.	Longitudinal Joint
	E.J.	Expansion Joint
	C.J.	Construction Joint

**GENERAL KEY:**

	Site Boundary
	Proposed Concrete
	As Built Slab
	Proposed D.o.T Type 1
	Proposed Asphalt Surfacing
	200mm thk Concrete Slab with A393 mesh reinforcement

**APPROVAL & COMMENT**

Rev	Date	Rev By	Chkd	Description
C	17-07-20	AF	OAJ	Amended to Suit BioConstruct Layout
B	26-06-20	AF	OAJ	Amended to Suit BioConstruct Layout
A	16-06-20	AF	OAJ	Minor Amendments
0	20-05-20	-	AF	First Issue

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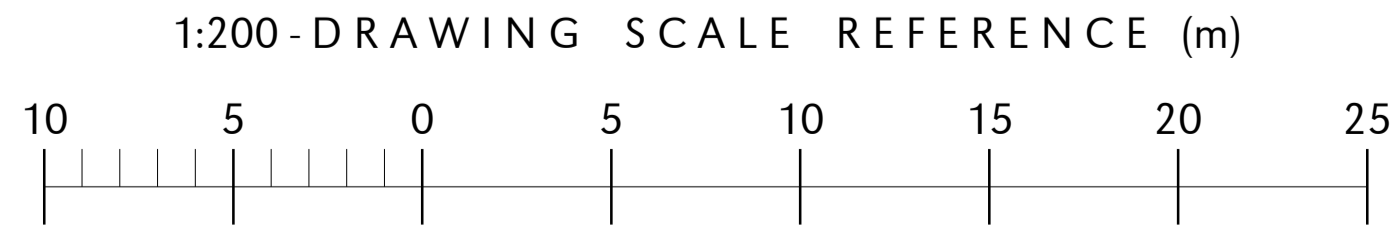
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Client  
**O'Brien Moran & Co Ltd.**

Project  
**Proposed AD Plant  
Lower Drayton Farm  
Penkridge, Stafford, ST195RE**

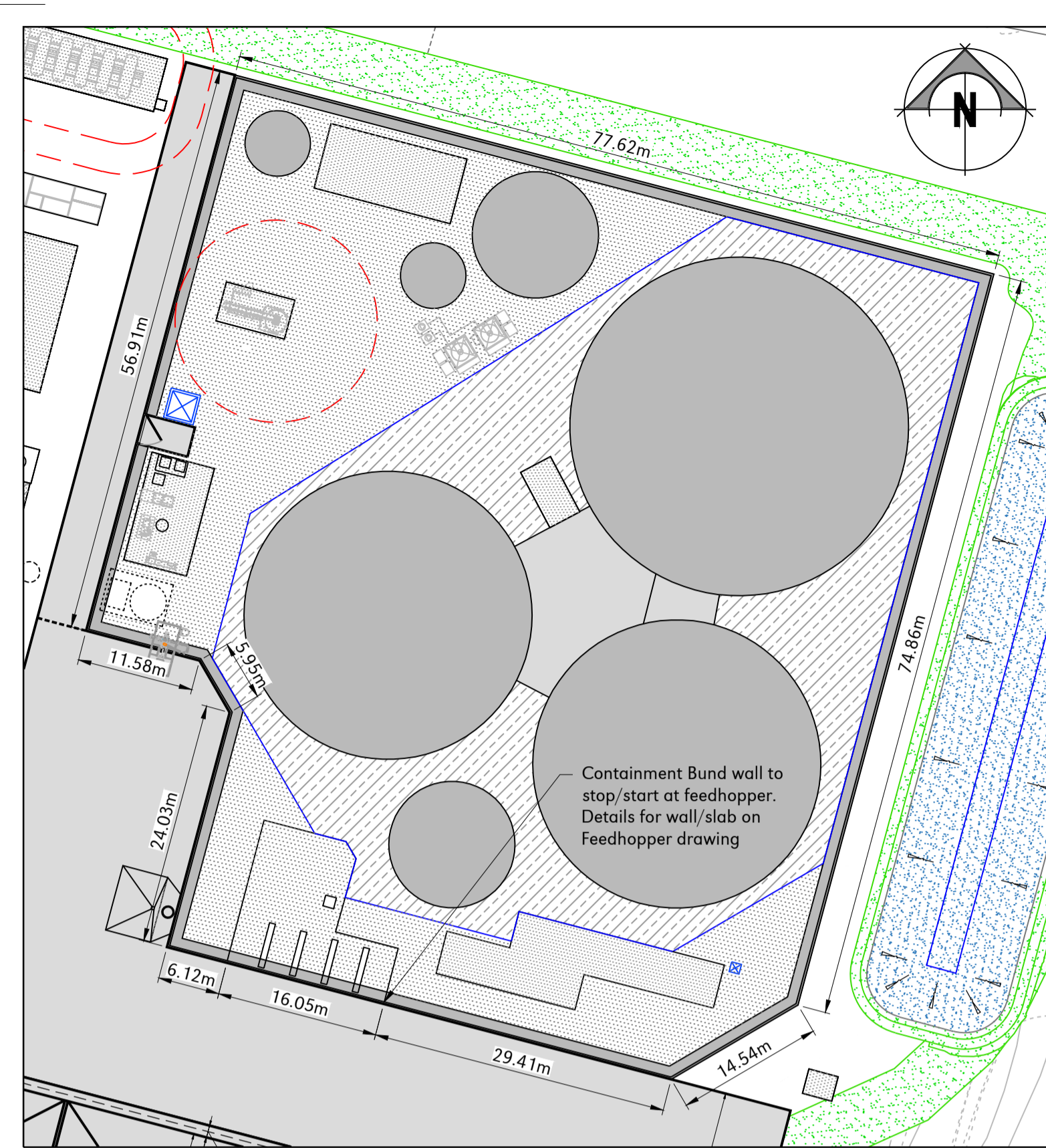
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Scale	U.N.O.	Date	Drawn By
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Drawing No.	25998/008		Rev C

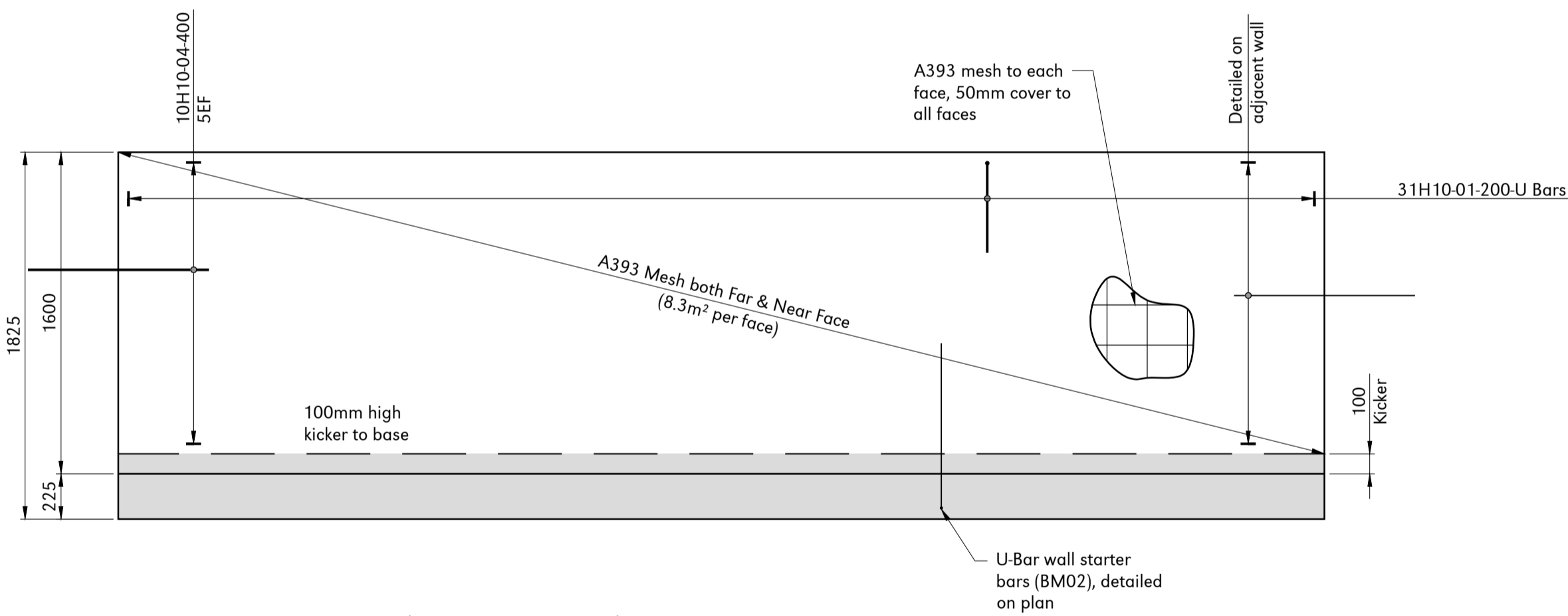


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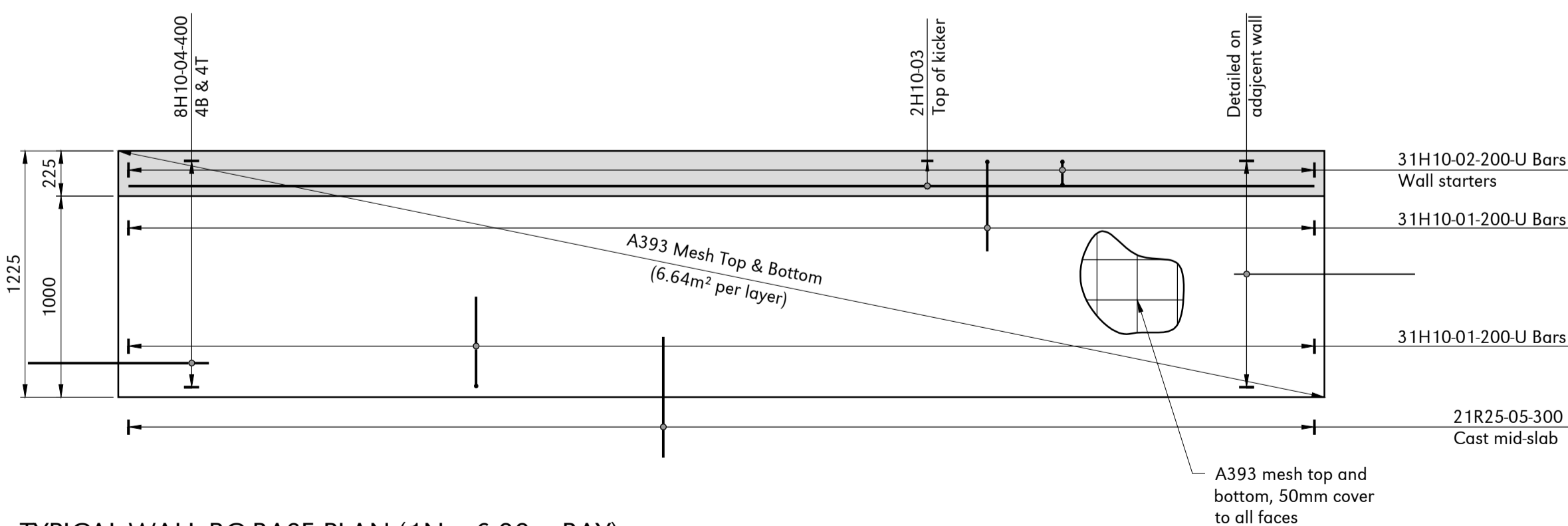




**CONTAINMENT BUND PLAN**  
(APPROX 301 L/M OF BUND WALL)  
Scale 1:500



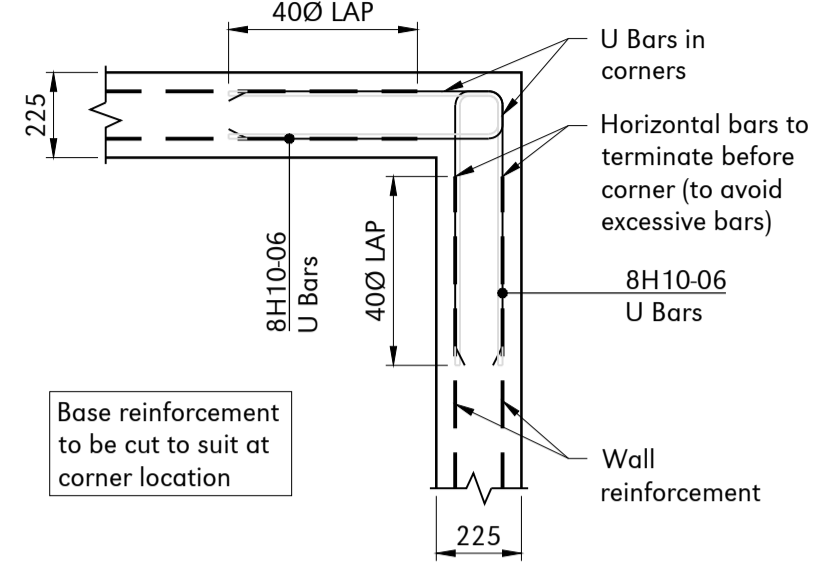
**TYPICAL WALL RC ELEVATION (1No. 6.00m BAY)**  
Scale 1:25



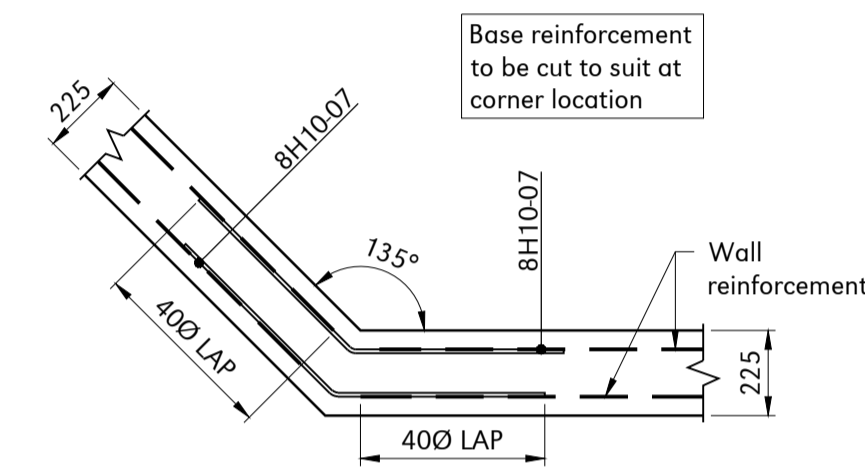
**TYPICAL WALL RC BASE PLAN (1No. 6.00m BAY)**  
Scale 1:25

NOTE: for bund wall corners, reinforcement to be cut to suit or adjusted for wall lengths

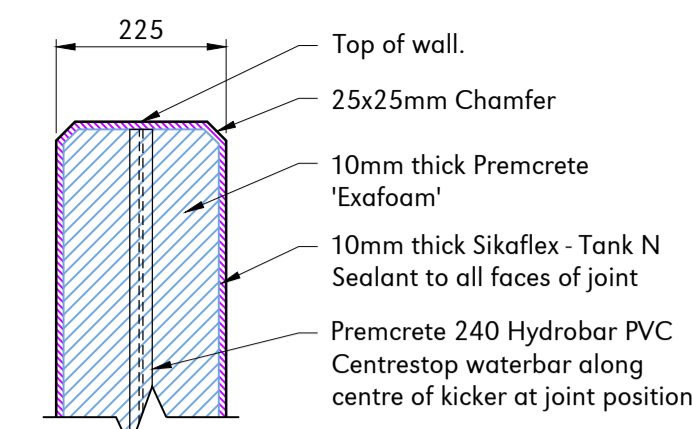
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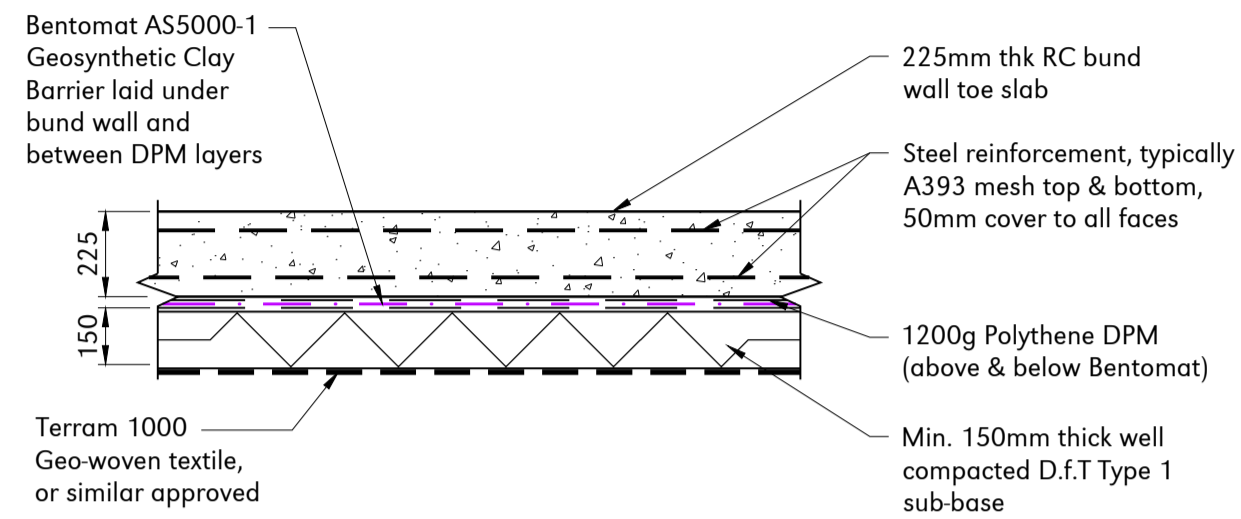
**WALL CORNER 'A' DETAIL PLAN (4No. THUS)**  
Scale 1:20



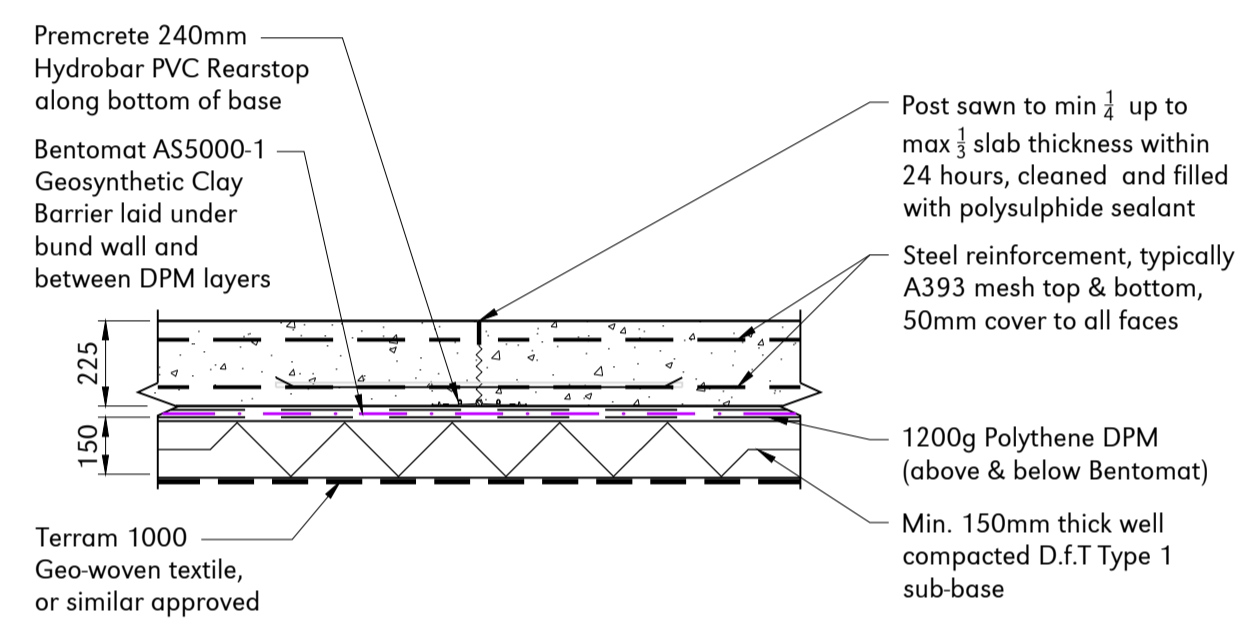
**WALL CORNER 'B' DETAIL PLAN (4No. THUS)**  
Scale 1:20



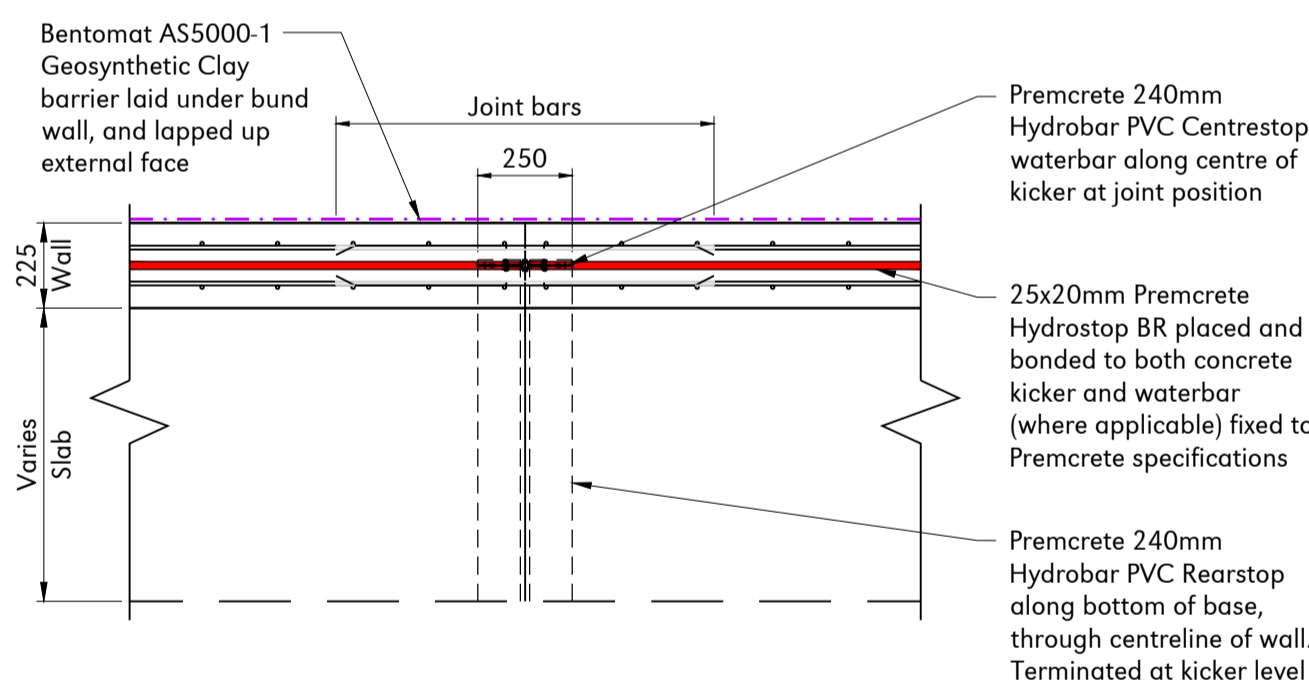
**TYPICAL ELEVATION DETAIL OF VERTICAL INTUMESCENT JOINT SEAL**  
Scale 1:10



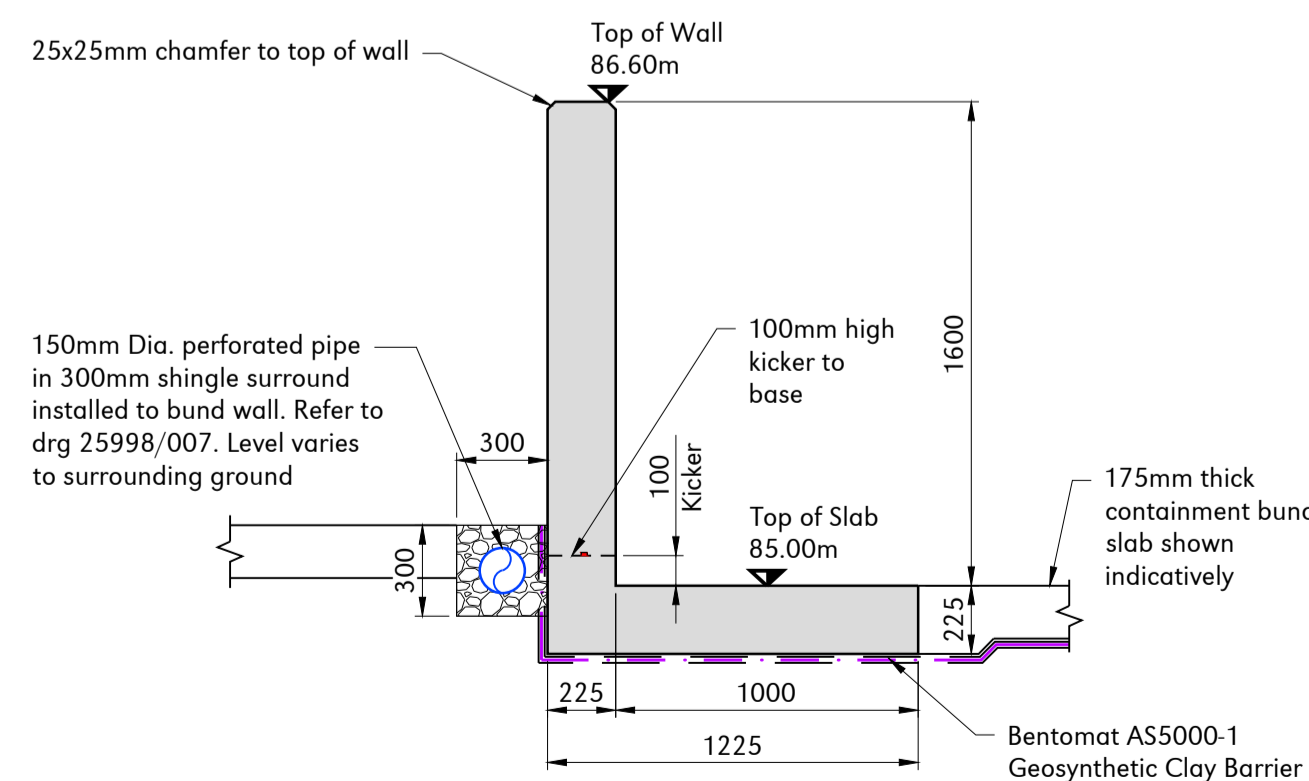
**TYPICAL BUND WALL TOE SECTION**  
Scale 1:20



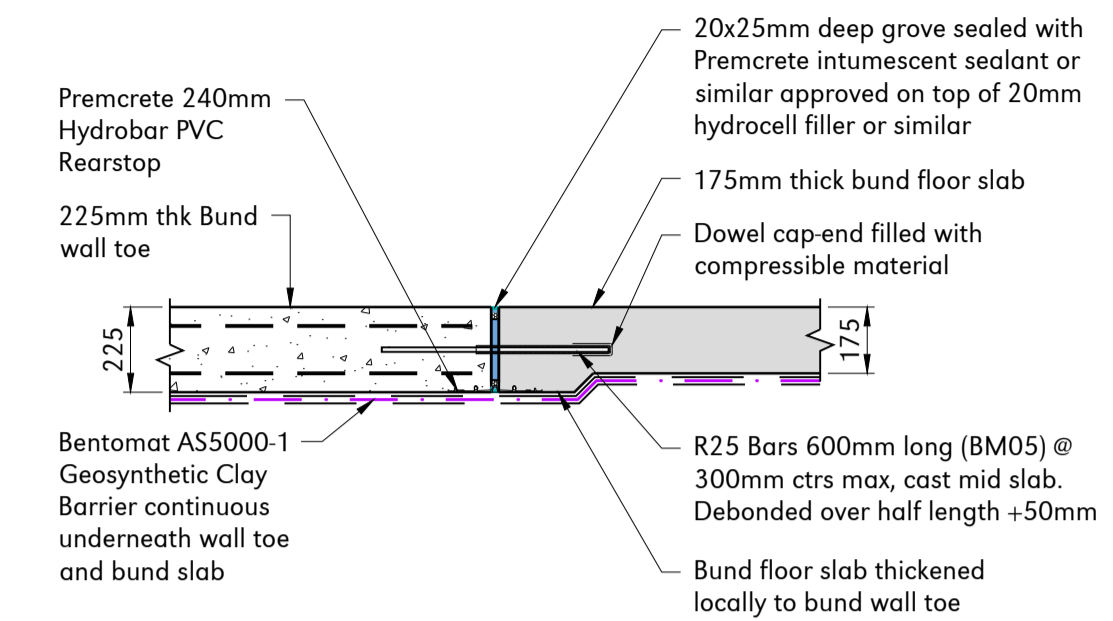
**TYPICAL BUND WALL TOE CONTRACTION JOINT DETAIL**  
Scale 1:20



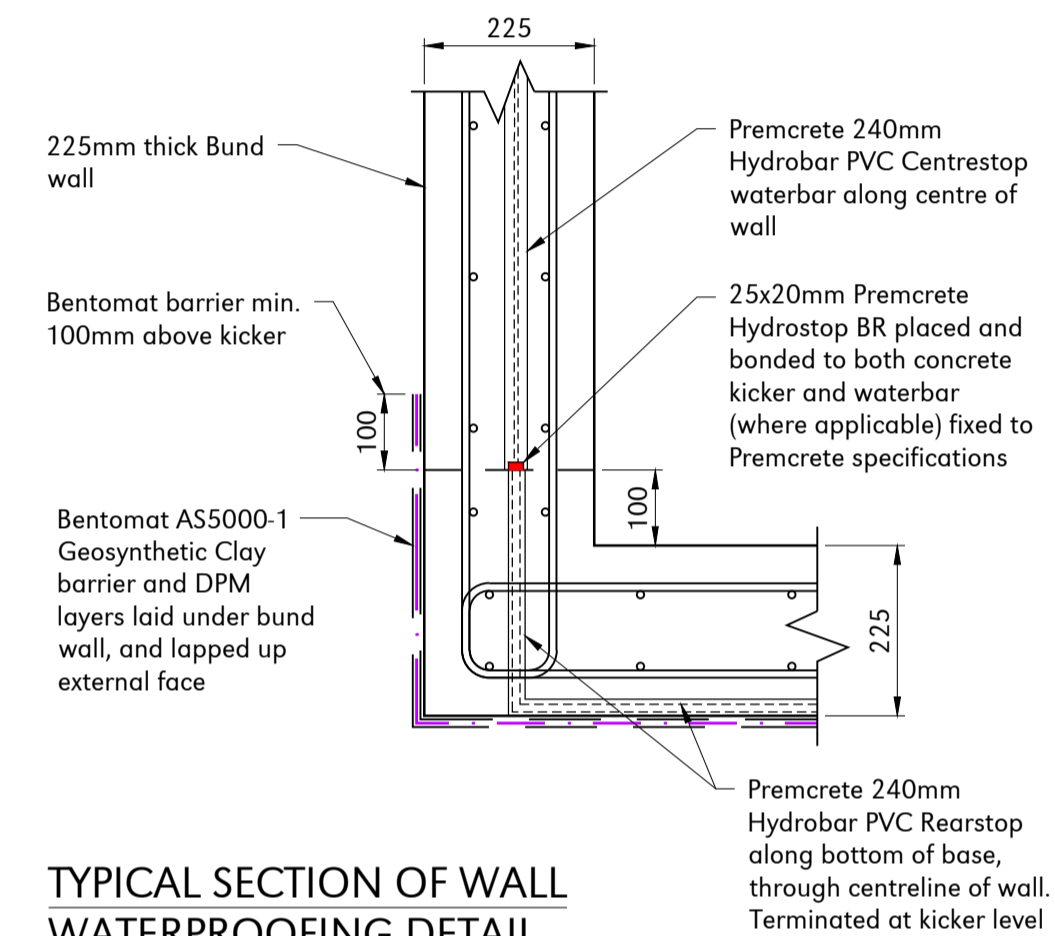
**TYPICAL PLAN OF WALL WATERPROOFING THROUGH CONTRACTION JOINT (C.J)**  
Scale 1:20



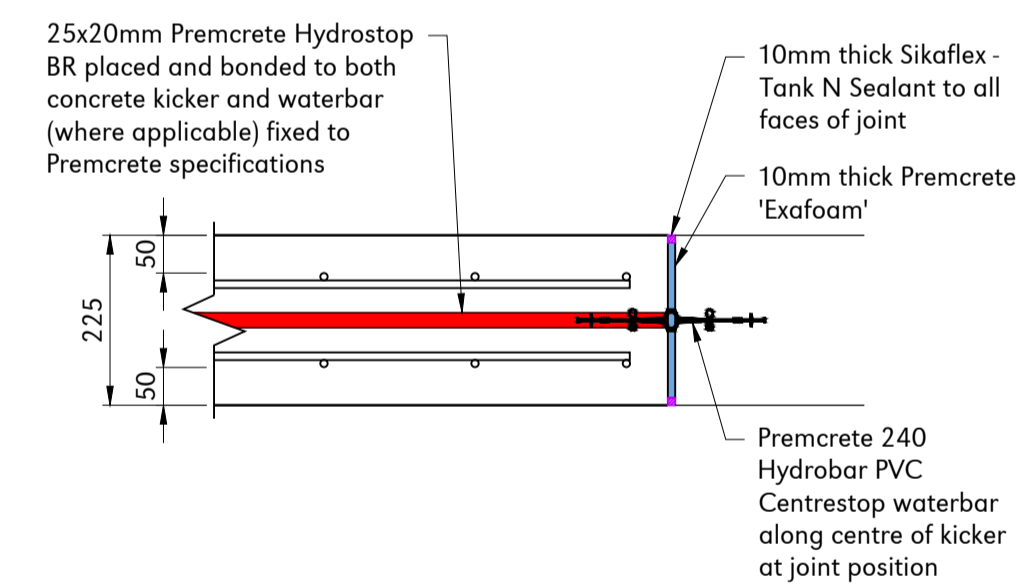
**TYPICAL 1.6m HIGH WALL SECTION**  
Scale 1:25



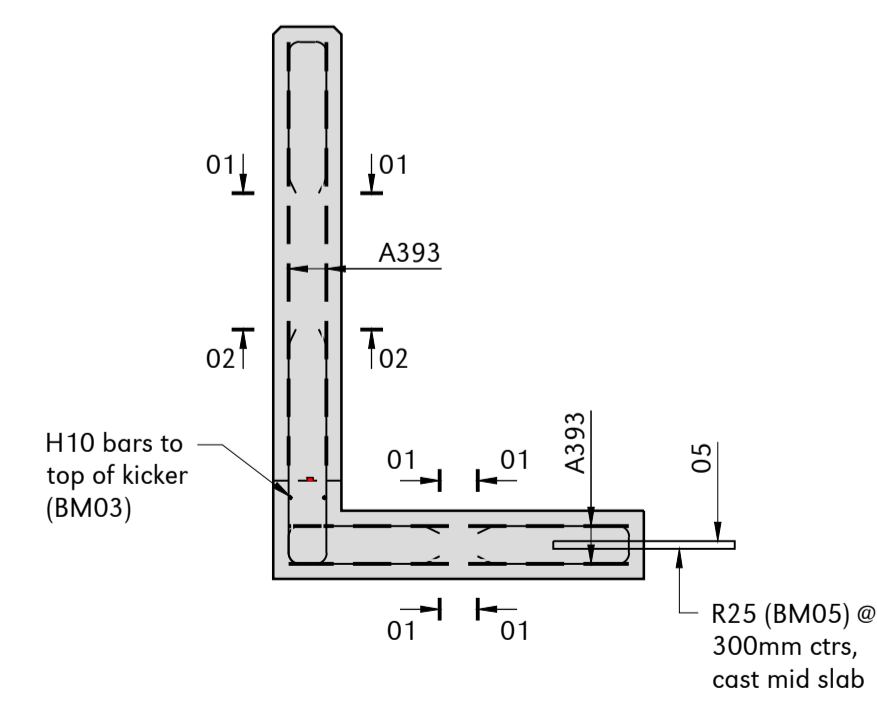
**TYPICAL BUND WALL TO BUND SLAB EXPANSION JOINT DETAIL**  
Scale 1:20



**TYPICAL SECTION OF WALL WATERPROOFING DETAIL**  
Scale 1:10



**TYPICAL PLAN DETAIL OF VERTICAL INTUMESCENT JOINT SEAL**  
Scale 1:10



**TYPICAL WALL RC SECTION**  
Scale 1:25

- NOTES:**
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  - This drawing is to be read in conjunction with all other relevant documents relating to the project.
  - All setting out to be coordinated by the Contractor and to be checked onsite prior to construction.
  - To be read in conjunction with the following Plandescil Drawings, schedules and documents:  
25998/080/01 BS - Bar Bending Schedule
  - Contractor led design, Plandescil Ltd conforming to Contractor preferred practices.

- REINFORCED CONCRETE:**
- Insitu Concrete to be RC40/50 with max w/c ratio 0.45, 360kg/m<sup>3</sup> cement/combination content (III-A), with 20mm max. aggregate, chloride content class 0.4cl and minimum slump of class S3 (90mm Slump).
  - Insitu Concrete to be in accordance with BS 8110 & BS 8500-1.
  - Reinforcement to be Grade H 500N/mm<sup>2</sup> High Yield, Deformed Type 2 Bar detailed in accordance with BS 4449 and BS 8666.
  - Walls nominal 225mm thick, 50mm cover to bottom, sides and top.
  - Wall toe nominal 225mm thick, 50mm cover to bottom, sides and top. Wall to have 25x25mm chamfered edges to top.
  - Floor Classification to meet FM3 standard for Flatness and Level ±5mm. Construction tolerance to be in accordance with the NSCS for Building Structures.
  - Slab to have brushed finish to exposed surface and fair face shutter finish to sides.
  - Walls to have fair faced shuttered finish to sides and top.

- CONCRETE JOINT NOTES:**
- All joint dowel/reinforcement shall be set level and perpendicular to the joint face prior to casting. Damage or bent dowels are to be re-aligned or replaced prior to casting.
  - All formed joints are to be cleaned of concrete overruns to ensure accidental restraint is not created.
  - All joints are to be sufficiently cured and cleaned of all contaminations prior to sealing.
  - All sealants are to be installed as per manufacturers specification and must be suitable for the joint type.

- FOUNDATION NOTES:**
- Assumed GBP value of 225kN/m<sup>2</sup> has been used. Value provided by the Independent Stabilisation Company Ltd Interim Operation & Maintenance Manual (June 2020). Confirmation of minimum GBP of 225kN/m<sup>2</sup> required prior to construction.
  - Any soft spots or deleterious material is to be removed & taken down to virgin ground level & replaced with compact D.F.T Type 1 or suitable hogging material.
  - Overdig to be made up in compacted D.F.T. Type 1 or lean mix concrete.

ALL PROPRIETARY MATERIALS TO BE FIXED STRICTLY IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS USING MATERIALS APPROVED BY THE MANUFACTURER.

**APPROVAL & COMMENT**

Rev	Date	Rev By	Chkd	Description
A	16-06-20	IGC	AF	Bund slab & Bentomat detail updated
0	26-05-20	-	AF	First Issue

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Client  
**O'Brien Moran & Co Ltd.**

Project  
**Proposed AD Plant Lower Drayton Farm, Penkridge, Staffordshire**

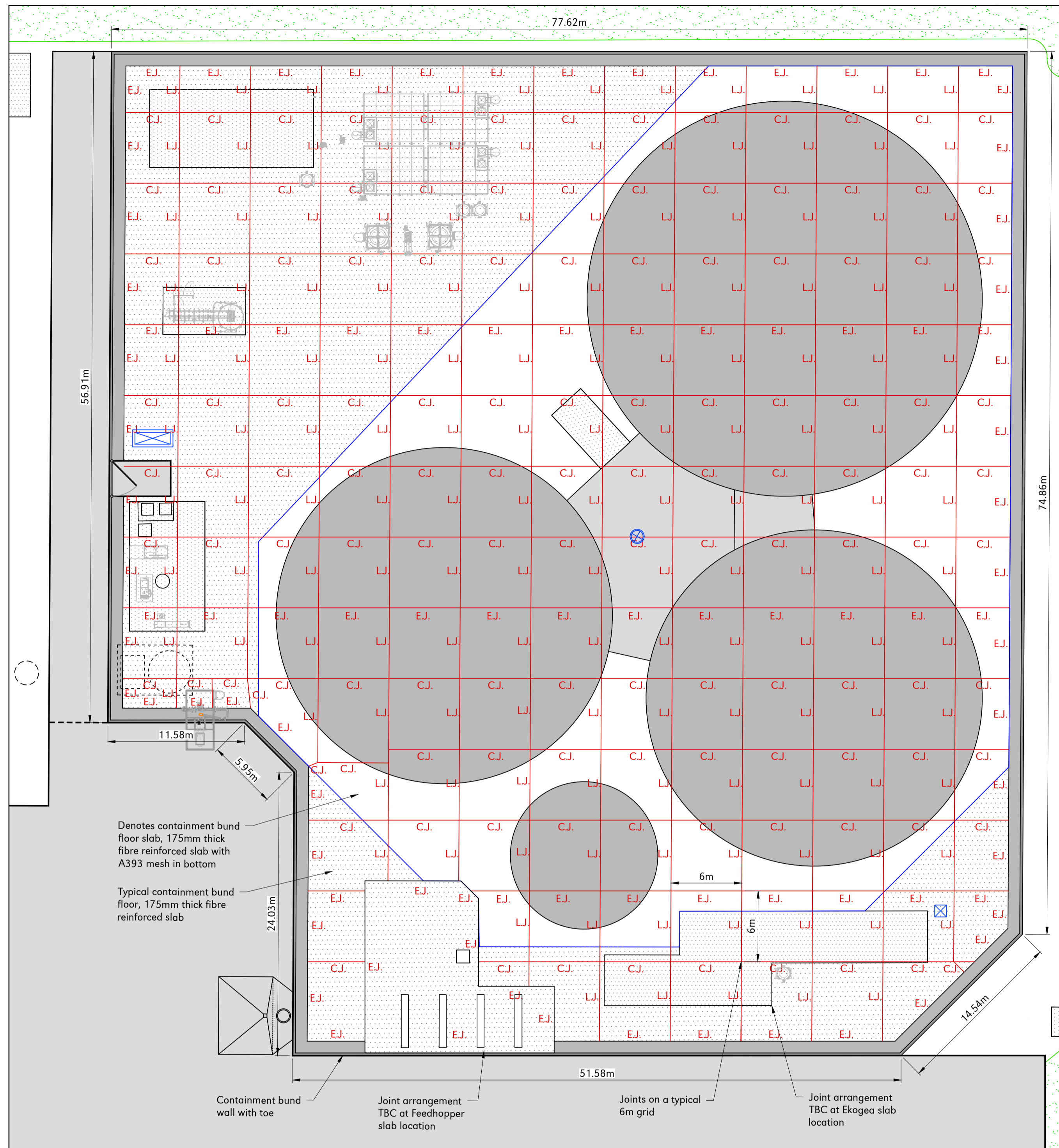
Drawing Title

**1.6m Containment Bund Wall RC Details (6m Bay)**

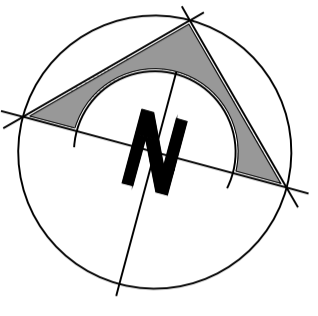
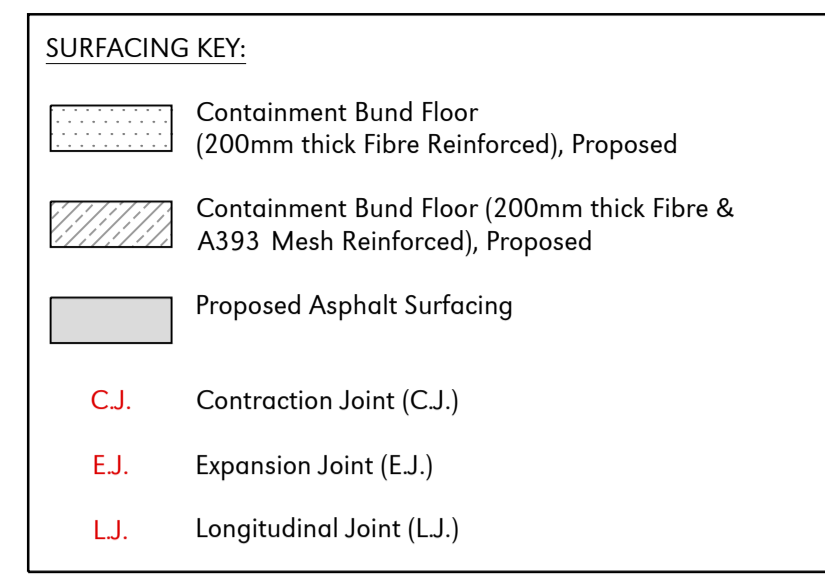
Scale U.N.O. Date May 2020 Drawn By IGC

Drawing No. **25998/080** Rev **A**

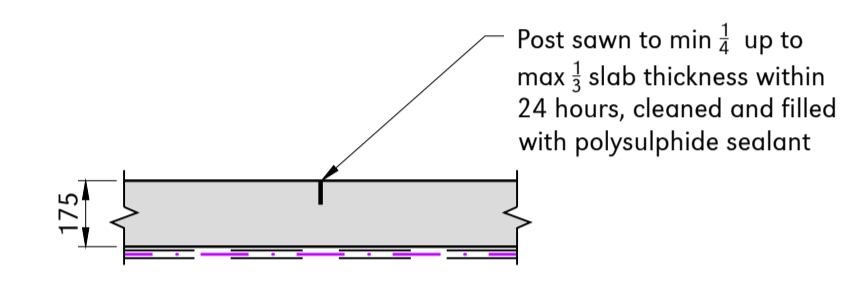




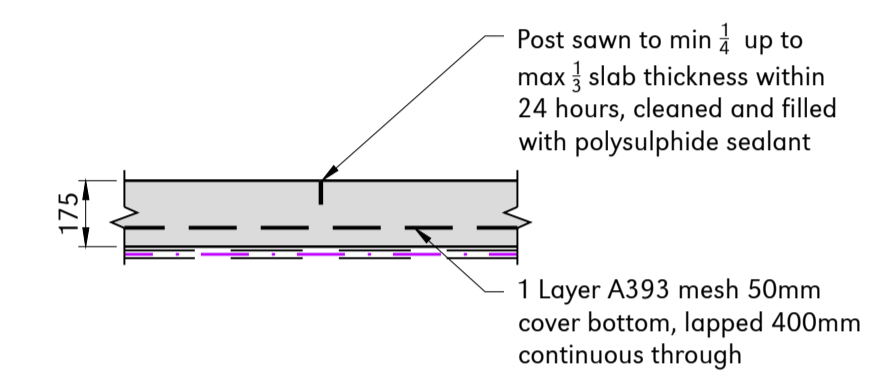
**CONTAINMENT BUND FLOOR JOINT PLAN**  
Scale 1:250



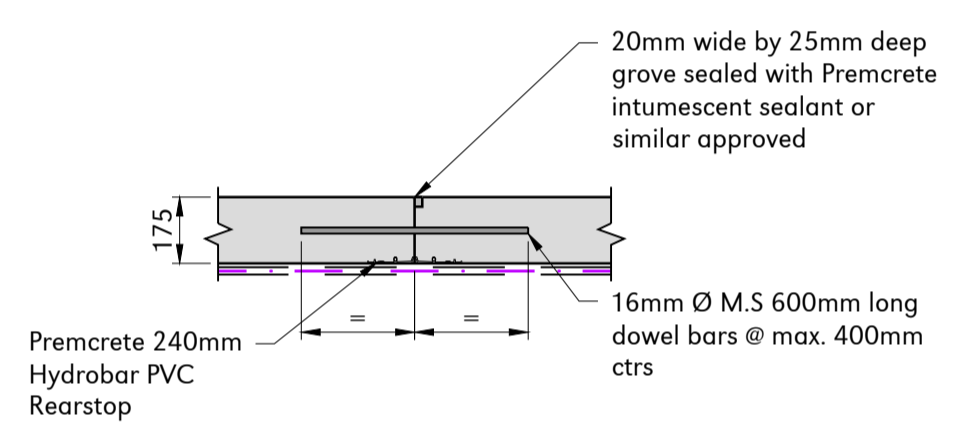
**NOTE: BENTOMAT AS 5000-1 GEOSYNTHETIC CLAY BARRIER TO BE CONTINUOUS UNDER ALL JOINT LOCATIONS. 1200G POLYTHENE DPM TO BE LAID ABOVE AND BELOW BENTOMAT BARRIER, LAPPED/SEALED IN STRICT ACCORDANCE TO MANUFACTURER SPECIFICATION**



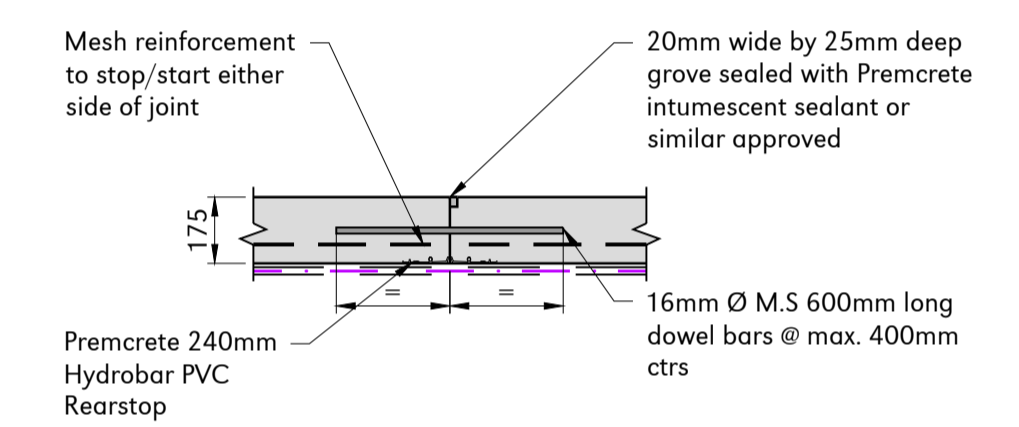
**TYPICAL FIBRE SLAB CONTRACTION JOINT (C.J.)**  
Scale 1:20



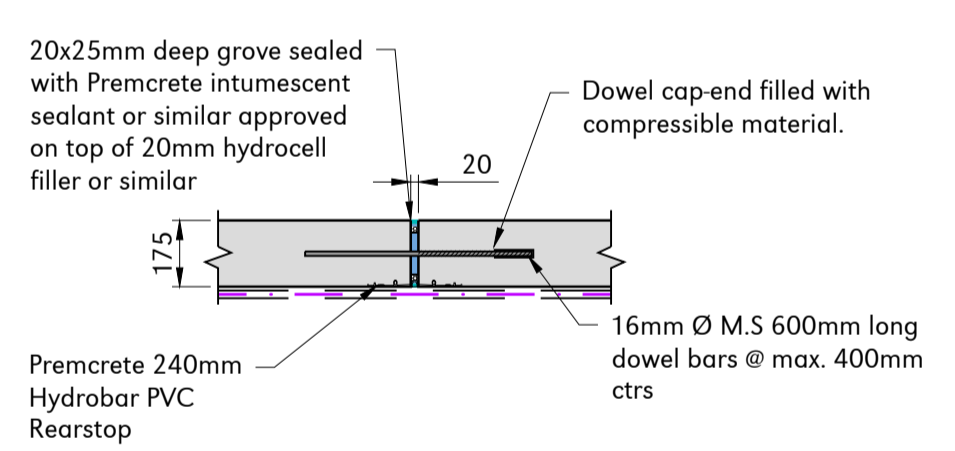
**TANK FIBRE SLAB CONTRACTION JOINT (C.J.)**  
Scale 1:20



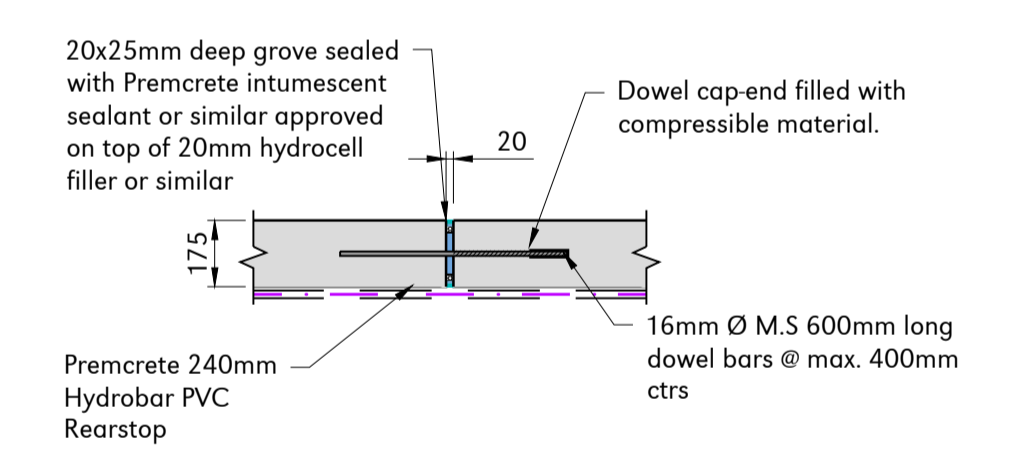
**TYPICAL FIBRE SLAB LONGITUDINAL JOINT (L.J.)**  
Scale 1:20



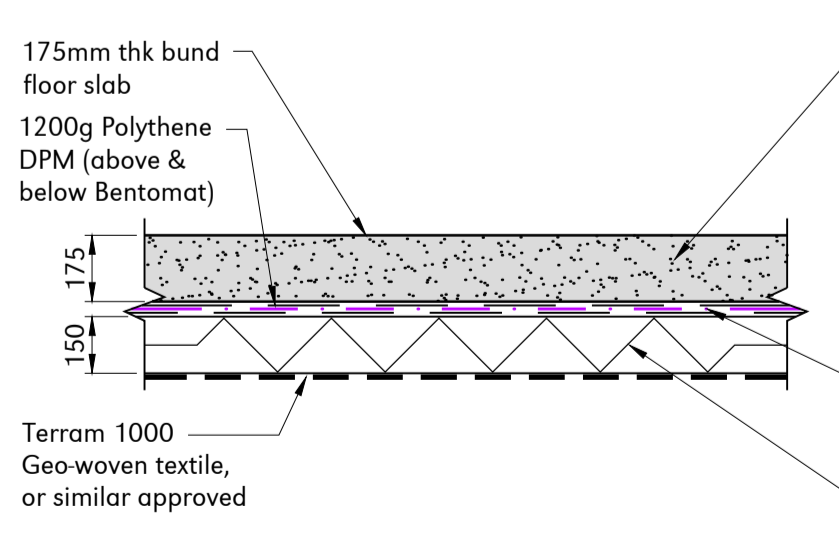
**TANK FIBRE SLAB LONGITUDINAL JOINT (L.J.)**  
Scale 1:20



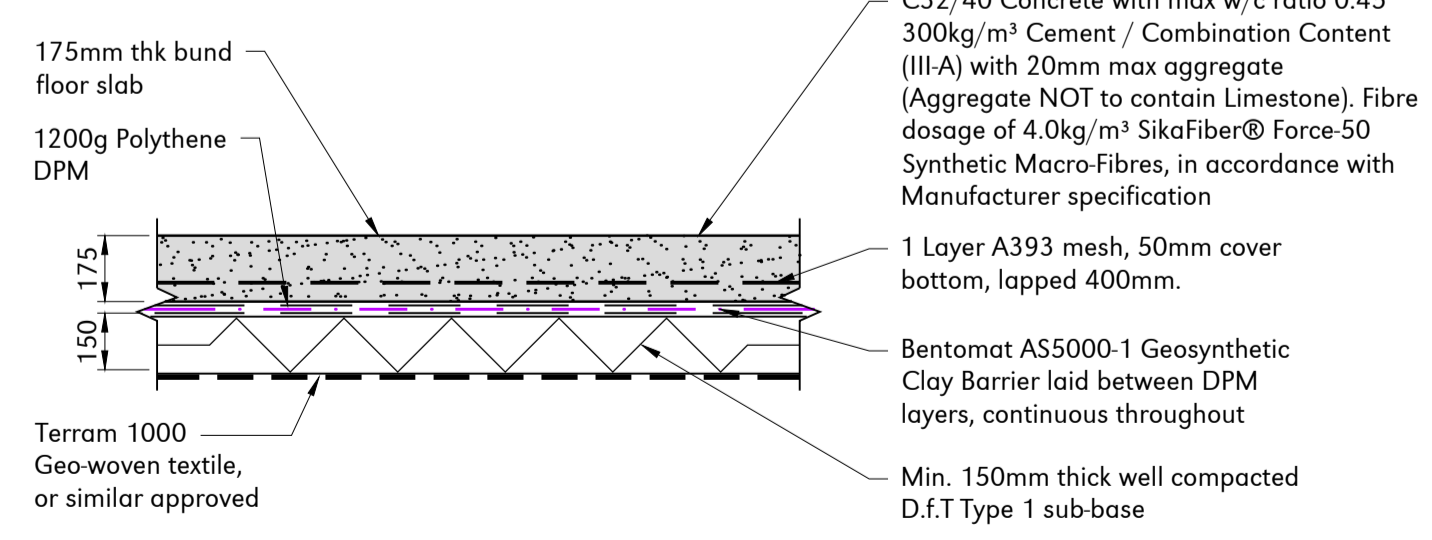
**TYPICAL FIBRE SLAB EXPANSION JOINT (E.J.)**  
Scale 1:20



**TANK FIBRE SLAB EXPANSION JOINT (E.J.)**  
Scale 1:20

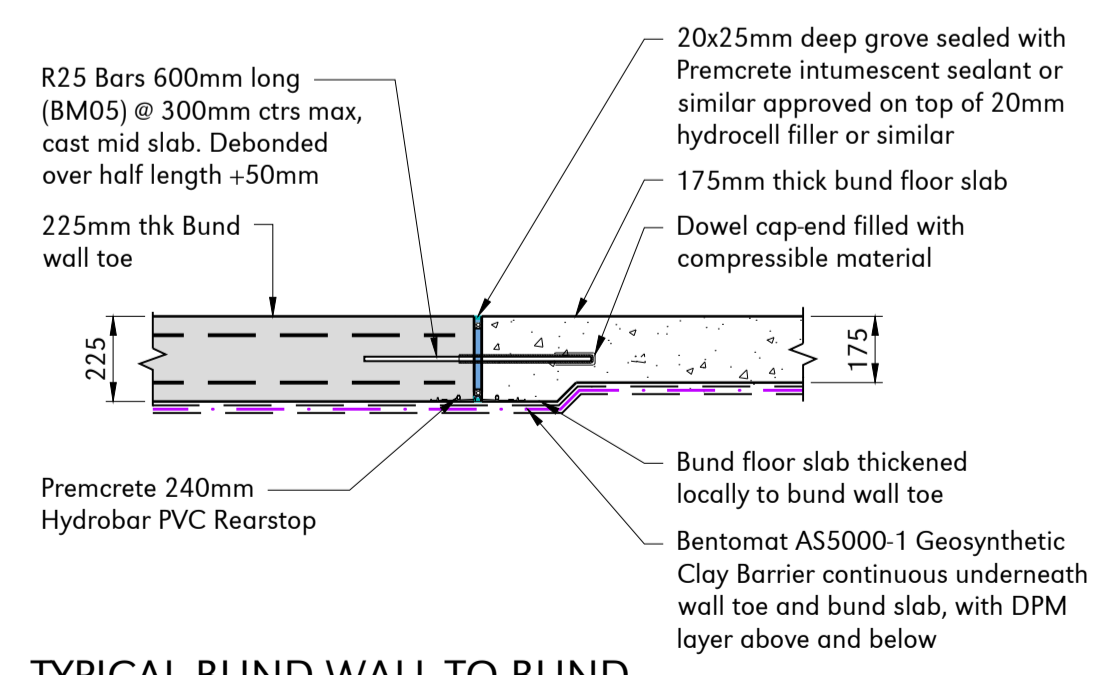


**TYPICAL FIBRE REINFORCED SLAB CONSTRUCTION**  
Scale 1:20



**TYPICAL FIBRE & MESH REINFORCED SLAB CONSTRUCTION**  
Scale 1:20

**NOTE: Slab construction under Tanks as denoted on site plan, Plandescil Drg 25998/005**



**TYPICAL BUND WALL TO BUND SLAB EXPANSION JOINT DETAIL**  
Scale 1:20

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  - This drawing is to be read in conjunction with all other relevant documents relating to the project.
  - All setting out to be coordinated by the Contractor and to be checked onsite prior to construction.
  - To be read in conjunction with the following Plandescil Drawings, schedules and documents:  
25998/008 - Containment Bund Wall RC Details
  - Contractor led design, Plandescil Ltd conforming to Contractor preferred practices.

- REINFORCED CONCRETE:**
- Containment Slab Concrete to be RC32/40 with max w/c ratio 0.45, 300kg/m³ cement/combination content (III-A), with 20mm max. aggregate (non-limestone), chloride content class 0.4cl and minimum slump of class S3 (90mm Slump). Fibre dosage of 4.0kg/m³ SikaFiber® Force-50 Synthetic Macro-Fibres, in accordance with Manufacturer specification and design calculations; SikaFiber® Product Proposals for fibre reinforced slabs on ground, Ref - JF10b (04/06/2020).
  - For Containment Slab under tanks, the above mix design is to be used in addition to A393 mesh reinforcement in the bottom with 50mm cover to all faces.
  - In situ Concrete to be in accordance with BS 8110 & BS 8500-1. Reinforcement to be Grade H 500N/mm² High Yield, Deformed Type 2 Bar detailed in accordance with BS 4449 and BS 8666. Slab nominal 175mm thick, 50mm cover to bottom and sides.

- CONCRETE JOINT NOTES:**
- All joint dowel/reinforcement shall be set level and perpendicular to the joint face prior to casting. Damage or bent dowels are to be realigned or replaced prior to casting.
  - All formed joints are to be cleaned of concrete overruns to ensure accidental restraint is not created.
  - All joints are to be sufficiently cured and cleaned of all contaminations prior to sealing.
  - All sealants are to be installed as per manufacturers specification and must be suitable for the joint type.
  - Joints subject to confirmation by Fibres used in mix design supplies. Fibre Supplier/Designer to check and approve joints.

- FOUNDATION NOTES:**
- Assumed GBP value of 225kN/m² has been used. Value provided by the Independent Stabilisation Company Ltd Interim Operation & Maintenance Manual (June 2020). Confirmation of minimum GBP of 225kN/m² required prior to construction.
  - Any soft spots or deleterious material is to be removed & taken down to virgin ground level & replaced with compact D.F.T Type 1 or suitable hogging material.
  - Overdig to be made up in compacted D.F.T. Type 1 or lean mix concrete.

**ALL PROPRIETARY MATERIALS TO BE FIXED STRICTLY IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS USING MATERIALS APPROVED BY THE MANUFACTURER.**

APPROVAL & COMMENT				
C	17-07-20	AF	OAJ	Ekogea Plant Arrangement Amended
B	25-06-20	AF	OAJ	Ekogea Plant Arrangement Amended
A	16-06-20	IGC	AF	Slab reduced to 175thk, fibre spec updated. Bentomat with DPM below
O	26-05-20	-	AF	First Issue
Rev	Date	Rev By	Chkd	Description



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Client  
**O'Brien Moran & Co Ltd.**

Project  
**Proposed AD Plant Lower Drayton Farm, Penkridge, Staffordshire**

Drawing Title  
**Typical Containment Bund Slab & Joint Details**

Scale	U.N.O.	Date	May 2020	Drawn By	IGC
As noted	(A1)				
Drawing No.	25998/100			Rev	C



 <p>Connaught Road, Attleborough, Norfolk, NR17 2BW. T: (01953) 452001 e: pdc@plandesil.co.uk www.plandesil.co.uk</p>	Job No. 25998					Bund Capacity Ref:		B
	Date prepared: 01/05/2020 Date revised: 15/05/2020 Prepared by: AF Site Ref: 25998							Status: Construction Checked by: OAJ
<b>Bund Capacity Calculations</b>								Section 4, CIRIA C736
								<b>Comments, sources of information</b>
<b>Volume of inventory</b>								
	1	2	3	4	5	6	<b>Total</b>	
	Largest Tank					Smallest Tank		Arrange tanks from largest to smallest, left to right
<b>Above Ground</b>								
Tank rated capacity / fill level (m) (h)	6	6	6	6				based on tank dimensions provided by client
Tank brimful / level (m) (H= h+1)	6	6	6	6				brimful and rated capacity, see CIRIA C736 page 43
Tank diameter (m) (d)	33	28	28	12				
brimful capacity (cu.m)	5,129.19	3,692.64	3,692.64	678.24	0.00	0.00	13,192.71	
Tank Area	855.30	615.75	615.75	113.10	0.00	0.00	2,199.90	m2
25% brimful capacity (cu.m)							3,298.18	
110% brimful capacity largest tank (cu.m)							5,642.11	
							5,642.11	
Total Tank Area							2,199.90	
rated capacity (cu.m)	5,129.19	3,692.64	3,692.64	678.24	0.00	0.00		
total rated capacity (cu.m)							13,192.71	
25% rated capacity (cu.m)							3,298.18	
110% rated capacity largest tank (cu.m)							5,642.11	
<b>Storage Capacity For Calculation</b>							<b>5,642.11</b>	Used in calc
<b>Rainfall</b>								
24h duration (mm)	53.07							based on data page 45 CIRIA 736. Must be refined by system designer
24h duration (m)	0.053							
8d duration (mm)								
8d duration (m)								
10d duration (mm)	107.390							Site specific, check with MH
10d duration (m)	0.107							
annual rainfall (mm)	676.00							Site specific, check with MH
annual rainfall (m)	0.68							
length of bund (m)	85.00							
width of bund (m)	77.00							Need to check jetting and stand-off distances between tanks and
or equivalent area	6,050.00							
height of bund (m)	1.60							1.5m is maximum desirable height to be able to see into bund etc. Page 85 CIRIA C736
freeboard (m)	0.25							250mm freeboard for secondary containment in the absence of detailed analysis. Page 85 CIRIA C736
capacity of bund (cu.m)	8,167.50							with no deduction for tank base volume
base volume of remaining diameter tanks (cu.m)		830.84	830.84	152.60	0.00	0.00	1,814.29	assume 2 largest diameter tanks are intact and hence taking up the most volume at the base of the bund
Volume of Depressed Basin							0.00	
<b>available bund capacity</b>	<b>6,353.21</b>							
volume rainfall arising over 24h (cu.m)	347.34							these volumes will need refining as set out on page 44 C736
volume rainfall arising over 8d (cu.m)	0.00						347.34	Volume of rainfall captured in 24h + 8d
volume rainfall arising over 10d (cu.m)	702.28							
volume rainfall arising over one year (cu.m)	4,424.42							
conservative assessment, remaining capacity (cu.m)	363.76							largest tank fails, has rained for 24h before and for 8d afterwards. No firewater.
<b>Firewater</b>								client advises no risk of fire
foam allowance (m)	0.00							100mm freeboard for firefighting foam. Page 85 CIRIA C736
foam volume (cu.m)	0.00							
Firewater estimate (cu.m)	0.00							not included in assessment
<b>Residual Bund Volume</b>								
conservative assessment, remaining capacity (cu.m)	363.76							largest tank fails, has rained for 24h before and for 8d afterwards.
<b>All Area Ex Tanks (m<sup>2</sup>)= 3,850</b> <b>Wall Heights (m)= 1.6</b>								Area for hatch comparison (Total containment volume inside wall minus all tank areas)



Tedds

Plandescil

Connaught Road

Attleborough

Norfolk

Project Lower Drayton - Proposed AD Plant			Job Ref. 25998		
Section Scenario 1 - 1.60m High Containment Analysis & Design			Sheet no./rev. 1		
Calc. by AF	Date 16/06/2020	Chk'd by OAJ	Date	App'd by	Date

### RETAINING WALL ANALYSIS

In accordance with EN1997-1:2004 incorporating Corrigendum dated February 2009 and the UK National Annex incorporating Corrigendum No.1

Tedds calculation version 2.9.06

#### Retaining wall details

Stem type	Cantilever		
Stem height	$h_{stem} = 1600$ mm		
Stem thickness	$t_{stem} = 225$ mm		
Angle to rear face of stem	$\alpha = 90$ deg		
Stem density	$\gamma_{stem} = 25$ kN/m <sup>3</sup>		
Toe length	$l_{toe} = 1000$ mm		
Base thickness	$t_{base} = 225$ mm		
Base density	$\gamma_{base} = 25$ kN/m <sup>3</sup>		
Height of retained soil	$h_{ret} = 475$ mm	Angle of soil surface	$\beta = 0$ deg
Depth of cover	$d_{cover} = 0$ mm		

#### Retained soil properties

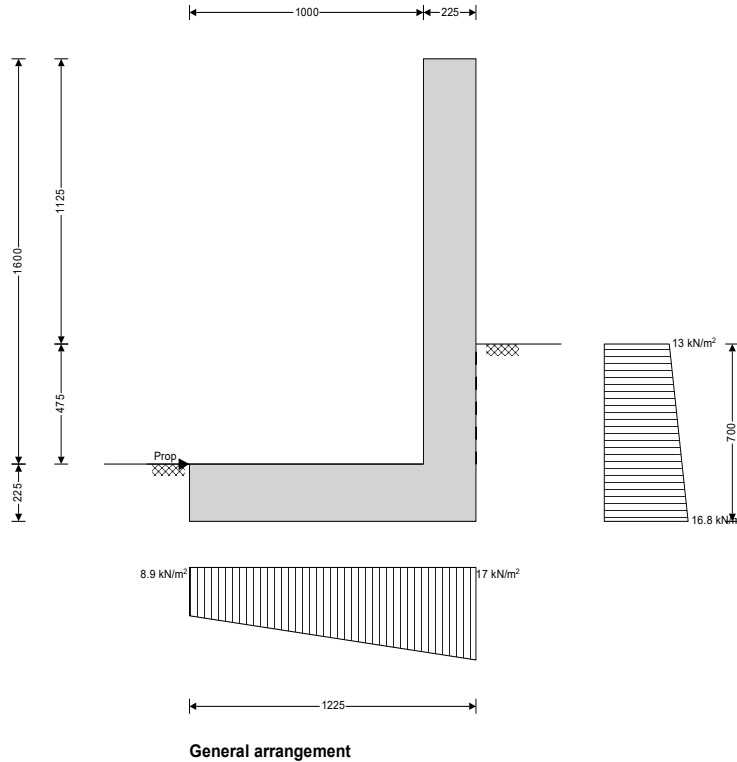
Moist density	$\gamma_{mr} = 21$ kN/m <sup>3</sup>		
Saturated density	$\gamma_{sr} = 23$ kN/m <sup>3</sup>		
Characteristic effective shear resistance angle		$\phi'_{r,k} = 33$ deg	
Characteristic wall friction angle		$\delta_{r,k} = 15$ deg	

#### Base soil properties

Soil density	$\gamma_b = 18$ kN/m <sup>3</sup>		
Characteristic effective shear resistance angle		$\phi'_{b,k} = 33$ deg	
Characteristic wall friction angle		$\delta_{b,k} = 15$ deg	
Characteristic base friction angle		$\delta_{bb,k} = 33$ deg	
Presumed bearing capacity	$P_{bearing} = 225$ kN/m <sup>2</sup>		

#### Loading details

Variable surcharge load	Surcharge <sub>Q</sub> = 50 kN/m <sup>2</sup>
-------------------------	---



### Calculate retaining wall geometry

Base length	$l_{base} = 1225$ mm		
Moist soil height	$h_{moist} = 475$ mm		
Length of surcharge load	$l_{sur} = 0$ mm		
Vertical distance	$x_{sur\_v} = 1225$ mm		
Effective height of wall	$h_{eff} = 700$ mm		
Horizontal distance	$x_{sur\_h} = 350$ mm		
Area of wall stem	$A_{stem} = 0.36$ m <sup>2</sup>	Vertical distance	$x_{stem} = 1113$ mm
Area of wall base	$A_{base} = 0.276$ m <sup>2</sup>	Vertical distance	$x_{base} = 613$ mm

### Using Coulomb theory

Active pressure coefficient	$K_A = 0.268$	Passive pressure coefficient	$K_P = 5.854$
-----------------------------	---------------	------------------------------	---------------

### Bearing pressure check

#### Vertical forces on wall

Total  $F_{total\_v} = F_{stem} + F_{base} = 15.9$  kN/m

#### Horizontal forces on wall

Total  $F_{total\_h} = F_{sur\_h} + F_{moist\_h} + F_{pass\_h} = 7.8$  kN/m

#### Moments on wall

Total  $M_{total} = M_{stem} + M_{base} + M_{sur} + M_{moist} = 10.7$  kNm/m

### Check bearing pressure

Propping force  $F_{prop\_base} = 7.8$  kN/m



Tedds

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Attleborough  
Norfolk

Project Lower Drayton - Proposed AD Plant				Job Ref. 25998	
Section Scenario 1 - 1.60m High Containment Analysis & Design				Sheet no./rev. 3	
Calc. by AF	Date 16/06/2020	Chk'd by OAJ	Date	App'd by	Date

Bearing pressure at toe  $q_{toe} = 8.9 \text{ kN/m}^2$       Bearing pressure at heel  $q_{heel} = 17 \text{ kN/m}^2$   
 Factor of safety  $FoS_{bp} = 13.216$

**PASS - Allowable bearing pressure exceeds maximum applied bearing pressure**

**RETAINING WALL DESIGN**

In accordance with EN1992-1-1:2004 incorporating Corrigendum dated January 2008 and the UK National Annex incorporating National Amendment No.1

Tedds calculation version 2.9.06

**Concrete details - Table 3.1 - Strength and deformation characteristics for concrete**

Concrete strength class  $C40/50$   
 Char.comp.cylinder strength  $f_{ck} = 40 \text{ N/mm}^2$       Mean axial tensile strength  $f_{ctm} = 3.5 \text{ N/mm}^2$   
 Secant modulus of elasticity  $E_{cm} = 35220 \text{ N/mm}^2$       Maximum aggregate size  $h_{agg} = 20 \text{ mm}$   
 Design comp.concrete strength  $f_{cd} = 22.7 \text{ N/mm}^2$       Partial factor  $\gamma_c = 1.50$

**Reinforcement details**

Characteristic yield strength  $f_{yk} = 500 \text{ N/mm}^2$       Modulus of elasticity  $E_s = 200000 \text{ N/mm}^2$   
 Design yield strength  $f_{yd} = 435 \text{ N/mm}^2$       Partial factor  $\gamma_s = 1.15$

**Cover to reinforcement**

Front face of stem  $C_{sf} = 50 \text{ mm}$       Rear face of stem  $C_{sr} = 50 \text{ mm}$   
 Top face of base  $C_{bt} = 50 \text{ mm}$       Bottom face of base  $C_{bb} = 50 \text{ mm}$

**Check stem design at base of stem**

Depth of section  $h = 225 \text{ mm}$

**Rectangular section in flexure - Section 6.1**

Design bending moment  $M = 2.3 \text{ kNm/m}$        $K = 0.002$        $K' = 0.207$

**$K' > K$  - No compression reinforcement is required**

Tens.reinforcement required  $A_{sr,req} = 33 \text{ mm}^2/\text{m}$   
 Tens.reinforcement provided 10 dia.bars @ 200 c/c      Tens.reinforcement provided  $A_{sr,prov} = 393 \text{ mm}^2/\text{m}$   
 Min.area of reinforcement  $A_{sr,min} = 310 \text{ mm}^2/\text{m}$       Max.area of reinforcement  $A_{sr,max} = 9000 \text{ mm}^2/\text{m}$

**PASS - Area of reinforcement provided is greater than area of reinforcement required**

Library item: Rectangular single summary

**Deflection control - Section 7.4**

Limiting span to depth ratio 16      Actual span to depth ratio 9.4

**PASS - Span to depth ratio is less than deflection control limit**

**Crack control - Section 7.3**

Limiting crack width  $w_{max} = 0.2 \text{ mm}$       Maximum crack width  $w_k = 0.021 \text{ mm}$

**PASS - Maximum crack width is less than limiting crack width**

**Rectangular section in shear - Section 6.2**

Design shear force  $V = 10.1 \text{ kN/m}$       Design shear resistance  $V_{Rd,c} = 106.4 \text{ kN/m}$

**PASS - Design shear resistance exceeds design shear force**

**Horizontal reinforcement parallel to face of stem - Section 9.6**

Min.area of reinforcement  $A_{sx,req} = 225 \text{ mm}^2/\text{m}$       Max.spacing of reinforcement  $S_{sx,max} = 400 \text{ mm}$   
 Trans.reinforcement provided 10 dia.bars @ 200 c/c      Trans.reinforcement provided  $A_{sx,prov} = 393 \text{ mm}^2/\text{m}$

**PASS - Area of reinforcement provided is greater than area of reinforcement required**

Project Lower Drayton - Proposed AD Plant			Job Ref. 25998		
Section Scenario 1 - 1.60m High Containment Analysis & Design			Sheet no./rev. 4		
Calc. by AF	Date 16/06/2020	Chk'd by OAJ	Date	App'd by	Date

**Check base design at toe**

Depth of section  $h = 225$  mm

**Rectangular section in flexure - Section 6.1**

Design bending moment  $M = 4.7$  kNm/m  $K = 0.004$   $K' = 0.207$

**$K' > K$  - No compression reinforcement is required**

Tens.reinforcement required  $A_{bb.req} = 67$  mm<sup>2</sup>/m

Tens.reinforcement provided 10 dia.bars @ 200 c/c

Min.area of reinforcement  $A_{bb.min} = 310$  mm<sup>2</sup>/m

Tens.reinforcement provided  $A_{bb.prov} = 393$  mm<sup>2</sup>/m

Max.area of reinforcement  $A_{bb.max} = 9000$  mm<sup>2</sup>/m

**PASS - Area of reinforcement provided is greater than area of reinforcement required**

Library item: Rectangular single summary

**Crack control - Section 7.3**

Limiting crack width  $w_{max} = 0.2$  mm

Maximum crack width  $w_k = 0.06$  mm

**PASS - Maximum crack width is less than limiting crack width**

**Rectangular section in shear - Section 6.2**

Design shear force  $V = 9.3$  kN/m

Design shear resistance  $V_{Rd.c} = 106.4$  kN/m

**PASS - Design shear resistance exceeds design shear force**

**Secondary transverse reinforcement to base - Section 9.3**

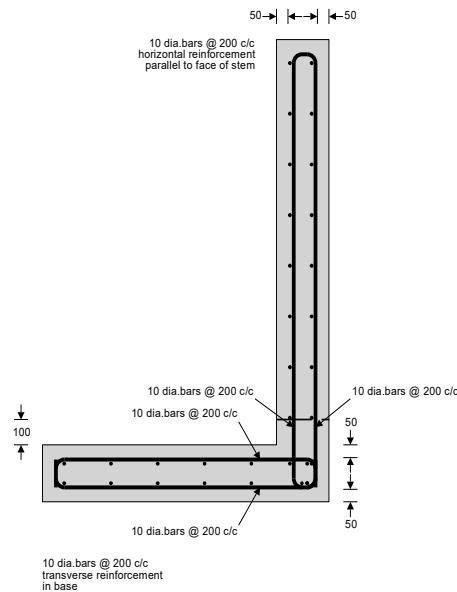
Min.area of reinforcement  $A_{bx.req} = 79$  mm<sup>2</sup>/m

Trans.reinforcement provided 10 dia.bars @ 200 c/c

Max.spacing of reinforcement  $S_{bx.max} = 450$  mm

Trans.reinforcement provided  $A_{bx.prov} = 393$  mm<sup>2</sup>/m

**PASS - Area of reinforcement provided is greater than area of reinforcement required**



**Reinforcement details**



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Project Lower Drayton - Proposed AD Plant			Job Ref. 25998		
Section Scenario 2 - 1.60m High Containment Analysis & Design			Sheet no./rev. 1		
Calc. by AF	Date 16/06/2020	Chk'd by OAJ	Date	App'd by	Date

### RETAINING WALL ANALYSIS

In accordance with EN1997-1:2004 incorporating Corrigendum dated February 2009 and the UK National Annex incorporating Corrigendum No.1

Tedds calculation version 2.9.06

#### **Retaining wall details**

Stem type	Cantilever		
Stem height	$h_{stem} = 1600$ mm		
Stem thickness	$t_{stem} = 225$ mm		
Angle to rear face of stem	$\alpha = 90$ deg		
Stem density	$\gamma_{stem} = 25$ kN/m <sup>3</sup>		
Heel length	$l_{heel} = 1000$ mm		
Base thickness	$t_{base} = 225$ mm		
Base density	$\gamma_{base} = 25$ kN/m <sup>3</sup>		
Height of retained soil	$h_{ret} = 1350$ mm	Angle of soil surface	$\beta = 0$ deg
Depth of cover	$d_{cover} = 0$ mm		

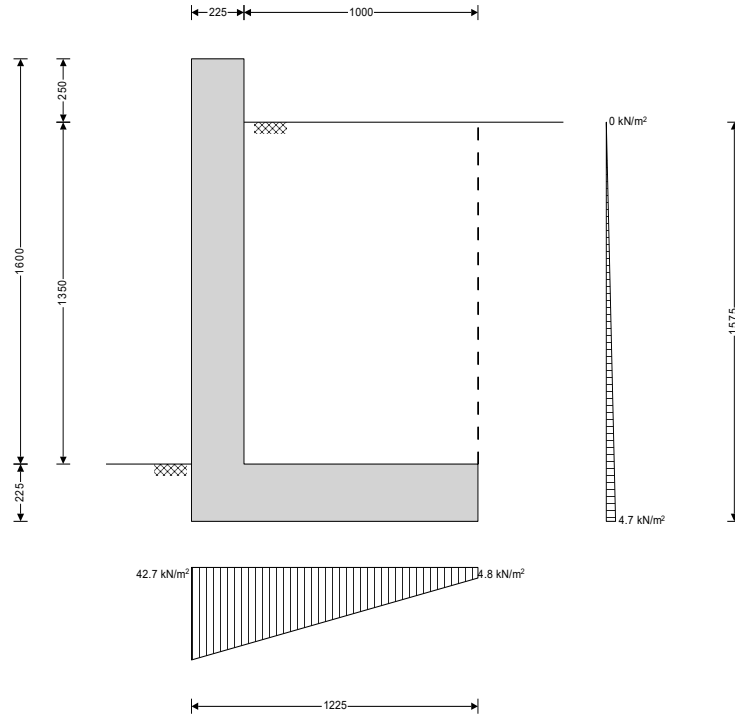
#### **Retained soil properties**

Moist density	$\gamma_{mr} = 9.8$ kN/m <sup>3</sup>		
Saturated density	$\gamma_{sr} = 9.8$ kN/m <sup>3</sup>		
Characteristic effective shear resistance angle		$\phi'_{r,k} = 30$ deg	
Characteristic wall friction angle		$\delta_{r,k} = 11$ deg	

#### **Base soil properties**

Soil density	$\gamma_b = 18$ kN/m <sup>3</sup>		
Characteristic effective shear resistance angle		$\phi'_{b,k} = 33$ deg	
Characteristic wall friction angle		$\delta_{b,k} = 15$ deg	
Characteristic base friction angle		$\delta_{bb,k} = 33$ deg	
Presumed bearing capacity	$P_{bearing} = 225$ kN/m <sup>2</sup>		

Project Lower Drayton - Proposed AD Plant			Job Ref. 25998		
Section Scenario 2 - 1.60m High Containment Analysis & Design			Sheet no./rev. 2		
Calc. by AF	Date 16/06/2020	Chk'd by OAJ	Date	App'd by	Date



General arrangement

### Calculate retaining wall geometry

Base length	$l_{\text{base}} = 1225 \text{ mm}$	Vertical distance	$x_{\text{stem}} = 113 \text{ mm}$
Moist soil height	$h_{\text{moist}} = 1350 \text{ mm}$	Vertical distance	$x_{\text{base}} = 613 \text{ mm}$
Retained surface length	$l_{\text{sur}} = 1000 \text{ mm}$	Vertical distance	$x_{\text{moist}_v} = 725 \text{ mm}$
Effective height of wall	$h_{\text{eff}} = 1575 \text{ mm}$	Horizontal distance	$x_{\text{moist}_h} = 525 \text{ mm}$
Area of wall stem	$A_{\text{stem}} = 0.36 \text{ m}^2$		
Area of wall base	$A_{\text{base}} = 0.276 \text{ m}^2$		
Area of moist soil	$A_{\text{moist}} = 1.35 \text{ m}^2$		

### Using Coulomb theory

Active pressure coefficient	$K_A = 0.307$	Passive pressure coefficient	$K_P = 5.854$
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### Bearing pressure check

#### Vertical forces on wall

Total  $F_{\text{total}_v} = F_{\text{stem}} + F_{\text{base}} + F_{\text{moist}_v} = 29.1 \text{ kN/m}$

#### Horizontal forces on wall

Total  $F_{\text{total}_h} = \max(F_{\text{moist}_h} + F_{\text{pass}_h} - F_{\text{total}_v} \times \tan(\delta_{\text{bb.k}}), 0 \text{ kN/m}) = 0 \text{ kN/m}$

#### Moments on wall

Total  $M_{\text{total}} = M_{\text{stem}} + M_{\text{base}} + M_{\text{moist}} + M_{\text{pass}} = 13.1 \text{ kNm/m}$

### Check bearing pressure

Bearing pressure at toe	$q_{\text{toe}} = 42.7 \text{ kN/m}^2$	Bearing pressure at heel	$q_{\text{heel}} = 4.8 \text{ kN/m}^2$
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Project Lower Drayton - Proposed AD Plant				Job Ref. 25998	
Section Scenario 2 - 1.60m High Containment Analysis & Design				Sheet no./rev. 3	
Calc. by AF	Date 16/06/2020	Chk'd by OAJ	Date	App'd by	Date

Factor of safety

$FoS_{bp} = 5.265$

**PASS - Allowable bearing pressure exceeds maximum applied bearing pressure**

**Design approach 1**

**Partial factors on actions - Table A.3 - Combination 1**

Partial factor set A1

Permanent unfavourable action

$\gamma_G = 1.35$

Permanent favourable action

$\gamma_{Gf} = 1.00$

Variable unfavourable action  $\gamma_Q = 1.50$

Variable favourable action

$\gamma_{Qf} = 0.00$

**Partial factors for soil parameters – Table A.4 - Combination 1**

Soil parameter set M1

Angle of shearing resistance  $\gamma_\psi = 1.00$

Effective cohesion

$\gamma_{c'} = 1.00$

Weight density  $\gamma_\gamma = 1.00$

Library item Partial factors summary

**Retained soil properties**

Design moist density  $\gamma_{mr}' = 9.8 \text{ kN/m}^3$

Design saturated density

$\gamma_{sr}' = 9.8 \text{ kN/m}^3$

Des. eff. shear resist. angle  $\phi'_{r,d} = 30 \text{ deg}$

Design wall friction angle

$\delta_{r,d} = 11 \text{ deg}$

**Base soil properties**

Design soil density  $\gamma_b' = 18 \text{ kN/m}^3$

Des. eff. shear resist. angle

$\phi'_{b,d} = 33 \text{ deg}$

Design wall friction angle  $\delta_{b,d} = 15 \text{ deg}$

Design base friction angle

$\delta_{bb,d} = 33 \text{ deg}$

Design effective cohesion  $c'_{b,d} = 0 \text{ kN/m}^2$

**Using Coulomb theory**

Active pressure coefficient  $K_A = 0.307$

Passive pressure coefficient

$K_P = 5.854$

**Sliding check**

**Vertical forces on wall**

Total  $F_{total\_v} = F_{stem} + F_{base} + F_{moist\_v} = 29.1 \text{ kN/m}$

**Horizontal forces on wall**

Total  $F_{total\_h} = F_{moist\_h} = 4.9 \text{ kN/m}$

**Check stability against sliding**

Resistance to sliding  $F_{rest} = 21.5 \text{ kN/m}$

Factor of safety

$FoS_{sl} = 4.345$

**PASS - Resistance to sliding is greater than sliding force**

**Overturning check**

**Vertical forces on wall**

Total  $F_{total\_v} = F_{stem} + F_{base} + F_{moist\_v} = 29.1 \text{ kN/m}$

**Horizontal forces on wall**

Total  $F_{total\_h} = F_{moist\_h} + F_{exc\_h} = 2.4 \text{ kN/m}$

**Overturning moments on wall**

Total  $M_{total\_OT} = M_{moist\_OT} = 2.6 \text{ kNm/m}$

**Restoring moments on wall**

Total  $M_{total\_R} = M_{stem\_R} + M_{base\_R} + M_{moist\_R} + M_{exc\_R} = 15 \text{ kNm/m}$

**Check stability against overturning**

Factor of safety  $FoS_{ot} = 5.786$



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Project Lower Drayton - Proposed AD Plant			Job Ref. 25998		
Section Scenario 2 - 1.60m High Containment Analysis & Design			Sheet no./rev. 4		
Calc. by AF	Date 16/06/2020	Chk'd by OAJ	Date	App'd by	Date

**PASS - Maximum restoring moment is greater than overturning moment**

**Design approach 1**

**Partial factors on actions - Table A.3 - Combination 2**

Partial factor set	A2			
Permanent unfavourable action	$\gamma_G = 1.00$	Permanent favourable action		
	$\gamma_{Gf} = 1.00$			
Variable unfavourable action	$\gamma_Q = 1.30$	Variable favourable action	$\gamma_{Qf} = 0.00$	

**Partial factors for soil parameters – Table A.4 - Combination 2**

Soil parameter set	M2			
Angle of shearing resistance	$\gamma_\psi = 1.25$	Effective cohesion	$\gamma_{c'} = 1.25$	
Weight density	$\gamma_\gamma = 1.00$			
				Library item Partial factors summary

**Retained soil properties**

Design moist density	$\gamma_{m'} = 9.8 \text{ kN/m}^3$	Design saturated density	$\gamma_{sr'} = 9.8 \text{ kN/m}^3$
Des. eff. shear resist. angle	$\phi_{r,d}^1 = 24.8 \text{ deg}$	Design wall friction angle	$\delta_{r,d} = 8.8 \text{ deg}$

**Base soil properties**

Design soil density	$\gamma_b' = 18 \text{ kN/m}^3$	Des. eff. shear resist. angle	$\phi_{b,d}^1 = 27.5 \text{ deg}$
Design wall friction angle	$\delta_{b,d} = 12.1 \text{ deg}$	Design base friction angle	$\delta_{bb,d} = 27.5 \text{ deg}$
Design effective cohesion	$c_{b,d} = 0 \text{ kN/m}^2$		

**Using Coulomb theory**

Active pressure coefficient	$K_A = 0.378$	Passive pressure coefficient	$K_P = 3.941$
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**Sliding check**

**Vertical forces on wall**

Total	$F_{total\_v} = F_{stem} + F_{base} + F_{moist\_v} = 29.1 \text{ kN/m}$
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**Horizontal forces on wall**

Total	$F_{total\_h} = F_{moist\_h} = 4.5 \text{ kN/m}$
-------	--

**Check stability against sliding**

Resistance to sliding	$F_{rest} = 16.9 \text{ kN/m}$	Factor of safety	$FoS_{Sl} = 3.713$
<b>PASS - Resistance to sliding is greater than sliding force</b>			

**Overturning check**

**Vertical forces on wall**

Total	$F_{total\_v} = F_{stem} + F_{base} + F_{moist\_v} = 29.1 \text{ kN/m}$
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**Horizontal forces on wall**

Total	$F_{total\_h} = F_{moist\_h} + F_{exc\_h} = 2.8 \text{ kN/m}$
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**Overturning moments on wall**

Total	$M_{total\_OT} = M_{moist\_OT} = 2.4 \text{ kNm/m}$
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**Restoring moments on wall**

Total	$M_{total\_R} = M_{stem\_R} + M_{base\_R} + M_{moist\_R} + M_{exc\_R} = 15 \text{ kNm/m}$
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**Check stability against overturning**

Factor of safety	$FoS_{ot} = 6.267$
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**PASS - Maximum restoring moment is greater than overturning moment**



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Project Lower Drayton - Proposed AD Plant			Job Ref. 25998		
Section Scenario 2 - 1.60m High Containment Analysis & Design			Sheet no./rev. 5		
Calc. by AF	Date 16/06/2020	Chk'd by OAJ	Date	App'd by	Date

**RETAINING WALL DESIGN**

In accordance with EN1992-1-1:2004 incorporating Corrigendum dated January 2008 and the UK National Annex incorporating National Amendment No.1

Tedds calculation version 2.9.06

**Concrete details - Table 3.1 - Strength and deformation characteristics for concrete**

Concrete strength class	C40/50	Mean axial tensile strength	$f_{ctm} = 3.5 \text{ N/mm}^2$
Char.comp.cylinder strength	$f_{ck} = 40 \text{ N/mm}^2$	Maximum aggregate size	$h_{agg} = 20 \text{ mm}$
Secant modulus of elasticity	$E_{cm} = 35220 \text{ N/mm}^2$	Design comp.concrete strength	Partial factor $\gamma_c = 1.50$
		$f_{cd} = 22.7 \text{ N/mm}^2$	

**Reinforcement details**

Characteristic yield strength	$f_{yk} = 500 \text{ N/mm}^2$	Modulus of elasticity	$E_s = 200000 \text{ N/mm}^2$
Design yield strength	$f_{yd} = 435 \text{ N/mm}^2$	Partial factor	$\gamma_s = 1.15$

**Cover to reinforcement**

Front face of stem	$C_{sf} = 50 \text{ mm}$	Rear face of stem	$C_{sr} = 50 \text{ mm}$
Top face of base	$C_{bt} = 50 \text{ mm}$	Bottom face of base	$C_{bb} = 50 \text{ mm}$

**Check stem design at base of stem**

Depth of section  $h = 225 \text{ mm}$

**Rectangular section in flexure - Section 6.1**

Design bending moment  $M = 1.6 \text{ kNm/m}$   $K = 0.001$   $K' = 0.207$

***K' > K - No compression reinforcement is required***

Tens.reinforcement required	$A_{sr,req} = 23 \text{ mm}^2/\text{m}$	Tens.reinforcement provided	$A_{sr,prov} = 393 \text{ mm}^2/\text{m}$
Tens.reinforcement provided	10 dia.bars @ 200 c/c	Max.area of reinforcement	$A_{sr,max} = 9000 \text{ mm}^2/\text{m}$
Min.area of reinforcement	$A_{sr,min} = 310 \text{ mm}^2/\text{m}$		

***PASS - Area of reinforcement provided is greater than area of reinforcement required***

Library item: Rectangular single summary

**Deflection control - Section 7.4**

Limiting span to depth ratio 16 Actual span to depth ratio 9.4

***PASS - Span to depth ratio is less than deflection control limit***

**Crack control - Section 7.3**

Limiting crack width  $w_{max} = 0.2 \text{ mm}$  Maximum crack width  $w_k = 0.027 \text{ mm}$

***PASS - Maximum crack width is less than limiting crack width***

**Rectangular section in shear - Section 6.2**

Design shear force  $V = 3.6 \text{ kN/m}$  Design shear resistance  $V_{Rd,c} = 106.4 \text{ kN/m}$

***PASS - Design shear resistance exceeds design shear force***

**Horizontal reinforcement parallel to face of stem - Section 9.6**

Min.area of reinforcement	$A_{sx,req} = 225 \text{ mm}^2/\text{m}$	Max.spacing of reinforcement	$S_{sx,max} = 400 \text{ mm}$
Trans.reinforcement provided	10 dia.bars @ 200 c/c	Trans.reinforcement provided	$A_{sx,prov} = 393 \text{ mm}^2/\text{m}$

***PASS - Area of reinforcement provided is greater than area of reinforcement required***

**Check base design at heel**

Depth of section  $h = 225 \text{ mm}$

**Rectangular section in flexure - Section 6.1**

Design bending moment  $M = 2.7 \text{ kNm/m}$   $K = 0.002$   $K' = 0.207$

Project Lower Drayton - Proposed AD Plant			Job Ref. 25998		
Section Scenario 2 - 1.60m High Containment Analysis & Design			Sheet no./rev. 6		
Calc. by AF	Date 16/06/2020	Chk'd by OAJ	Date	App'd by	Date

***K' > K - No compression reinforcement is required***

Tens.reinforcement required  $A_{bt,req} = 38 \text{ mm}^2/\text{m}$

Tens.reinforcement provided 10 dia.bars @ 200 c/c

Min.area of reinforcement  $A_{bt,min} = 310 \text{ mm}^2/\text{m}$

Tens.reinforcement provided  $A_{bt,prov} = 393 \text{ mm}^2/\text{m}$

Max.area of reinforcement  $A_{bt,max} = 9000 \text{ mm}^2/\text{m}$

***PASS - Area of reinforcement provided is greater than area of reinforcement required***

Library item: Rectangular single summary

**Crack control - Section 7.3**

Limiting crack width  $w_{max} = 0.2 \text{ mm}$

Maximum crack width  $w_k = 0.042 \text{ mm}$

***PASS - Maximum crack width is less than limiting crack width***

**Rectangular section in shear - Section 6.2**

Design shear force  $V = 4.4 \text{ kN/m}$

Design shear resistance  $V_{Rd,c} = 106.4 \text{ kN/m}$

***PASS - Design shear resistance exceeds design shear force***

**Secondary transverse reinforcement to base - Section 9.3**

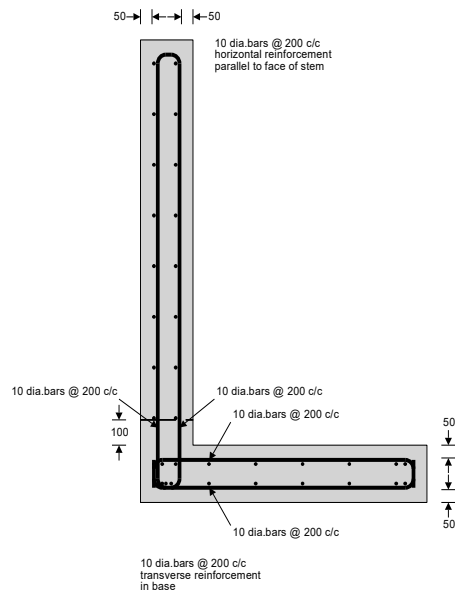
Min.area of reinforcement  $A_{bx,req} = 79 \text{ mm}^2/\text{m}$

Max.spacing of reinforcement  $S_{bx,max} = 450 \text{ mm}$

Trans.reinforcement provided 10 dia.bars @ 200 c/c

Trans.reinforcement provided  $A_{bx,prov} = 393 \text{ mm}^2/\text{m}$

***PASS - Area of reinforcement provided is greater than area of reinforcement required***



**Reinforcement details**



# Hydrobar PVC

High Performance Waterstop Range

## DESCRIPTION

HYDROBAR PVC is a range of high performance waterstops extruded from PVC material designed to prevent the passage of water at both construction and expansion joints in watertight structures. The Hydrobar PVC waterstop range includes a range of sizes, pre-formed junction pieces and sections depending upon the exact situation.

## USES

Hydrobar PVC waterstops are designed for use as method of sealing both construction and expansion joints in cast in-situ concrete structures. The waterstops are intended for use on both water retaining and water excluding structures including: reservoirs, water tanks, dams, swimming pools, basements, tunnels, underground carparks etc.

## ADVANTAGES

- Available in range of profiles and sizes.
- Joints are easily welded on site.
- Full range of preformed junction pieces for ease of use.
- Complete fabrication service available for complicated networks.

## TYPICAL PROPERTIES

Property	Value
Elongation at Break	>300%
Tensile Strength	14.9MPa
Shore A Hardness	80 -90
Relative Density	1.44
B. S. Softness	28 @ 20°C

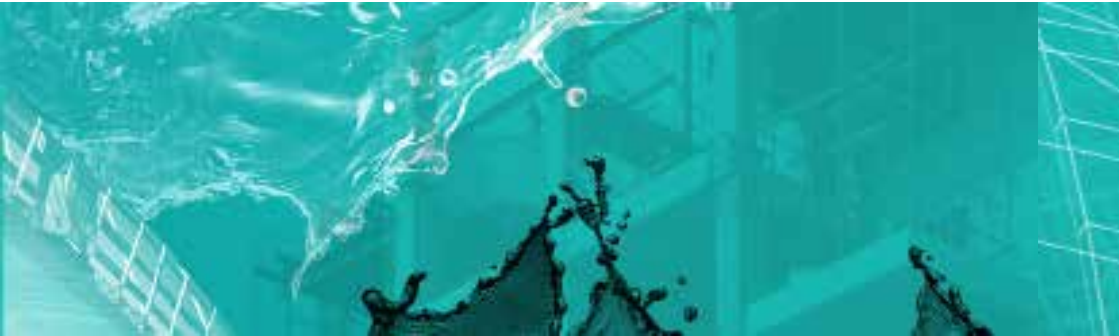
## HYDROBAR RANGE

**Hydrobar Centrestop** has been specifically developed, with the unique rib and end bulb profiles to provide a totally effective water barrier when cast centrally within concrete wall and floor joints.

Hydrobar Centrestop has been independently tested in accordance with BS2782 to withstand ingress of water, up to 32M head in construction and expansion joints in water retaining and excluding structures. Hydrobar Centrestop is available in two different web profiles. The standard Hydrobar Centrestop has a web profile of 5mm, the Heavy Duty Centrestop has a web profile of 10mm and is designed for use where more rigidity is required during the concrete pour.

**Hydrobar Rearstop** is a high performance, heavy duty profile waterstop specifically developed to seal joints in concrete structures at the outside surface thus protecting the reinforcing steel against corrosion attack, in addition to providing a totally watertight seal.





Hydrobar Rearstop has been independently tested to provide a totally effective water barrier up to 32M head in construction, expansion and kicker joints in concrete water retaining and excluding structures.

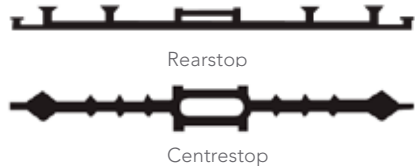
#### PROCEDURE

**Installation of Centrestop:** The waterstop must be positioned centrally in the thickness of the section being poured and spanning the construction/expansion joint. The waterstop should be held in position using the metal eyelets, tied to the reinforcement. Ensure the concrete around the waterstop section is well compacted to prevent passage of water around the waterbar through any voids or porous areas.

**Installation of Rearstop:** Where the waterstop is used to waterproof joints on a vertical section of concrete, the waterstop should be nailed to the shutter through the outer nailing flanges. The nails should be left protruding so that they are cast into the concrete to prevent damage to the waterbar when striking the shutter. Where the waterstop is used to waterproof joints on a ground bearing slab then the waterstop should be laid on the substrate centrally over the joint and tied to prevent displacement during the placement of the concrete.

**Jointing of Hydrobar:** Jointing of the waterstop is easily carried out on site using a Hydrobar Jointing Jig and Hydrobar Hot Knife. The ends to be jointed should be clamped into the Jointing

Jig and pressed against either side of the Hot Knife until an even bead of molten PVC forms along the entire width of the waterstop. The Hot knife should then be removed and the two sections be pushed together allowing the PVC to cool producing a completely fused watertight connection.



#### PACKAGING

Type	Width	Roll Length
Centrestop	190 mm	25 M
	240 mm	25 M
Rearstop	190 mm	25 M
	240 mm	25 M

#### STORAGE

Store Hydrobar PVC in original packaging in cool dry conditions.

#### HEALTH AND SAFETY

Please refer to separate Material Safety Datasheet.

The information provided in this data sheet is intended for general guidance only and is given in good faith based on Premcrete's current knowledge and experience. No warranty in respect of fitness for a purpose, or any other liability whatsoever can be inferred from the information contained within this datasheet. Users should determine the suitability of the materials for their particular application and should always refer to the most recent issue of the product data sheet for the product concerned.

All materials are supplied in accordance with Premcrete Sales Terms & Conditions (available upon request)





# Hydrostop WSM

Gun Grade Hydrophilic Sealant

## DESCRIPTION

HYDROSTOP WSM is a hydrophilic, gun-grade sealant. The hydrophilic properties of Hydrostop WSM display good consistency in swell rate during repeated wet/dry cycling. Expansion of the product on contact with water creates a positive pressure against the faces of the concrete joint, thus preventing the passage of water.

## USES

HYDROSTOP WSM can be used as an adhesive for bonding Hydrostop water bars or as a problem solving hydrophilic sealant in difficult access areas including:

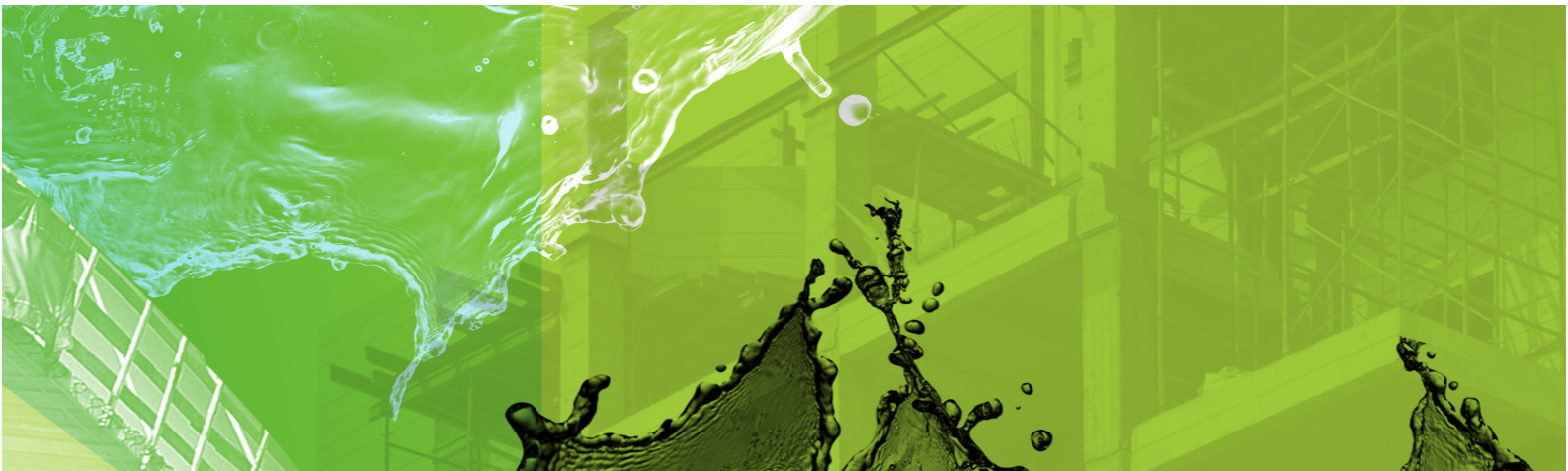
- Sealing around joints in precast manhole covers, cable ducts and pipes etc.
- Sealing around precast segments
- Sealing between rough surfaces, e.g. slurry walls and concrete slabs
- Sealing around H-beams and other penetrations through concrete structures
- Sealing around conventional rubber and plastic waterstops to provide a 'belt and braces' seal prior to concrete pour

## TYPICAL PROPERTIES

Property	Value
Form	Thisotropic Sealant
Colour	Black/Grey
Tack-free Time	Approximately 1 hour
Hardness Shore 'A'	30
Cure Rate	3 mm in 24 hours
Swell Ratio	200%

## ADVANTAGES

- Excellent seal on rough concrete: Gives improved water tightness. Plug in irregularities rough concrete to produce a water-tight seal.
- Excellent adhesion: Quick and easy to apply to a variety of damp and uneven joint surfaces remaining firmly in place during concrete pour.
- Water swellable: Expands by 200% producing a watertight compression seal.
- Durable: Excellent wet/dry cycling retaining elastomeric character and swelling performance due to high tolerance of the cementitious environment.



## PROCEDURE

**Surface Preparation:** Remove all obvious loose debris and soil, moss and organic growth from the substrate. Hydrostop WSM can be applied to damp concrete but always ensure the surface is free from running water and brush away any standing or seeping water. Divert running channels away from area before application.

**Application:** Cut the end of the foil sachet and place the sachet into the sealant applicator gun and apply like a conventional sealant. Extrude a bead of not less than 10mm diameter onto the substrate, ensuring that there is no break in the bead.

## PACKAGING

Pack Size: 600 ml sachet

Coverage: A 600 ml sachet will extrude a 6 metre bead 10 mm diameter.

## STORAGE

Shelf life is 9 months.

Store in original unopened packaging in a cool, dry conditions.

## LIMITATIONS

Hydrostop WSM should not be used for expansion jointing or for joints subject to significant repetitive movements. Hydrostop WSM should be positioned to ensure that there is a minimum of 70mm concrete cover to accommodate pressure developed during the swelling process. Hydrostop WSM will establish a firm bond to the concrete. However, as with any hydrophilic waterstop, care should be taken during concreting to avoid pouring directly onto the seal.

N.B: Hydrostop WSM should not be used as a sealant in general building applications.

## HEALTH AND SAFETY

Please refer to separate Material Safety datasheets.

The information provided in this data sheet is intended for general guidance only and is given in good faith based on Premcrete's current knowledge and experience. No warranty in respect of fitness for a purpose, or any other liability whatsoever can be inferred from the information contained within this datasheet. Users should determine the suitability of the materials for their particular application and should always refer to the most recent issue of the product data sheet for the product concerned.

All materials are supplied in accordance with Premcrete Sales Terms & Conditions (available upon request)



**HYDROSTOP BR  
SAFETY DATA SHEET**

According to 1907/2006/EC, article 31

**1. IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING**

**1.1 Product Identifier**

Hydrostop BR

**Relevant uses of the substance or mixture and uses advised against**

Hydroswellung Bentonite joint sealant for waterproofing of construction and cold joints in concrete.

**1.1 Details of the supplier of the data sheet**

Premcrete  
Seymour House  
Mayflower Close  
Chandlers Ford  
Eastleigh  
Hampshire  
SO53 4AR

[Sales@premcrete.com](mailto:Sales@premcrete.com)

[www.premcrete.com](http://www.premcrete.com)

**1.2 Emergency telephone number**

+44 (0) 800 6191619  
6:30am-5:00pm Mon-Fri

**2. HAZARDS IDENTIFICATION**

**2.1 None to our knowledge.**

**3. COMPOSITION/INFORMATION ON INGREDIENTS**

**3.1 Mixtures**

**Chemical Composition:** Blend of Butylrubber and Sodium Bentonite

**4. FIRST AID MEASURES**

- 4.1 General advice:** In case of doubt or with persisting symptoms obtain medical attention. Never pass anything through the mouth of an unconscious person.
- 4.2 Skin contact:** Remove soiled clothing.
- 4.3 Eye contact:** Rinse immediately with eye wash or clean water for at least 15 min. Seek medical attention
- 4.4 Ingestion:** Immediately rinse mouth out. Do not induce vomiting. Seek immediate medical advice.



PAGE: 1

REVISION: 1

REVISION DATE: 23-06-2016

## 5. FIRE-FIGHTING MEASURES

- 5.1 Suitable extinguishing media:** Carbon dioxide, dry powder, halon, foam or water
- 5.2 Unsuitable extinguishing media:** None
- 5.3 Exposure hazards:** None
- 5.4 Special protective equipment:** Fire fighters should wear full protective clothing and self-contained breathing apparatus

## 6. ACCIDENTAL RELEASE MEASURES

- 6.1 Personal precautions:** None.
- 6.2 Environmental precautions:** Prevent material from entering sewage system, water courses or water treatment installations.

## 7. HANDLING AND STORAGE

- 7.1 Storage:** Keep cartons dry and closed.

## 8. EXPOSURE CONTROL/PERSONAL PROTECTION

- 8.1 Skin protection:** Cotton or cotton/synthetic or coveralls are suitable.

## 9. Physical and chemical properties

### 9.1 Information on basic and chemical properties

- Appearance:** Green Solid
- Melting point::** 80°C
- Flash Point:** Not applicable
- Flammability:** Non-flammable
- Auto flammability:** Not applicable
- Relative density:** 1,48
- Solubility in water:** Non Soluble

## 10. STABILITY AND REACTIVITY

- 10.1 Stability:** Stable under normal ambient conditions
- 10.2 Conditions to avoid:** Avoid water
- 10.3 Materials to avoid:** Water
- 10.4 Haz. decomp. Products:** None in ambient conditions

## 11 TOXICOLOGICAL INFORMATION

- 11.1 Routes of exposure:** Eye contact.

## 12 ECOLOGICAL INFORMATION

- 12.1 Ecological Information:** None



### 13 DISPOSAL CONSIDERATIONS

#### 13.1 Disposal Considerations:

Do not allow into drains or water courses or where ground water or surface waters may be affected. Ensure any containers containing waste material are correctly labelled. Wastes, including emptied containers, are controlled wastes and should be disposed of in accordance with local, state or EC regulations at an authorised site.

### 14 TRANSPORT INFORMATION

**14.1 Transport Information:** The product has no classification

### 15 REGULATORY INFORMATION

**15.1 Regulatory Information:** None

### 16 OTHER INFORMATION

**Training advice:** Do not use unless trained to do so.

**Recommended uses:** The product is only supplied for use in accordance with uses listed in sec 1.

*The information supplied in the Safety Data Sheet is designed only as guidance for the safe use, storage and handling of the product. The information is correct to the best of our knowledge and belief at the date of publication however no guarantee is made to its accuracy. This information relates only to the specific materials designated and may not be valid for such material used in combination with any other materials or in any other process.*



# SIKAFIBER® Product Proposal

## FOR FIBER REINFORCED CONCRETE SLABS ON GROUND

### PROJECT INFORMATION

Project reference	JF10b
Project name	Lower Drayton Farm bund slabs
Customer	plandescil
Date	04/06/2020
Calculation title	Beneath Tanks Slabs
Calculation by	
Approved by	
Remarks	
Country	United Kingdom

### PRODUCT INFORMATION

Product	SikaFiber® Force-50
Dosage	4.0 kg/m <sup>3</sup>

### DESIGN SUMMARY

Design method	Concrete Society Technical Report 34 - Concrete Industrial Ground Floors, 4th Edition
Regulations	EN 1992-1-1. Eurocode 2: Design of structures - Part 1-1: General rules and rules for buildings
Concrete class	C32/40
Slab thickness	h = 175 mm
Joint spacing	x = 6000 mm; y = 6000 mm
Modulus of subgrade reaction	k = 0.225 N/mm <sup>3</sup>

### LOADING SUMMARY

CHECKING TYPE	LOAD CASE	VALUE
Bending	--	--
Bending (MHE)	MHE 1	0.1184
Punching	--	--
Uniformly distributed loads	beneath Tank slabs	0.8850
Linearly distributed loads	--	--



## NOTES

---

Joints are placed in the slab to minimize the risk of cracking

---

- In fiber reinforced floors use square panels or limit the length-to-width (aspect ratio) to 1:1.5
  - Limit the longest dimension between to sawn joints <6 m
  - Avoid re-entrant corners
  - Avoid slabs with acute angles at corners
  - Avoid restrained shrinkage of the slab, isolate the slab around fixed points
  - Avoid point loads in corners
- 

Shrinkage and curling shall be evaluated on a project basis. There are several factors including, but not limited to.

---

- Internal concrete stresses occur greatly depending on the aggregate size, type and quality; the water content, cement paste content, admixture usage, concrete temperature and generally the mix design.
  - Placement conditions due to the sub-grade moisture and preparation, sub-grade restraint and protection from environmental and ambient conditions (temperature variations, wind and humidity)
  - Location and timeliness of jointing and proper joint activation.
  - Proper curing is vital to all concrete construction. The standard rules of good concreting practice, concerning production and placing, shall be followed.
-

## INDEX

1.- DESIGN DATA.....	4
2.- RESULTS.....	5
2.1.- Summary of results.....	5
2.2.- Fibre reinforcement proposal .....	5
2.3.- Capacity of fibre reinforced section .....	5
2.4.- Bending checking .....	7
2.5.- Punching checking .....	8
2.6.- Line load checking .....	8
2.7.- Uniform distributed load (UDL) checking.....	8
2.8.- Other verifications.....	8
3.- ALSO AVAILABLE FROM SIKA.....	9
4.- LEGAL DISCLAIMER.....	10
5.- ABOUT SIKAFIBER® CALCULATION SOFTWARE.....	10

## 1.- DESIGN DATA

### Regulations

Concrete Society Technical Report No. 34 (TR 34): Concrete industrial ground floors. A guide to design and construction.

EN 1992-1-1. Eurocode 2: Design of structures - Part 1-1: General rules and rules for buildings

### Partial safety factors for materials

Material	$\gamma_m$
Concrete / Fibre reinforced concrete	1.50
Steel	1.15

### Partial safety factors for loads

Loads	$\gamma_f$
Racking loads	1.20
Permanent loads	1.35
Variable loads	1.50
Dynamic loads	1.60
Uniformly distributed loads	1.00
Linearly distributed loads	1.00

### Soil parameters

k: modulus of subgrade reaction

k : 0.225 N/mm<sup>3</sup>

### Concrete data

Concrete class: C32/40

$f_{ck}$ : Characteristic cylinder compressive strength of concrete

$f_{ck}$  : 32.00 MPa

$E_{cm}$ : secant modulus of elasticity of concrete

$E_{cm}$  : 33345.76 MPa

$f_{ctm}$ : Mean axial tensile strength

$f_{ctm}$  : 3.02 MPa

$\nu$ : Poisson's ratio

$\nu$  : 0.20

### Slab panel data

Panel dimensions: 6000 x 6000 mm

Load transfer at the edge: 15.0%

Load transfer at the corner: 15.0%

### Reinforcement information

Reinforcement for bending: Considered

r: reinforcement ratio

r : 0.245

$c_t$ : reinforcement bottom cover

$c_t$  : 50 mm

Local reinforcement for punching: Considered

$r_r$ : reinforcement ratio for punching

$r_r$  : 0.485

$f_{yk}$ : yield strength of reinforcement

$f_{yk}$  : 420.00 MPa

## 2.- RESULTS

### 2.1.- Summary of results

Checking	Load case	Type	Usage ratio
Bending	--	--	--
Bending (MHE)	MHE 1	Single point load	0.1184
Punching	--	--	--
Uniformly distributed loads	beneath Tank slabs	Uniformly distributed load	0.8850
Linearly distributed loads	--	--	--

### 2.2.- Fibre reinforcement proposal

Fibre-reinforced concrete data	
Fibre type: Synthetic Macro-fibres	
Sika product: SikaFiber® Force-50	
Fibre dosage: 4.0kg/m <sup>3</sup>	
$f_{ck}$ : Characteristic cylinder compressive strength of concrete	$f_{ck} : \underline{32.00}$ MPa
$f_{R1}$ : Residual flexural strength at CMOD 0.5	$f_{R1} : \underline{1.52}$ MPa
$f_{R2}$ : Residual flexural strength at CMOD 1.5	$f_{R2} : \underline{1.71}$ MPa
$f_{R3}$ : Residual flexural strength at CMOD 2.5	$f_{R3} : \underline{1.99}$ MPa
$f_{R4}$ : Residual flexural strength at CMOD 3.5	$f_{R4} : \underline{2.11}$ MPa
h: Thickness of the slab	$h : \underline{175}$ mm
Joint spacing (X-direction): 6000mm	
Joint spacing (Y-direction): 6000mm	

### 2.3.- Capacity of fibre reinforced section

The ultimate moment capacity is dependent on the strain at the extremity of the section. On the compression face, the strain is limited to 0.0035, as is the case for conventional reinforced concrete sections. On the tension face, the strain is limited to 0.025.

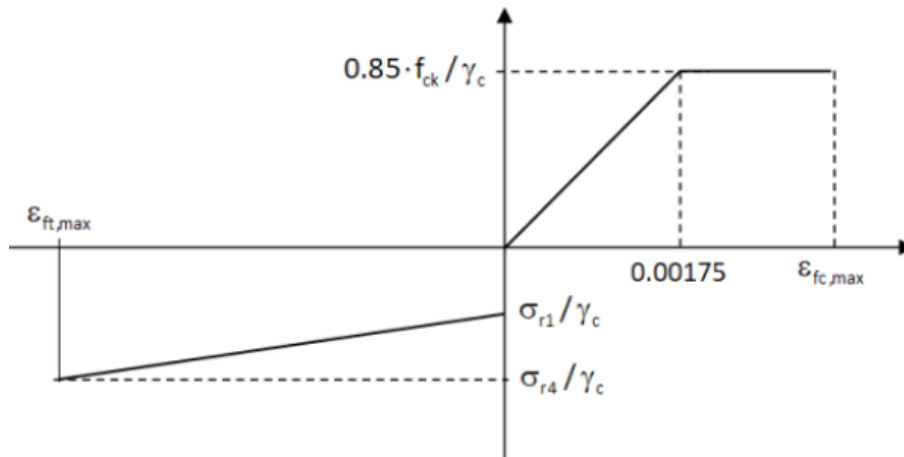
The moment - crack width (M-w) response of the section is derived in terms of the residual strengths  $f_{R1}$  and  $f_{R4}$  obtained from the EN 14651 beam test.  $f_{R1}$  and  $f_{R4}$  represent the flexural tensile stresses at a Crack Mouth Opening Displacement (CMOD) of 0.5mm and 3.5mm respectively in the 150mm deep test beam. Although in sections deeper than 150mm, the strain at a CMOD of 3.5mm will be lower than in the test beam, the maximum tensile strain is set at the value resulting from a CMOD of 3.5mm, subject to a limiting maximum strain of 0.025.

For a slab with a low (cracked) flexural tensile capacity, the compressive strain in the concrete may remain in the elastic range, below 0.00175, in which case the concrete stress block is triangular. As the flexural tensile capacity increases, the compressive strain in the concrete increases and the compressive stress block becomes bi-linear.

Stress and strain diagram for bi-linear stress block for strain softening  $|\sigma_{r1}| \geq |\sigma_{r4}|$

Stress and strain diagram for bi-linear stress block for strain hardening  $|\sigma_{r1}| < |\sigma_{r4}|$





$\epsilon_{ft,max}$ : Maximum tensile strain in fibre reinforced concrete

$$\epsilon_{ft,max} : \underline{25.00} \text{ ‰}$$

$\epsilon_{fc,max}$ : Maximum compressive strain concrete

$$\epsilon_{fc,max} : \underline{3.50} \text{ ‰}$$

$S_{r1}$ : Mean axial tensile strength derived from beam test EN 14651 at CMOD 0.5

$$S_{r1} : \underline{0.68} \text{ MPa}$$

$$\sigma_{r1} = 0.45 \cdot f_{r1}$$

$f_{r1}$ : Residual flexural strength at CMOD 0.5

$$f_{r1} : \underline{1.52} \text{ MPa}$$

$S_{r4}$ : Mean axial tensile strength derived from beam test EN 14651 at CMOD 3.5

$$S_{r4} : \underline{0.78} \text{ MPa}$$

$$\sigma_{r4} = 0.37 \cdot f_{r4}$$

$f_{r4}$ : Residual flexural strength at CMOD 3.5

$$f_{r4} : \underline{2.11} \text{ MPa}$$

$f_{ck}$ : Characteristic cylinder compressive strength of concrete

$$f_{ck} : \underline{32.00} \text{ MPa}$$

$g_c$ : Partial safety factor for concrete

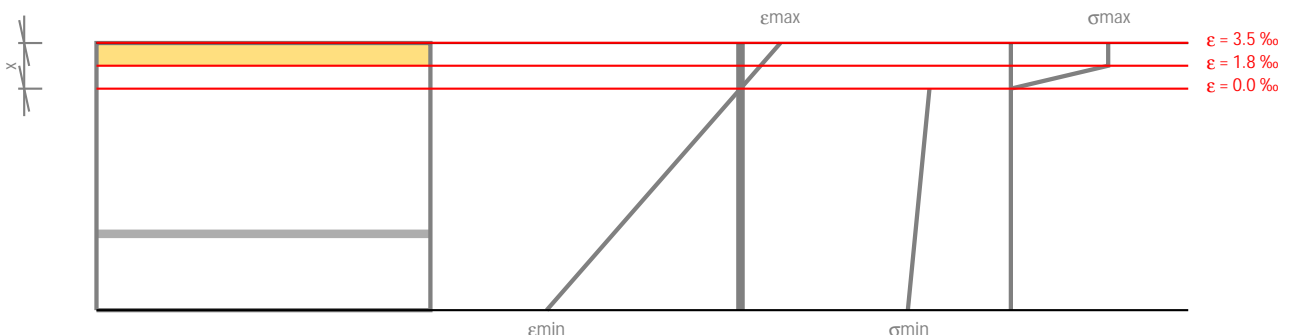
$$g_c : \underline{1.50}$$

The stresses in the steel reinforcement are derived from the stress-strain curves in the section 3.2 of EN 1992-1-1:

$M_p$ : Ultimate positive resistance moment per unit width of slab

$$M_p : \underline{41.11} \text{ kN-m/m}$$

Balance for section failure



$\epsilon_{max}$ : Maximum strain

$$\epsilon_{max} : \underline{3.48} \text{ ‰}$$

$\epsilon_{min}$ : Minimum strain

$$\epsilon_{min} : \underline{-16.90} \text{ ‰}$$

$S_{max}$ : Maximum stress

$$S_{max} : \underline{18.13} \text{ MPa}$$

$s_{min}$ : Minimum stress  
 $x$ : Distance from extreme compression fiber to neutral axis  
 $M_n$ : Negative resistance moment per unit width of slab  
 The negative moment of the slab is taken to be that of the plain unreinforced concrete.

$$\begin{aligned}
 s_{min} &: \underline{-1.92} \text{ MPa} \\
 x &: \underline{30} \text{ mm} \\
 M_n &: \underline{14.66} \text{ kN}\cdot\text{m/m}
 \end{aligned}$$

$$M_n = f_{ctd,fl} (h^2 / 6)$$

$h$ : Slab thickness

$f_{ctd,fl}$ : Design concrete flexural tensile strength

$$f_{ctd,fl} = f_{ctm} \times (1.6 - h / 1000) / \gamma_c \geq f_{ctm} / \gamma_c$$

$f_{ctm}$ : Mean axial tensile strength

$\gamma_c$ : Partial safety factor for material

$$\begin{aligned}
 h &: \underline{175} \text{ mm} \\
 f_{ctd,fl} &: \underline{2.87} \text{ MPa} \\
 f_{ctm} &: \underline{3.02} \text{ MPa} \\
 \gamma_c &: \underline{1.50}
 \end{aligned}$$

#### 2.4. - Bending checking

Single point load

Corner location

$$P_d / P_u \leq 1.0$$

$P_d$ : required ultimate load

$$P_d = \sum \gamma_{Fi} \cdot P_i \cdot (1 - \alpha / 100)$$

$\gamma_F$ : Partial safety factor for load

$P$ : Point load

$a$ : Load transfer at the corner

$P_u$ : Total failure load

Failure load obtained by linear interpolation between values of  $a/l$  between 0 and 0.2

$P_{u,0}$ : total failure load with  $a/l = 0$

$$P_{u,0} = 2M_n$$

$P_{u,0.2}$ : total failure load with  $a/l = 0.2$

$$P_{u,0.2} = 4M_n / [1 - (a/l)]$$

$a/l$ : radius of contact area-radius of relative stiffness ratio

$a$ : equivalent radius of contact area of the load

$$a = \sqrt{A / \pi}$$

$A_p$ : baseplate area

$l$ : radius of relative stiffness

$$l = [(E_{cm} h^3) / (12(1 - \nu^2)k)]^{0.25}$$

$E_{cm}$ : secant modulus of elasticity of concrete

$\nu$ : Poisson's ratio

$h$ : Slab thickness

$k$ : modulus of subgrade reaction

$M_n$ : negative resistance moment per unit width of slab

$$\begin{aligned}
 P_d / P_u &: \underline{0.1184} \quad \checkmark \\
 P_d &: \underline{4.760} \text{ kN}
 \end{aligned}$$

$$\begin{aligned}
 \gamma_F &: \underline{1.60} \\
 P &: \underline{3.500} \text{ kN} \\
 a &: \underline{15.0} \% \\
 P_u &: \underline{40.206} \text{ kN}
 \end{aligned}$$

$$P_{u,0} : \underline{29.325} \text{ kN}$$

$$P_{u,0.2} : \underline{62.736} \text{ kN}$$

$$\begin{aligned}
 a/l &: \underline{0.07} \\
 a &: \underline{33} \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 A_p &: \underline{3500} \text{ mm}^2 \\
 l &: \underline{512} \text{ mm}
 \end{aligned}$$

$$E_{cm} : \underline{33345.76} \text{ MPa}$$

$$\nu : \underline{0.20}$$

$$h : \underline{175} \text{ mm}$$

$$k : \underline{0.225} \text{ N/mm}^3$$

$$M_n : \underline{14.66} \text{ kN}\cdot\text{m/m}$$

## 2.5.- Punching checking

There are no load case to perform the check

## 2.6.- Line load checking

There are no load case to perform the check

## 2.7.- Uniform distributed load (UDL) checking

$$q_d / q_u \leq 1.0$$

$q_d$ : required ultimate uniformly distributed load

$$q_d = \gamma_F \cdot q$$

$\gamma_F$ : Partial safety factor for load

Partial safety factor for load (TR-34 4th Edition, clause 7.12). The elastic analysis is based on the work of Hentenyi. This analysis has traditionally used a global safety factor of 1.5. As a factor of 1.5 is already applied to the material properties, an additional factor should not be applied to the load.

$q$ : Uniformly distributed load

$q_u$ : load capacity of the slab per unit area

$$q_u = \text{MIN}(q_{u1}, q_{u2})$$

$$q_u = 5.95 \lambda^2 M_n$$

$$q_u = 6.20 \lambda^2 (M_p + M_n)$$

$\lambda$ : Characteristic of the system

$$\lambda = \left( \frac{3k}{E_{cm} h^3} \right)^{0.25}$$

$k$ : Modulus of subgrade reaction

$E_{cm}$ : Modulus of elasticity of the concrete

$h$ : Slab thickness

$M_n$ : negative resistance moment per unit width of slab

$$M_n = f_{ctd,fl} (h^2 / 6)$$

$f_{ctd,fl}$ : Design concrete flexural tensile strength

$M_p$ : ultimate positive resistance moment per unit width of slab

$$q_d / q_u : \frac{0.8850}{150.0} \text{ kN/m}^2 \quad \checkmark$$

$$\gamma_F : 1.00$$

$$q : 150.0 \text{ kN/m}^2$$

$$q_u : 169.5 \text{ kN/m}^2$$

$$\lambda : 0.013941 \text{ 1/cm}$$

$$k : 0.225 \text{ N/mm}^3$$

$$E_{cm} : 33345.76 \text{ MPa}$$

$$h : 175 \text{ mm}$$

$$M_n : 14.66 \text{ kN}\cdot\text{m/m}$$

$$f_{ctd,fl} : 2.87 \text{ MPa}$$

$$M_p : 41.11 \text{ kN}\cdot\text{m/m}$$

The maximum negative moment is induced between a pair of patch loads each of breadth  $\pi/\lambda$  spaced a distance  $\pi/\lambda$  apart. This spacing is commonly known as the critical aisle width. The maximum positive bending moment in the slab is caused by a load of breadth  $\pi/2\lambda$ .

## 2.8.- Other verifications

The panel length to width ratio should not exceed 1:1.5.

$$\frac{L_{\max}}{L_{\min}} \leq 1.5$$

$$L_{\max} / L_{\min} : 1.00 \quad \checkmark$$

Limiting the longest dimension between sawn joints to typically 6000 mm.

$$L_{\max} \leq 6000 \text{ mm}$$

$$L_{\max} : 6000 \text{ mm} \quad \checkmark$$

$$L_{\max} = \text{MAX}(X, Y)$$

$$L_{\min} = \text{MIN}(X, Y)$$

X: X joint spacing

X : 6000 mm

Y: Y joint spacing

Y : 6000 mm

3.- ALSO AVAILABLE FROM SIKA

Concrete Admixtures	Optimising the fresh and/or hardened properties of concrete using plasticizers, water reducers, accelerators, retarders, air-entrainment, shrinkage reducers, antifreeze, corrosion inhibitors	Sika Viscoflow®, Viscocrete®, SikaControl®, FerroGard®, SikaRapid®
Pumping	For use with unfavourable aggregates and protecting equipment from excessive wear. Maintains internal cohesion.	SikaPump® Sika® Stabilizer
Curing	Liquid agents or sheets protecting the slab from premature drying.	Antisol®, Sika® Ultracure
Mould Release	Extend longevity of formwork by preventing concrete from sticking to the mould.	Sika® Separol®
Joints	Preventing dirt from filling the joint, accommodating movement and protecting the edges allowing smooth joint crossing.	Sikaflex®
Surface hardeners	Improve slab life span by impregnating the surface or by forming a monolithic layer.	Sika® CureHard, Sikafloor®
Surface coatings	Increase resistance against mechanical and chemical attack.	Sikafloor®, SikaScreed®



#### 4.- LEGAL DISCLAIMER

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#### 5.- ABOUT SIKAFIBER® CALCULATION SOFTWARE

Engineered by:



Cype Software - Eusebio Sempere, 5 - 03003 Alicante (Spain)

[www.cype.com](http://www.cype.com)

**BUILDING TRUST**



# BENTOMAT AS5000-1 Self

## GEOSYNTHETIC CLAY BARRIER (GBR-C)

BENTOMAT AS5000-1 Self is a reinforced GBR-C consisting of a layer of sodium bentonite between a woven and a nonwoven geotextile, which are needlepunched together to provide internal reinforcement. The internal reinforcement minimizes clay shifting, thus allowing the GBR-C to maintain consistent low permeability and maximum performance under a wide variety of field conditions.

TECHNICAL DATA			
MATERIAL PROPERTY	TEST METHOD	TYPICAL VALUE	TEST FREQUENCY
<b>GBR-C</b>			
Index Flux <sup>(1)</sup>	EN 16416	3,0x10 <sup>-09</sup> (m <sup>3</sup> /m <sup>2</sup> )/s	Production week <sup>(2)</sup>
Hydraulic Conductivity	EN 16416	1,5x10 <sup>-11</sup> m/s	Production week <sup>(2)</sup>
Total Mass/Unit Area <sup>(3)</sup>	EN 14196	5,33 kg/m <sup>2</sup>	5000 m <sup>2</sup>
Bentonite Mass/Unit Area <sup>(3)</sup>	EN 14196	5,00 kg/m <sup>2</sup>	5000 m <sup>2</sup>
Tensile Strength MD/CMD <sup>(4)</sup>	EN ISO 10319	12,0/12,0 kN/m	5000 m <sup>2</sup>
Elongation at Break MD/CMD	EN ISO 10319	15%	5000 m <sup>2</sup>
Puncture Resistance (CBR) <sup>(5)</sup>	EN ISO 12236	2,0 kN	5000 m <sup>2</sup>
Peel Strength <sup>(6)</sup>	ASTM D 6496	650 N/m	5000 m <sup>2</sup>
Thickness	EN ISO 9863-1	7,5 mm	5000 m <sup>2</sup>
Roll Length	–	40,0 m	Continuous
Roll Width	–	5,0 m	Continuous
<b>BENTONITE</b>			
Free Swell	ASTM D 5890	25 ml/2 g	5000 m <sup>2</sup>
Fluid Loss	ASTM D 5891	max 18 ml	5000 m <sup>2</sup>
Montmorillonite content <sup>(7)</sup>	XRD	80%	Certified by supplier
<b>GEOTEXTILES (PP)</b>			
Non-Woven Mass/Unit Area	EN ISO 9864	200 g/m <sup>2</sup>	Certified by supplier
Woven Mass/Unit Area	EN ISO 9864	130 g/m <sup>2</sup>	Certified by supplier

Bentonite powder is impregnated into overlap area 50cm from both sides.

Notes:

- <sup>1</sup> Index Flux with tolerance +0,5x10<sup>-09</sup> (m<sup>3</sup>/m<sup>2</sup>)/s
- <sup>2</sup> Production week = average 75 000 m<sup>2</sup> of one type of Bentomat
- <sup>3</sup> Bentonite mass/unit area reported at 12% moisture content
- <sup>4</sup> Tensile Strength with tolerance -1,0 kN/m
- <sup>5</sup> Puncture Resistance (CBR) with tolerance -0,2 kN
- <sup>6</sup> Peel Strength testing is performed in machine direction
- <sup>7</sup> Montmorillonite content with tolerance ±10%

## civil engineering and building



- Industrial, Commercial, Agricultural and Domestic building design
- Foundation Design and ground improvements
- Highway Engineering including PDS/Civil 3D
- Retaining walls
- Sheet Piling
- Infrastructure planning and design
- Design of sustainable drainage system (SUDS)
- Soakaway design
- Architectural design of industrial buildings
- Planning and building regulation applications
- 3D conceptual models
- Renewable Energy Civil Engineering design and project management
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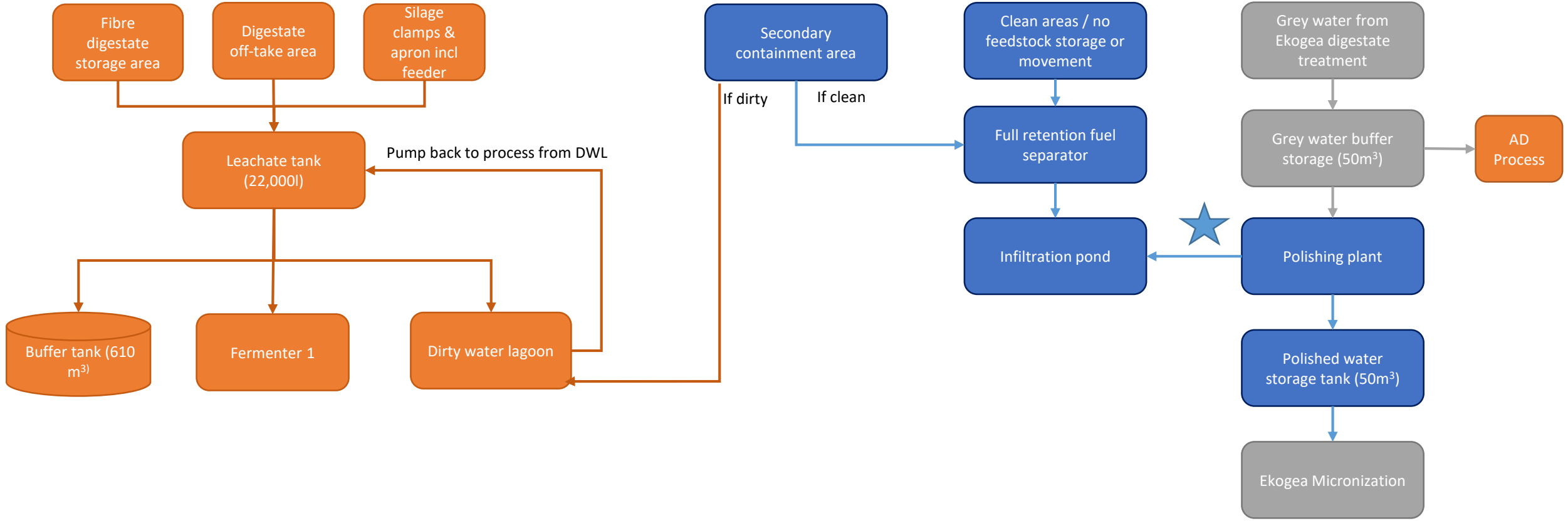
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## **Appendix E – Drainage Process Flow**

Lower Drayton Biogas, Drainage Process Flow Diagram V1.1

★ In-line quality monitor / consent limits



## **Appendix F – Effluent Infiltration Assessment**



June 2020  
Report No 10573-R01

# **ANAEROBIC DIGESTION PLANT EFFLUENT INFILTRATION ASSESSMENT**

Prepared for  
**BioConstruct NewEnergy Limited**



**TerraConsult**

**ANAEROBIC DIGESTION PLANT**

**EFFLUENT INFILTRATION ASSESSMENT**

June 2020

**Carried Out For:**

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# ANAEROBIC DIGESTION PLANT EFFLUENT INFILTRATION ASSESSMENT

## CONTENTS

	<b>Page</b>
<b>1. INTRODUCTION</b>	<b>1</b>
1.1 Background	1
<b>2. SITE SETTING</b>	<b>1</b>
2.1 Setting	1
2.2 Geology	2
2.3 Hydrogeology and Hydrology	4
<b>3. RISK ASSESSMENT</b>	<b>4</b>
3.1 Introduction	4
3.2 Effluent Source	5
3.3 Conceptual Model	7
3.4 Risk Assessment Methodology and Receptors	8
3.5 River Dilution	9
3.6 Infiltration Assessment	10
<b>4. INFILTRATION SYSTEM DESIGN</b>	<b>11</b>
<b>5. SUMMARY AND CONCLUSION</b>	<b>11</b>

## TABLES

<b>Table 1</b>	<b>Top of Mercia Mudstone and Base of Glacial Deposits with Groundwater</b>	<b>3</b>
<b>Table 2</b>	<b>Infiltration Test Results within Proposed Footprint of Infiltration Lagoon</b>	<b>4</b>
<b>Table 3</b>	<b>Water Quality Standards for Groundwater and the River Penk at Lower Drayton</b>	<b>6</b>
<b>Table 4</b>	<b>Calculated Release Concentration if Discharged to River Penk</b>	<b>10</b>
<b>Table 5</b>	<b>Ammoniacal-N Dispersion within Pathway to River Penk Sensitivity Analysis</b>	<b>10</b>

## FIGURES

<b>Figure 1</b>	<b>Site Location</b>	<b>2</b>
<b>Figure 2</b>	<b>Superficial Geology</b>	<b>3</b>
<b>Figure 3</b>	<b>Conceptual Model</b>	<b>7</b>
<b>Figure 4</b>	<b>Infiltration Pond Location in Relation to Surface Water Features</b>	<b>8</b>

## **1. INTRODUCTION**

### **1.1 Background**

This report has been prepared by TerraConsult Ltd (TCL) on behalf of BioConstruct NewEnergy Ltd as an infiltration assessment for the treated effluent generated from a proposed Anaerobic Digestion (AD) Plant at Lower Drayton Lane, Penkridge, Stafford, ST19 5RE.

This report has been prepared based on publicly available information and the following documentation

- Plandescil (June 2020) Design Strategy and Details of Proposed Site Drainage Scheme. Job No. 25998
- Georisk Management (June 2018) Ground Investigation. Lower Drayton Farm AD Plant, Lower Drayton Lane, Penkridge, ST19 5RE. Ref. 18133/LO.001/AMG
- British Geological Survey (November 2019) GeoReports. Report ID BGS\_304963/6385
- Groundsure (June 2020) Report Lower Drayton Farm, Penkridge. Ref. GS-6788097

The process combines “traditional” anaerobic digestion with an EKOGEA concentrator unit designed to increase the efficiency of the AD process, along with liquid effluent polishing plant. The majority of process water is returned through the process, however, there is an estimated 23m<sup>3</sup>/day of excess water which will be produced and requires management.

As part of this application, this excess polished water effluent will be discharged via an infiltration system which has also been designed to receive clean surface water run-off from the site area.

The infiltration system has been designed to receive a 1 in 100 year storm event plus 40%, as well as the 23m<sup>3</sup>/day EKOGEA system effluent. The infiltration lagoon has a capacity of 365m<sup>3</sup>, and a basal footprint of 315m<sup>2</sup> and length (east to west) of 65.7m and width (north to south) of 4.8m.

This assessment presents a risk assessment following the methodology set out in the Environment Agency’s Annex J5 Spreadsheet model<sup>1</sup>.

## **2. SITE SETTING**

### **2.1 Setting**

The site is located within an agricultural area at the east of Lower Drayton and some 536m to north of Penkridge and 4.3km south of Stafford. The site is located midway between the M6 motorway some 380m to the east of the site and the A449 Stafford Road the same distance to the west.

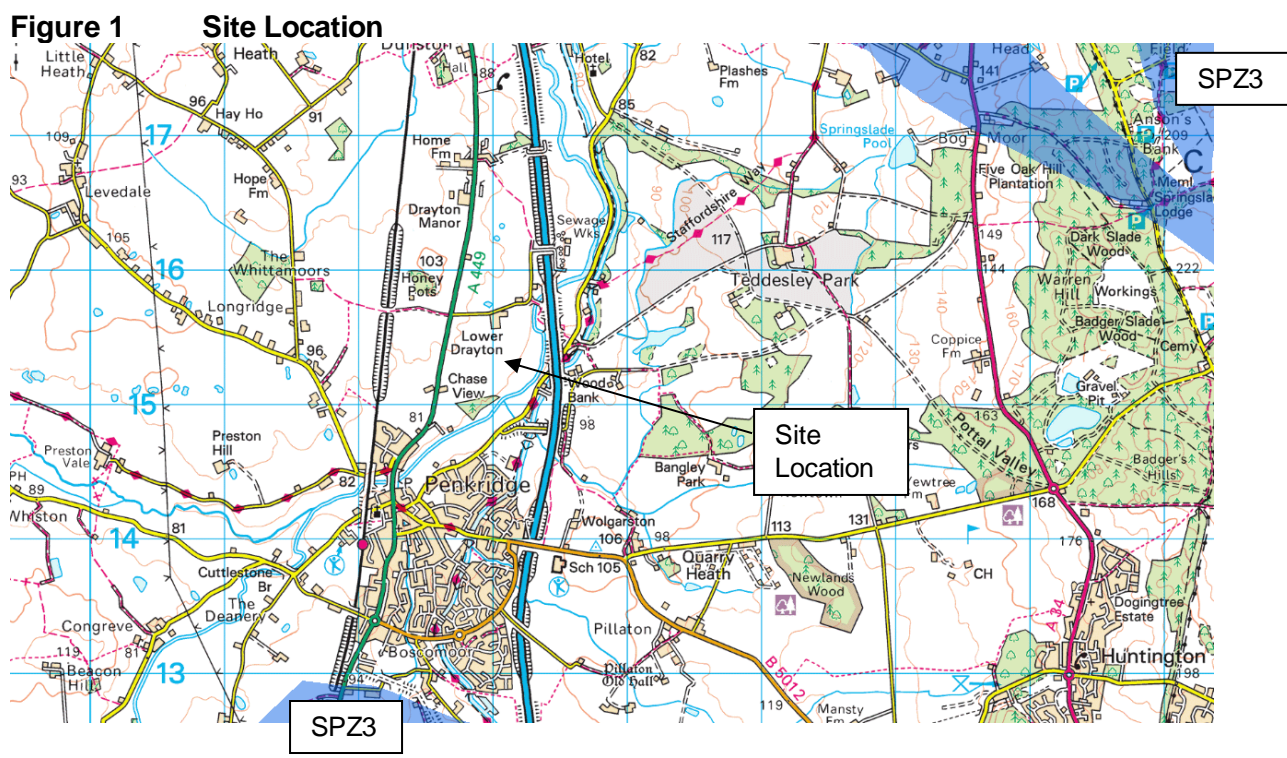
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<sup>1</sup> Additional Guidance for: Groundwater risk assessment for treated effluent discharges to infiltration systems. Annex J5: Infiltration Worksheet User Manual v 2.0 accessed at <https://www.gov.uk/government/publications/h1-annex-j5-infiltration-worksheet>



The River Penk flows from south to north, towards Stafford between the site and the M6 motorway. The river is some 67m from the edge of the proposed development in its southeast corner at its closest point. A sewage treatment works is identified on OS Mapping some 975m to the northeast of the site. Although the sewage works is located on the same side of the river as Lower Drayton Farm, the works are separated from the site by the M6 motorway.

The topography slopes from 103mAOD to the northeast of the site to the river Penk at <80mAOD. The proposed infiltration lagoon area is located between the 85mAOD and 80mAOD contour lines. There is a National River Flow Archive (NRFA) Gauging Station located at the north of Penkridge (Station 28053<sup>2</sup>), which reports a river elevation of 76.3mAOD.



## 2.2 Geology

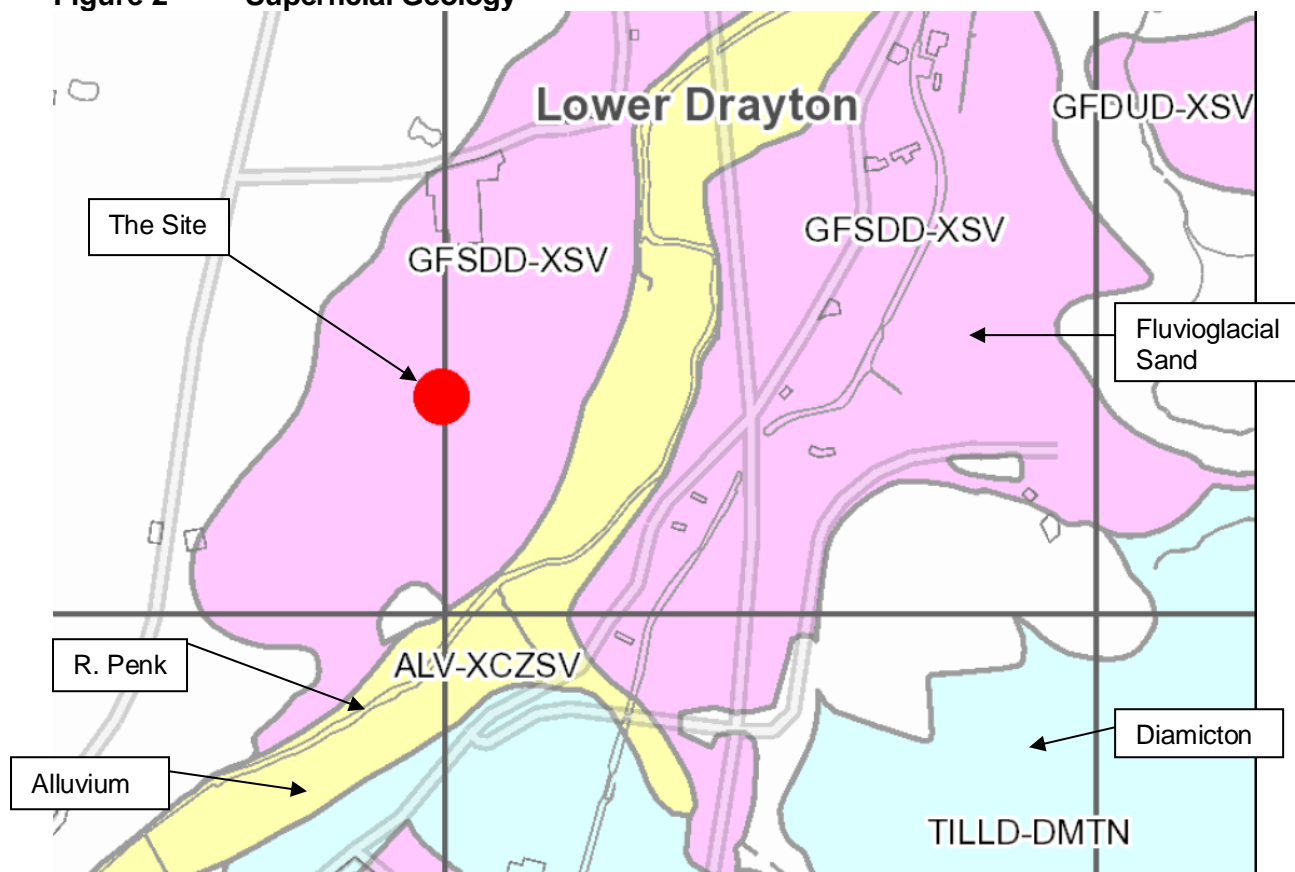
The site is located within an area of

- ~6m of Glaciofluvial Sand Deposits; overlying
- 85m of Mercia Mudstone

There is no Diamicton Till within the site area and the glacial sands extend some 200m to the west of the site, where Mercia Mudstone outcrops at the surface. The glacial sand extends eastwards across the River Penk valley. The glacial sand is overlain by alluvium at the base of the river valley, but does not extend into the site area (Figure 2).

<sup>2</sup> NRFA Gauging Station Penk at Penkridge. <https://nrfa.ceh.ac.uk/data/station/info/28053>

**Figure 2 Superficial Geology**



Site investigation (GeoRisk Management, 2018) describes the fluvioglacial sand as a medium dense tight orangish brown fine sand within the main plant area. However there are fluvioglacial clay units interbedded within the sand. This 2018 site investigation was terminated before the Mercia Mudstone was encountered in the majority of locations. Mercia Mudstone was however encountered at 80.82mAOD in WS01, but not at the adjacent WS02 at the lower termination depth of 80.48mAOD (Table 1).

**Table 1 Top of Mercia Mudstone and Base of Glacial Deposits with Groundwater**

Location	Top of Mercia Mudstone mAOD	Groundwater mAOD
WS01	80.82	82.22
WS02	<80.48	81.08
WS03	<82.10	83.30
WS04	<82.13	<82.13
WS05	<81.19	82.09
WS06	<80.09	81.69
WS07	<81.09	82.69
WS08	<82.35	<82.35
WS09	<82.20	<82.20
WS10	<82.47	<82.47
WS11	<82.36	<82.36
WS12	<82.86	<82.26
WS13	<82.33	<82.33
WS14	<79.87 (Clay from 83.57)	82.17

A brown slightly silty sand was encountered within six shallow trial pits excavated during October 2019 in the location of the proposed lagoons as part of the Plandescil Drainage Report investigations. Each trial pit was excavated to 1.5 – 2mbgl and did not encounter groundwater.

Infiltration tests carried out on these trial pits returned soil infiltration rates of  $3.4 \times 10^{-5} \text{m/s}$  to  $4.3 \times 10^{-5} \text{m/s}$  (Table 2). Taking the reciprocal of this rate allows a conversion from m/s to s/mm, which equates to a rate of 23.3s/mm to 29.4s/mm.

**Table 2 Infiltration Test Results within Proposed Footprint of Infiltration Lagoon**

Location & Test	Rate	
	m/s	s/mm
S2-C Test No 1	$3.6 \times 10^{-5}$	27.8
S2-C Test No.2	$3.8 \times 10^{-5}$	26.3
S3 Test No 1	$4.3 \times 10^{-5}$	23.3
S2 Test No 2	$3.4 \times 10^{-5}$	29.4

### 2.3 Hydrogeology and Hydrology

Groundwater was identified between 81.08mAOD and 83.3mAOD, with a large proportion of investigation holes not encountering groundwater when terminated between 82.13mAOD and 82.47mAOD.

A groundwater piezometric surface is therefore expected to be from <82.2mAOD at the site, which falls towards the River at <76.3mAOD. Taking a minimum distance to the river of 67m from the edge of the site area and a groundwater elevation change from 82.2mAOD to 76.3mAOD, there is a hydraulic gradient through the fluvioglacial sands to the River Penk of some 0.088. This would then flow through a saturated layer some 2m in thickness, although, this is also expected to increase towards the river, where greater erosion rates by the river would have resulted in a thickening of the sands within the valley floor.

The River Penk Gauging Station at Penkridge reports median flow rates of  $1.435 \text{m}^3/\text{s}$  some 1,145m upstream of the site. Mean flow rates are  $2.296 \text{m}^3/\text{s}$ , with low flow (Q95) rates of  $0.55 \text{m}^3/\text{s}$ .

## 3. RISK ASSESSMENT

### 3.1 Introduction

The Environment Agency provide guidance for undertaking discharge to groundwater assessments<sup>3</sup>. This guidance sets out a number of criteria for such discharges, with basic locational constraints including overarching requirements for sanitary system discharges are that the discharge must not be:

- within 10m of the nearest watercourse;

<sup>3</sup> <https://www.gov.uk/guidance/infiltration-systems-groundwater-risk-assessments>

- within 50m of a well, spring, borehole or other source of water intended for human consumption;
- steeply sloping or waterlogged;
- less than 1.2m depth to water table below the invert of the drainage pipes; or
- where percolation rates fall outside an upper and lower range of values.

The site meets these criteria as the land is gently sloping and underlain by unsaturated sand deposits. The infiltration lagoon is located at least 80m from the River Penk. It is expected that the groundwater will provide baseflow to the river, there is also a spring and ditch system marked on OS mapping where the falling topography intersects with at the edge of the floodplain which connects to the river. This is likely to be an ephemeral feature located above alluvial clays deposited by the river.

The lagoons are not within a public water supply source protection zone, and there are no other groundwater or surface water abstractions within 500m of the site (Groundsure Report. Ref GS-6788097).

Both domestic and trade effluents can be discharged to infiltration systems, however, the level of information required is dependent on whether a trade effluent to be discharged is

- up to 25m<sup>3</sup> per day – extended or comprehensive information
- over 25m<sup>3</sup> per day – comprehensive

The applicant proposes that up to 23m<sup>3</sup>/day of excess “polished” effluent from the AD process is to be discharged to an infiltration system located at the southern edge of the plant area. This volume is therefore below the lower 25m<sup>3</sup>/day threshold.

A risk assessment is also required to demonstrate that pollution will not occur from the discharge of non-hazardous substances, whilst discernible hazardous substances are prohibited from the discharge.

The H1 Annex J5 worksheet is intended to be used to assess how sanitary effluents from a septic tank or package treatment plant infiltrate to ground with consideration of pathway attenuation properties and dilution within receiving waters. This methodology can be used for any other substance. Given the close proximity to the River Pent, consideration is also given to this receptor<sup>4</sup>.

### 3.2 Effluent Source

The effluent is the residual product after treatment of an anaerobic digestate. The AD plant will primarily be used for the generation of methane from poultry manure, farmyard manure with straw, rapeseed straw, maize silage and grass silage. The AD process is intended to produce biogas with a solid nutrient rich compost like output. However, in this case, the products are biogas, a thickened liquid digestate, a grey water that is returned to the process and a polished water that is either returned to the process or discharged as proposed.

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<sup>4</sup> Environment Agency (2011) Horizontal Guidance Note H1 – Environmental Risk Assessment for Permits. Annex (d) Surface Water Discharges (basic) with Environment Agency (2014) H1 Annex D2. Assessment of sanitary and other pollutants within Surface Water Discharges; and the 2016 update accessed at <https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit>



The AD process will remove pathogens within the manure, whilst with the feedstock intended, hazardous substances are not expected to be present within the feedstock to the AD plant. Similarly metals and salts are also expected to be low within an organic based feedstock. The two primary potential “pollutants” that could be present within the liquid phase are dissolved organic matter and ammonium, the soluble nitrogen form under anaerobic conditions.

AD plants convert biodegradable organic matter to biogas. Organic matter exerts a Biodegradable Oxygen Demand (BOD) which if high enough can result in the loss of dissolved oxygen within surface waters leading to eutrophication. However, as the AD process is specifically intended to convert this BOD content to biogas, the process is optimised to ensure that the maximum amount of BOD is reduced. The EKOGEA system has been specifically designed to enhance the performance of such a system.

Nitrogen is the largest non-carbon, oxygen and hydrogen component of organic matter and is reduced to ammonium during processing. As ammonium is highly soluble and a significant component will be fractionated into the digestate liquor, with the remainder either volatilised as nitrogen gas or concentrated within the residual solid organic matter.

The residual effluent following digestion is to be passed through the EKOGEA’s polishing plant for treatment. Normal practice with AD plant residual waters is for storage and then used as a seasonal irrigant to land, which supplies both water and nutrients. However, the optimisation process and polishing plant treats the effluent to a standard whereby the nutrient value is low and therefore a direct discharge to ground is preferred. This also overcomes the need for storage of this polished water until there is a seasonal need.

Hydrogen sulphide is also produced within an AD plant, however, this sulphide will precipitate any other hazardous and non-hazardous metals within the digestate, therefore metals such as zinc, copper and cadmium are not expected to be present. Sulphide is however expected to be primarily volatilised within the process and captured. However, by the use of an open lagoon for infiltration, sulphide will also be rapidly oxidised to sulphate under aerobic conditions. Sulphide is therefore not expected to be a significant effluent constituent.

The environmental significance of the effluent is determined by a combination of Drinking Water Quality Standards (DWS) within groundwaters and Environmental Quality Standards (EQS) within surface waters.

There is not a DWS for BOD and dissolved organic matter, however, there is an EQS, designed to prevent eutrophication. Ammoniacal-N can however be toxic if in the ammonia form (the high pH form) and there are both EQS and DWS. The value of the EQS is determined by the type of water as set out in the Annex D2 guidance and are presented within Table 3

**Table 3 Water Quality Standards for Groundwater and the River Penk at Lower Drayton**

	<b>BOD</b>	<b>Ammoniacal-N</b>
	<b>mg/l</b>	<b>mg/l</b>
DWS	None	0.39
EQS*	5	0.6

\*assumes Type 3,5,7 water (<80mAOD and alkalinity >50mg/l ) for River Penk

### 3.3 Conceptual Model

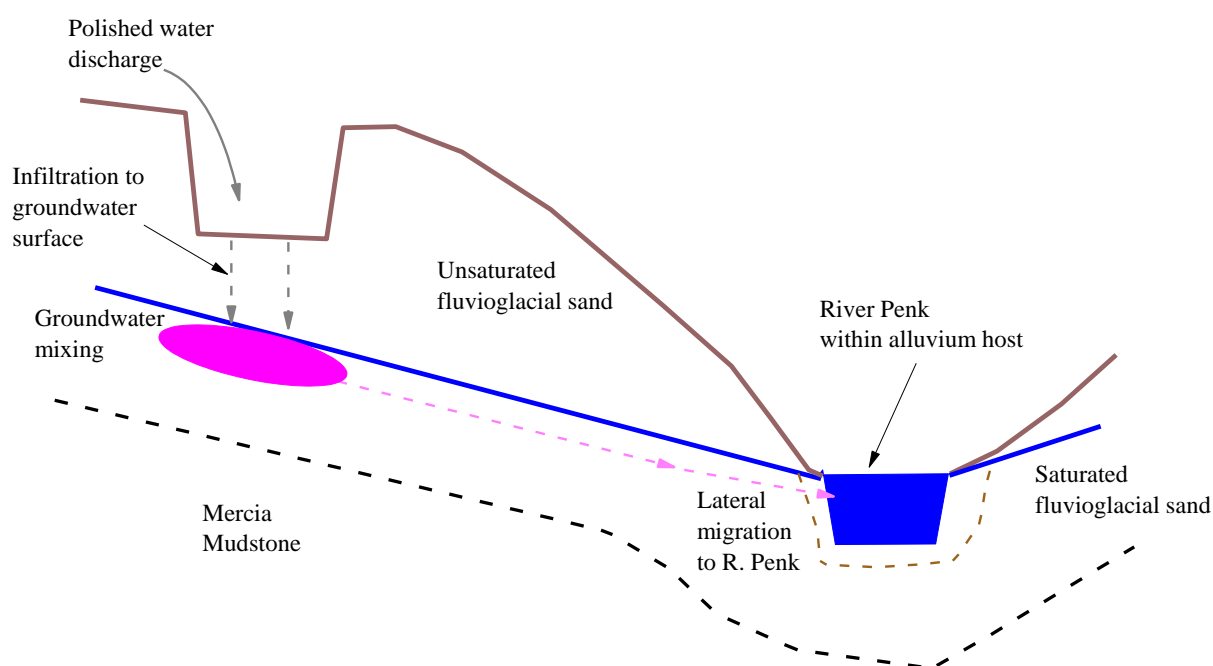
Conceptual Models are intended to present the system being evaluated within the

Source → Pathway → Receptor

framework and then to assess the processes that could occur along a pathway to a receptor to determine whether a release from a source could cause pollution, or the extent of managed controls required to mitigate the potential for pollution.

An illustration of the conceptualisation is presented as Figure 3.

**Figure 3 Conceptual Model**



The conceptual model can be summarised as

- 1) Infiltration through a soakaway at an infiltration rate of 23 to 29s/mm
- 2) Attenuation and aerobic processes within the unsaturated ground
- 3) Mixing with groundwater within the fluvioglacial sands
- 4) Lateral migration over at least a 67m pathway towards the River Penk
- 5) Mixing within the River Penk

The Mercia Mudstone is not water bearing and therefore infiltration to depth is not considered likely. Consequently any infiltrating waters are expected to enter a small ~2m saturated zone, before migrating laterally.

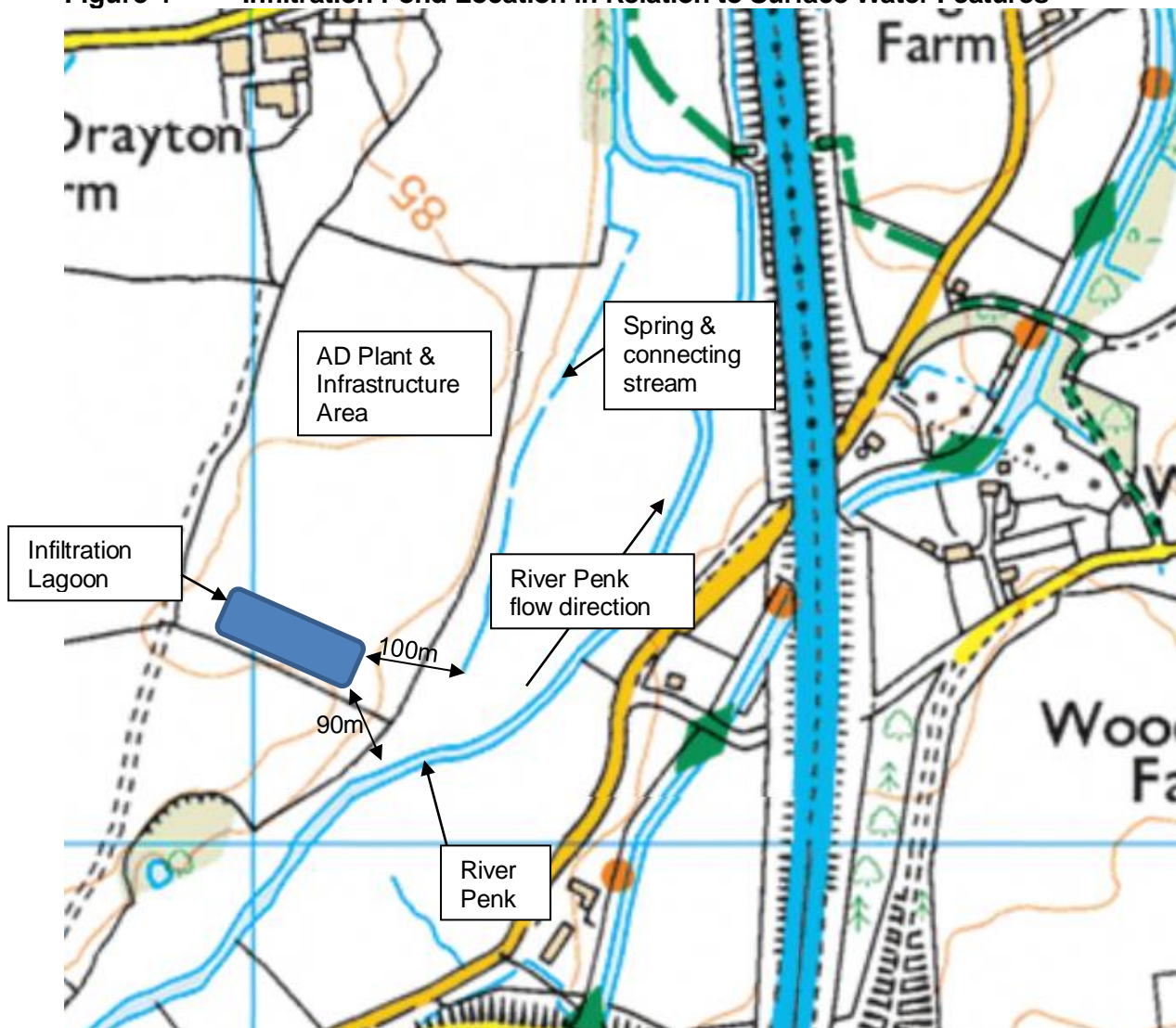
The infiltration lagoon will also be used for surface water run-off management and this facility is intended to prevent downstream flooding due to run-off from sealed surfaces. Consequently as the purpose of flood preventing lagoons and infiltration ponds has the purpose of retarding storm water flow to greenfield run-off rates, then this infiltration pond is expected to be empty for larger periods of time. Dilution / mixing of the effluent with the residual process water is therefore not guaranteed and would only occur on an occasional basis. Consequently an initial dilution stage has not been considered as part of the “steady-state” release of effluent.

### 3.4 Risk Assessment Methodology and Receptors

This assessment is intended to identify “safe” discharge concentrations for the primary effluent. Given the site setting and close proximity to the river, it is considered that the River Penk is the primary receptor for the site, albeit that there is also a requirement not to cause harm to the groundwater.

However, as the potential groundwater body is limited in size, *i.e.* a saturated layer of 1.4 to 1.7m (between 82.2mAOD and 80.8 to 80.5mAOD), there is limited, if any resource value to this unit, which is both thin and limited in recharge area to the west of the infiltration area. The fluvio-glacial sand is therefore considered as a pathway of some 90m at the shortest distance to both the River Penk to the south of the infiltration pond and the spring/stream to the east of the infiltration pond (Figure 4).

**Figure 4 Infiltration Pond Location in Relation to Surface Water Features**



The infiltration pond is an elongated structure parallel with the groundwater flux, some 66m long and 5m wide at the base. The surface area of the infiltration pond is somewhat larger to accommodate the 385m<sup>3</sup> holding capacity and to enable shallow side slopes to be constructed.

This type of assessment can be approached using two methodologies. The first is to assume no pathway attenuation or mixing and for the effluent to be discharged directly to surface water. Under this scenario the surface water risk assessment methodology (the standard “H1” model), the objective is to undertake a dilution/mixing assessment and then to determine the potential for harm, and to back-calculate a safe discharge concentration.

The second methodology is to undertake a sequential multi-stage assessment to determine the effects of mixing and dispersion within groundwater. This methodology “terminates” at a groundwater receptor, and does not take into consideration a second-stage dilution effect as would occur at the site, when the groundwater mixes with the river flow.

The potential to bypass the river is considered low, as the valley hydraulic gradient would follow the river and therefore all discharge flow would enter the river, albeit this may be some distance downstream of the site.

### 3.5 River Dilution

The surface water dilutionary model<sup>4</sup> is a simplistic model which calculates a dilution factor from the discharged rate and the river flow rate. Worst-case scenarios are under low flow river conditions (the Q95 rate) and are expected to occur during summer when extended dry periods would occur. Consequently rainfall dilution is not expected to occur under these circumstances.

The dilution factor for the effluent to enter the groundwater can be calculated as

$$Dilution = \frac{EFR}{RFR + EFR} \quad \text{Equation 1}$$

where

EFR = Effluent Flow Rate (23m<sup>3</sup>/day)  
RFR = River Flow Rate

A Process Concentration (PC) can then be calculated by multiplying the dilution factor by the effluent concentration. This can be reversed to establish a “Release Concentration”, whereby the discharge is not considered as significant. For the purposes of Risk Assessment, an insignificant discharge equates to a Process Contribution of 4% of the EQS in the receiving surface water.

For the River Penk, the PC target is therefore:

- 4% of 0.6mg/l ammoniacal-N EQS, which equates to 0.024mg/l
- 4% of the 5mg/l BOD EQS, which equates to 0.2mg/l

The initial Dilution “H1 Model” demonstrates that a release of 50mg/l ammoniacal-N and 413mg/l BOD is equivalent to a Process Contribution at 4% of their respective EQS (Table 4). This increases to 129mg/l and 1,078mg/l under median flow conditions.

Notably EQS is based on an annual average water quality objective, therefore a direct release at 129mg/l ammoniacal-N and ~1,000mg/l BOD is not expected to cause harm to receiving waters.

This latter for BOD is however extremely unlikely event, as such a BOD is feedstock for the AD plant and therefore it is not considered a realistic scenario that such a BOD could be



released under the normal operating conditions of the plant as this BOD would returned to the process.

**Table 4 Calculated Release Concentration if Discharged to River Penk**

		Ammoniacal-N		BOD	
		Q95	Q50	Q95	Q50
EFR	m <sup>3</sup> /d	23	23	23	23
	m <sup>3</sup> /s	0.000266	0.000266	0.000266	0.000266
RFR	m <sup>3</sup> /s	0.55	1.435	0.55	1.435
Dilution	Factor	2,067	5,392	2,067	5,392
Target PC	mg/l	0.024	0.024	0.2	0.2
<b>Release Concentration Equivalent to Target PC</b>					
RC	mg/l	50	129	413	1,078

### 3.6 Infiltration Assessment

The “J5” Infiltration Worksheet is a multi-stage model, which takes each parameter in turn. This model has been performed using three scenarios

- 1) to achieve a concentration within groundwater at the point of baseflow to the river, assuming a 0.39mg/l target in groundwater
- 2) as above, but with a 0.6mg/l discharge target in groundwater
- 3) repeated to consider multi-stage dilution and therefore setting a 50mg/l target at the point of entry to the River Penk (as established in Section 3.5).

The model sheets are appended. The model calculates that for ammoniacal-N, the concentration reduces for each stage of the process as shown in Table 5

**Table 5 Ammoniacal-N Dispersion within Pathway to River Penk Sensitivity Analysis**

Scenario	1	2	3
	(to DWS)	(to EQS)	(Surface water dilution)
	mg/l	mg/l	mg/l
Discharge Limit	50	50	636
Base UZ	49	49	626
Mixing	45	45	577
Edge R. Penk	3.93	3.93	50
<b>Target</b>	<b>0.39</b>	<b>0.6</b>	<b>50</b>
<b>Discharge Limit</b>	<b>4.96</b>	<b>7.64</b>	<b>636</b>

The model demonstrates that the primary attenuation component is the retarded travel through the saturated pathway. This is in part a reflection on the minimal quantity of groundwater at the site, where there is limited potential for dilution, hence the model returns calculated discharge concentration limits of ~5mg/l and ~8mg/l for the scenarios which assume a useable quantity of water, in a situation where there is the potential for this water to be used.

This minimal quantity of groundwater precludes its real use as a sustainable water body, and therefore it is not considered a valid scenario to assess the infiltrate against groundwater assessment limits. There is a similar reasoning for not considering the point of baseflow entry to surface water, *i.e.* it is not a receptor for non-hazardous substances.

Therefore given the low flow and limited recharge zone, it is considered that the assessment target should be after mixing with surface water, whereby the previously established target should be 50mg/l, which equates to a 636mg/l discharge concentration.

#### 4. INFILTRATION SYSTEM DESIGN

The infiltration system has been designed as an open pond, resting within the natural fluvioglacial sands. This type of approach is more akin to a vertical flow reed bed system, whereby there is direct mixing of air and the infiltrate during infiltration which significantly increases degradation rates for ammoniacal-N compared to that for an aquifer and unsaturated pathway beneath a landfill type setting.

The infiltration system also differs from the “infilled” and covered systems used for domestic type sewage effluents, whereby the infiltrate is released into a gravel drainage layer, which is capped with topsoil as set out in British Standard BS6297:2007 (+A1:2008)<sup>5</sup>.

Such a design is inappropriate for this situation, whereby a key function of the lagoon is to receive surface water run-off during storm periods. A gravel in-fill could reduce the storage capacity by some 40 – 60%, which in turn would require a proportional increase in infiltration pond capacity.

The primary reasoning for this design is to physically separate a sanitary effluent from direct human contact. However, in this case, such controls are not required as the effluent would have been previously treated via the EKOGEA system, and therefore all pathogens would have been released.

The infiltration system otherwise complies with the infiltration characteristics of this system, with the natural geology allowing infiltration towards the lower end of the 15 – 100 seconds per millimetre range required for such systems, at the 15 – 29S/mm range. At the hydraulic conductivity of the sands, the 23m<sup>3</sup>/day infiltrate could infiltrate into the ground over a 24hr period from an area of 6 – 8m<sup>2</sup>. The infiltration area design footprint is somewhat larger at 315m<sup>2</sup>

The daily effluent volume of 23m<sup>3</sup> is discharged as a single pulse would equate to a water depth of 7.3cm above the base of the 315m<sup>2</sup> basal footprint of the infiltration system. Therefore there will not a substantial depth of water within the system. Such a shallow water depth will prevent any other direct contact with the water, particularly as the infiltrate will be released throughout each day. There is therefore not expected to be any free-standing water within the infiltration pond, except during rainfall events, at which point the infiltrate will become further diluted.

#### 5. SUMMARY AND CONCLUSION

The proposed anaerobic digester at Lower Drayton is an “enhanced performance system” which benefits from an EKOGEA propriety unit. This system is intended to both increase the efficiency of the process and consume the majority of the process water. However, a small residual volume in the order of 23m<sup>3</sup>/day is expected to be produced.

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<sup>5</sup> British Standards 2007, Code of practice for the design and installation of drainage fields for use in wastewater treatment. BS 6297:2007 + A1:2008

This residual effluent will be treated and pass through a final polishing unit before discharge to ground via a combined surface water run-off and effluent infiltration system. This combined unit is therefore significantly larger than that required for the process effluent.

As an AD plant effluent, BOD is expected to be low, whilst other pollutants would be either treated by the process or accumulate within the solid residue. Ammoniacal-N is however soluble and has the potential to be present within the effluent.

The infiltrate will enter a shallow, thin groundwater body which is in hydraulic continuity with the River Penk a short distance downgradient of the site. It is this river which is considered to be the receptor at risk due to the small size of the groundwater body.

The effluent could be discharged directly to surface water at a concentration of 50mg/l without causing a discernible change in water chemistry, *i.e.* an insignificant discharge load. However, this discharge concentration increases to 636mg/l if discharged to soakaway. Discharging to soakaway has a number of pragmatic advantages, including the availability of on-site infrastructure and the ability to avoid placing pipework across adjacent lands and into the river.

Discharge to ground also allows a two-stage dilution and attenuation process to take place which would further reduce the potential to cause harm.

A higher BOD (of up to 1,000mg/l) could be released without causing harm. However, such an action should be avoided, not least because such a BOD forms the feedstock to the AD plant and therefore would be recirculated through the process.

## **Appendix G - Site Specific Bioaerosol Risk Assessment**



## **Bioaerosol Risk Assessment**

### **Lower Drayton Anaerobic Digestion Plant, Penkridge**

**Client: Lower Drayton Biogas ProjectCo Ltd**

**Reference: 3652r1**

**Date: 1<sup>st</sup> July 2020**



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## Table of Contents

<b>1.0 INTRODUCTION</b>	<b>1</b>
1.1 Background	1
1.2 Site Location and Context	1
<b>2.0 PROCESS DESCRIPTION</b>	<b>2</b>
2.1 Introduction	2
2.2 Management	2
2.3 Site Operating Hours	2
2.4 Feedstock Delivery and Storage	2
2.5 Transfer of Feedstocks	4
2.6 Anaerobic Digestion Plant Operation	4
2.7 Digestate	5
<b>3.0 BIOAEROSOL BACKGROUND</b>	<b>7</b>
3.1 Bioaerosol Definition	7
3.2 Health Risks from Bioaerosols	7
3.3 Bioaerosol Emissions from Waste Management Operations	8
3.4 Legislative Control	9
3.5 Environment Agency (EA) Policy	9
3.6 Benchmark Levels	10
3.7 Technical Guidance	10
<b>4.0 PROBLEM DEFINITION</b>	<b>11</b>
4.1 Introduction	11
4.2 Conceptual Model	11
4.3 Sources	11
Exposed Crop Feedstocks During Delivery and Storage	12
Exposed Manures During Delivery and Storage	13
Transfer of Feedstocks	13
Feed Hopper	14
Upgrade Plant Vent	14
Ekogea System	14
Solid Digestate	14
Digestate Tanker	15
Dirty Water Lagoon	15
4.4 Receptors	16
4.5 Prevailing Meteorological Conditions	17

4.6	Other Sources of Bioaerosols	18
<b>5.0</b>	<b>RISK ASSESSMENT METHODOLOGY</b>	<b>19</b>
5.1	Overview	19
5.2	Receptor	19
5.3	Probability of Exposure	19
5.4	Harm	20
5.5	Magnitude of Risk	20
5.6	Further Requirements	21
<b>6.0</b>	<b>RISK ASSESSMENT</b>	<b>22</b>
<b>7.0</b>	<b>CONCLUSION</b>	<b>28</b>
<b>8.0</b>	<b>ABBREVIATIONS</b>	<b>29</b>



## **1.0 INTRODUCTION**

### **1.1 Background**

1.1.1 Redmore Environmental Ltd was commissioned by Lower Drayton ProjectCo Ltd to produce a Bioaerosol Risk Assessment in support of the proposed Lower Drayton Anaerobic Digestion (AD) plant, Penkridge, Staffordshire.

1.1.2 During the operation of the facility there is the potential for bioaerosol emissions and associated impacts at sensitive receptor locations in the vicinity of the site. A Risk Assessment has therefore been undertaken to identify potential emission sources and evaluate effects in the local area.

1.1.3 The purpose of this Bioaerosol Risk Assessment is to:

- Establish the likely sources of bioaerosols arising from proposed operations at the site;
- Assess the potential for significant risk of impact at sensitive locations due to emissions from the identified sources; and,
- Identify any additional mitigation required to control potential effects.

### **1.2 Site Location and Context**

1.2.1 The proposed AD plant is located on land at Lower Drayton Farm, Penkridge, at National Grid Reference (NGR): 393034, 315398. Reference should be made to Figure 1 for a map of the site and surrounding area.

1.2.2 It is proposed to construct and operate an AD plant that will be fuelled by energy crops, straw and animal manures. The majority of the biogas produced by the AD process will be upgraded for injection into the national distribution grid. A proportion of the biogas will be combusted within a Combined Heat and Power (CHP) unit to generate electricity and heat. A flare is also included at the plant for emergency venting of biogas during abnormal operation.

1.2.3 The operation of the plant may result in bioaerosol emissions from a number of activities. These have the potential to cause impacts at sensitive locations within the vicinity of the site and have therefore been assessed within this report.

## **2.0 PROCESS DESCRIPTION**

### **2.1 Introduction**

2.1.1 A brief summary of the proposed AD process is provided in the following Sections.

2.1.2 Reference should be made to Figure 2 for a site layout plan.

### **2.2 Management**

2.2.1 The overall management responsibility for the plant will lie with the project company. The day to day facility management will be undertaken by an appointed Manager who will deal specifically with the operation of the plant.

2.2.2 Daily checks and maintenance will be undertaken by the Manager. A range of spare parts will be kept on site. If additional items are required these will be available within a 24-hour period. In addition, there is certain amount of redundancy factored into the plant operation which allows for some items to be out of action temporarily but for the remainder of the facility to continue operating normally.

### **2.3 Site Operating Hours**

2.3.1 The proposed key operating hours for the plant are 06:00 to 18:00, Monday to Sunday inclusive. However, it should be noted that the Planning Decision Notice for the facility (reference: 16/00717/FUL) does not restrict working hours and should any issues occur on site, there may be the requirement for operations to be undertaken over extended periods.

2.3.2 The actual AD process will be fully automated and will operate continuously 24-hours a day.

### **2.4 Feedstock Delivery and Storage**

2.4.1 The plant will operate using a range of solid biomass feedstocks. A summary of the types and tonnages of materials that will be processed at the facility is provided in Table 1.

**Table 1 Feedstock Types and Quantities**

Feedstock Type	Quantity (t/day)
Farmyard Manure (FYM)	43
Poultry Manure	28
Maize Silage	18
Grass Silage	12
Rape Straw	9.6

- 2.4.2 Crop feedstocks including maize silage, grass silage and rape straw, will be transferred to the facility using a tractor and trailer or Heavy Goods Vehicles (HGVs) during typical harvest periods and deposited within four clamps located on the southern section of the site. These will have a total working capacity of 12,000t.
- 2.4.3 The clamps will be compacted and covered using protective plastic sheeting. This will form an airtight layer to minimise emissions and preserve the feedstock throughout the year. It should be noted that any decomposition of the material would affect its effectiveness as a feedstock. As such, the protective sheeting will be specified to prevent water and air reaching the material and hence avoid any unwanted breakdown with associated emissions.
- 2.4.4 During operational periods, the cover on the clamps will be slightly open at one end to allow access to the feedstock for transportation to the AD plant. The sheeting will be replaced at the end of each working day in order to protect the feedstock and minimise the potential for emissions.
- 2.4.5 FYM and poultry manure will be delivered to the site, on an as required basis, using a tractor and trailer or HGVs and deposited within the clamp area for temporary storage prior to transfer to the AD plant. All manures processed at the site will remain uncovered throughout the short-term storage period.
- 2.4.6 Any surface runoff generated by feedstock storage operations will be transferred to an underground leachate tank and then to a dirty water lagoon on the eastern section of the site for storage prior to incorporation into the AD process.

## **2.5 Transfer of Feedstocks**

2.5.1 Crop feedstocks and manures will be transferred from the storage clamps to an open top BIG-MIX 150/4000/450 solid feed hopper using a bucket loader or similar. This will macerate and blend the material prior to processing within the AD plant. The operator will be provided with full training in the use of the loader and especially in how to maintain a tight clamp face which reduces material losses and associated emissions.

2.5.2 Any leachate generated by maceration and blending of materials within the feed hopper will be transferred to an underground leachate tank located adjacent to the plant and then to the dirty water lagoon for use within the process.

## **2.6 Anaerobic Digestion Plant Operation**

2.6.1 The feedstocks will be digested within two sealed AD tanks. These include all necessary non-return valves and pumps to ensure there are no losses from any part of the process. The facility will be fully automated to maintain maximum efficiency at all times.

2.6.2 The biogas produced by the process (a mixture of methane (CH<sub>4</sub>) and carbon dioxide (CO<sub>2</sub>)) will be collected in domes above the digesters prior to upgrade for injection into the gas grid. This involves stripping out impurities, mainly CO<sub>2</sub>, specific volatile organic compounds (VOCs) and hydrogen sulphide (H<sub>2</sub>S), before treatment with an odorant and transfer off-site. Exhaust gases generated by the upgrading process will be discharged to atmosphere via dedicated vent.

2.6.3 A proportion of the biogas will be transferred to the CHP unit where it will be combusted for the generation of electricity and heat. Exhaust gases from the CHP unit will be dispersed to atmosphere via a dedicated stack.

2.6.4 The site will also feature an automatic back-up flare that burns gas in a controlled manner if the CHP unit or upgrade system stops temporarily, or if plant maintenance is required. Should the flare fail for any reason the digester tanks are fitted with emergency release valves to avoid over pressure. These are a necessary safety feature. A record of their use will be kept and the reason for utilisation fully documented.



2.6.5 Frequent or extended use of the pressure release valves would indicate the plant is not being managed correctly and would have financial consequences for the operator due to loss of biogas and potential impacts to the digester conditions. It is therefore in their best interest to ensure they are utilised as infrequently as possible.

## **2.7 Digestate**

2.7.1 The process will create digestate which can be used as a high-quality fertiliser. Many types of AD feedstocks, including crops, are rich in plant nutrients. These remain within the material throughout the process, making digestate a valuable biofertiliser. By making the best possible use of digestate as a biofertiliser, nutrients are returned to the land through natural cycles to replace the input of inorganic fertiliser. Recycling in this way closes a loop to create more sustainable agricultural production systems.

2.7.2 Under normal operating scenarios, the digestate produced by the AD process will be treated by an Ekogea system. This will be completely enclosed and operated under negative pressure. Any emissions generated by the system during operation will be treated by dedicated carbon filters prior to discharge to atmosphere.

2.7.3 One part of the Ekogea system will deconstruct fibrous material within a micronisation unit to improve digestion and a further part will concentrate the output to provide a thickened digestate which will be transferred to a dedicated digestate storage tank. The tank will be fitted with a gas tight dome for storage prior to removal from the facility. The Ekogea system will also generate grey water which will either be reused within the process or transferred to the digestate storage tank. All grey water will be stored within a covered tank fitted with a carbon filter on the vent. Polished water will also be produced and will either be used within the micronisation unit or discharged via the clean water infiltration pond.

2.7.4 Removal of digestate from the tank will be undertaken using vacuum tankers. Air displaced from the tankers during filling will be passed through a carbon filter prior to discharge to atmosphere. This system is likely to provide beneficial reductions in bioaerosol concentrations between inlet and outlet air due to the impaction of microorganisms onto the carbon during operation.

2.7.5 During periods when the Ekogea system is not operational, due to plant failure or required maintenance, digestate will be divided into solid and liquid fractions using a screw separator. Solid digestate will be temporarily stockpiled below the separator and removed from site daily. The liquid fraction will be transferred to the digestate storage tank for holding prior to removal from the facility using vacuum tankers.

### **3.0 BIOAEROSOL BACKGROUND**

#### **3.1 Bioaerosol Definition**

3.1.1 Bioaerosol is a general term for microorganisms suspended in the air. These microorganisms include fungi and bacteria, as well as their components such as mycotoxins, endotoxins and glucans. Bioaerosols are generally less than 100µm in size and are not filtered out by hairs and specialised cells that line the nose. Due to their airborne nature and small size, many bioaerosols can penetrate the human respiratory system, resulting in inflammatory and allergic responses.

3.1.2 Although bioaerosols are ubiquitous, operations involving organic materials provide environments that are conducive to their growth. Bioaerosols are therefore likely to be associated with AD feedstocks and products, and in particular, handling activities, which release the microorganisms into the air.

#### **3.2 Health Risks from Bioaerosols**

3.2.1 Exposure to bioaerosols has been associated with human health effects, symptoms can include inflammation of the respiratory system, coughs and fever. Inhalation of bioaerosols may also cause or exacerbate respiratory diseases<sup>1</sup>. They have been known to cause gastrointestinal illness, eye irritation and dermatitis.

3.2.2 Possible links have also been made between exposure to bioaerosols and organic dust toxic syndrome. This is an acute disease that causes symptoms resembling those of influenza, such as shivering, an increase in body temperature, dry cough and muscle and joint pains. Of particular relevance to waste management facilities are infections caused by *Aspergillus fumigatus*. Invasive aspergillosis is a particularly severe infection, which may be fatal and is primarily a concern with at risk and immuno-suppressed patients.

3.2.3 Although some data is available, one of the major knowledge gaps for bioaerosols is their associated dose-response relationships. It is not currently possible to state with any certainty that a given concentration will result in a particular health impact. This is due to

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<sup>1</sup> Guidance on the evaluation of bioaerosol risk assessments for composting facilities, Environment Agency, undated.

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the number of bioaerosols that are naturally present within the environment as well as the complexities associated with human responses to different microorganisms.

### **3.3 Bioaerosol Emissions from Waste Management Operations**

- 3.3.1 Most scientific research on bioaerosol emissions from waste management operations focusses on open windrow and In-Vessel Composting (IVC) systems. Although it is recognised that there are fundamental differences between composting and AD processes, there are similarities between the types of feedstocks, handling activities and infrastructure utilised. As such, a review of relevant research has been undertaken in order to inform the assessment. The findings are detailed in the following Section.
- 3.3.2 The EA document 'Health Effects of Composting - A Study of Three Compost Sites and Review of Past Data'<sup>2</sup> summarises the findings of emissions measurement work undertaken at three composting facilities, including two open air turned windrow sites and one IVC plant. The results from the work indicated a well-defined decline in concentrations of bioaerosols with increased distance from source. In most cases, measured concentrations were at or below background levels within 250m of the sources assessed.
- 3.3.3 The ADAS report 'Bioaerosol Monitoring and Dispersal from Composting Sites'<sup>3</sup> provides a summary of the findings from measurement work undertaken at three composting sites. Sampling for bioaerosols was undertaken downwind of a wide range of composting activities including shredding, turning, loading, unloading and screening. The results indicated that 91% of all micro-organisms sampled across all three sites were below 1,000cfu/m<sup>3</sup> at a downwind distance of 125m.
- 3.3.4 The Scotland and Northern Ireland Forum for Environmental Research (SNIFFER) report 'Measurement and Modelling of Emissions from Three Composting Sites'<sup>4</sup> provides a summary of the findings from monitoring work undertaken at three composting sites, which included two IVC facilities and one open windrow system. The findings indicated that there is the potential for seasonal variation in ambient concentrations of the mould of *Aspergillus fumigatus*, with concentrations being the highest in the autumn. In most

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<sup>2</sup> Health Effects of Composting - A Study of Three Compost Sites and Review of Past Data, EA, 2001.

<sup>3</sup> Bioaerosol Monitoring and Dispersal from Composting Sites, ADAS, 2005.

<sup>4</sup> Measurement and Modelling of Emissions from Three Composting Sites, SNIFFER, 2007.



cases, levels of all bioaerosols assessed were at or below background equivalent concentrations within 250m of the sources assessed.

3.3.5 The Department for Environment Food and Rural Affairs (DEFRA) research report 'Bioaerosols and odour emissions from composting facilities'<sup>5</sup> focusses on the comparability of different sampling methodologies and the influence of spatial and temporal variation on ambient bioaerosol concentrations. Measurements were undertaken at four different composting facilities in England, which represent a range of system types. The results of the study corroborate existing research and suggest that concentrations of bioaerosols generally return to background levels within 250m of the source.

3.3.6 The findings of the review have been considered as appropriate throughout the assessment.

### **3.4 Legislative Control**

3.4.1 Atmospheric emissions from industry are controlled in the UK through the Environmental Permitting (England and Wales) Regulations (2016) and subsequent amendments. The operation of the proposed AD plant is included within the Regulations and as such the facility is required to obtain an Environmental Permit issued by the EA.

### **3.5 Environment Agency (EA) Policy**

3.5.1 The EA Regulatory Position Statement (RPS) 'Bioaerosol monitoring at regulated facilities - use of M9: RPS 209'<sup>6</sup> outlines the conditions that apply to facilities in relation to bioaerosol emissions.

3.5.2 The RPS states that if a regulated facility is located within 250m of a sensitive receptor (a place where people live or work for more than 6-hours at a time), the operator must:

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<sup>5</sup> Bioaerosols and odour emissions from composting facilities, DEFRA, 2013.

<sup>6</sup> Bioaerosol monitoring at regulated facilities - use of M9: RPS 209, EA, 2018.

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- Monitor bioaerosols in accordance with EA guidance 'M9: environmental monitoring of bioaerosols at regulated facilities'<sup>7</sup>; and,
- Undertake a site specific Bioaerosol Risk Assessment.

3.5.3 The conditions outlined within the RPS have been considered as appropriate throughout the assessment.

### **3.6 Benchmark Levels**

3.6.1 In the absence of dose-response data, the EA have adopted a precautionary risk-based approach in determining guidance levels for bioaerosols. The EA position statement 'Composting and potential health effects from bioaerosols: our interim guidance for permit applicants'<sup>8</sup> specifies the following criteria for acceptable concentrations of *Aspergillus fumigatus* and total bacteria at sensitive receptor locations.

- *Aspergillus fumigatus* - 500cfu/m<sup>3</sup>; and,
- Total bacteria - 1,000cfu/m<sup>3</sup>.

3.6.2 The relevant benchmark levels have been considered as appropriate throughout the assessment.

### **3.7 Technical Guidance**

3.7.1 The EA guidance 'How to comply with your environmental permit. Additional technical guidance for: Anaerobic Digestion'<sup>9</sup> sets out indicative Best Available Technique (BAT) or appropriate measures for the AD of organic materials. The document provides practical guidance on how and why bioaerosol emissions occur, as well as measures that can be employed to prevent or minimise release.

3.7.2 The requirements of the guidance have been considered throughout the assessment.

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<sup>7</sup> M9: environmental monitoring of bioaerosols at regulated facilities, EA, 2017.

<sup>8</sup> Composting and potential health effects from bioaerosols: our interim guidance for permit applicants, EA, 2010.

<sup>9</sup> How to comply with your environmental permit. Additional technical guidance for: Anaerobic Digestion, EA, 2013.

## 4.0 **PROBLEM DEFINITION**

### 4.1 **Introduction**

4.1.1 The first stage of any risk assessment is to clearly set out the problem, including what will be addressed and what will not. This determines the scope, level of detail and focus. In particular, the temporal and spatial scales, contaminants to be assessed, persons at risk and the endpoint are identified. These factors are considered in the following Sections.

### 4.2 **Conceptual Model**

4.2.1 Potential hazards from bioaerosols are summarised in the conceptual model in Table 2.

**Table 2 Conceptual Model**

Criteria	Comment
Source	Feedstocks and products on the site as outlined in Section 4.3
Hazard	Potential adverse health impacts as outlined in Section 3.2
Transport Mechanism	Airborne
Medium of Exposure	Inhalation, ingestion, absorption, injection
Receptor	Human receptors at the proposed development site as outlined in Section 4.4

### 4.3 **Sources**

4.3.1 The operation of the AD plant may result in bioaerosol emissions from a number of activities. The following sources were identified based on a review of the proposed operations:

- Exposed crop feedstocks during delivery and storage;
- Exposed manures during delivery and temporary storage;
- Exposed feedstocks during transfer to the AD hopper;
- Exposed material within the AD hopper;
- CO<sub>2</sub> vent on the gas upgrade unit;
- Air expelled from the Ekogea system carbon filters during operation;

- Solid digestate below the separator during periods when the Ekogea system is not operational;
- Air expelled from the carbon filter during digestate tanker filling; and,
- Surface runoff within the dirty water lagoon.

4.3.2 As stated previously, the actual AD process itself is sealed and therefore does not form a source of bioaerosols under normal operation. In addition, the digestate storage tank will feature a gas tight dome which will prevent any emissions to atmosphere.

4.3.3 The digesters and digestate storage tank will feature release valves to avoid over pressure. Any gases released from the valves are likely to contain bioaerosols as a result of the digestion processes. However, releases from these sources are expected to be extremely infrequent and short-term as they would only occur in an emergency situation. As such, the risk of impact from these emissions is not considered to be significant and they have not been evaluated further in the context of this assessment.

4.3.4 The CHP unit and flare stack will only emit products of combustion which do not contain any bioaerosols. As such, they have not been considered further in this report.

4.3.5 The potential for bioaerosol emissions from each remaining source is considered further in the following Sections.

#### **Exposed Crop Feedstocks During Delivery and Storage**

4.3.6 Crop feedstocks will be transferred to the facility using a tractor and trailer or HGVs during typical harvest periods. The feedstocks will be deposited within storage clamps located on the southern section of the site. Disturbance of the material during delivery may cause bioaerosol release. However, the seasonal nature of deliveries and short amount of time required to deposit loads is likely to minimise potential exposure durations.

4.3.7 Following delivery, the crop feedstocks will be compacted and covered with protective sheeting. This will help to minimise bioaerosol release during storage.

4.3.8 During operational periods, the cover on the clamps will be slightly open at one end to allow access to the feedstock for transportation to the AD plant. The sheeting will be replaced at the end of each working day in order to protect the feedstock and minimise



the potential for emissions. The area of uncovered material during transfer to the AD plant will be kept to a minimum at all times in order to limit the potential for surface wind stripping of microorganisms.

- 4.3.9 The clamps will be inspected on a daily basis to ensure the sheeting is intact and providing effective coverage of the feedstock material.

#### **Exposed Manures During Delivery and Storage**

- 4.3.10 FYM and poultry manure deliveries will occur throughout the year. The materials will be transferred to the site using a tractor and trailer or HGVs on a as required basis and then deposited within the clamp area for temporary storage. There is the potential for bioaerosol emissions to occur if the feedstocks are agitated during delivery. However, partial containment of the materials within the vehicles is likely to limit the release potential.

- 4.3.11 All manures processed at the site will remain uncovered throughout the short-term storage period. However, once placed within the clamp area, the materials will remain static until they are transferred to the AD feed hopper. The surface area of each pile will be kept to a minimum in order to limit the potential for surface wind stripping of microorganisms.

#### **Transfer of Feedstocks**

- 4.3.12 Crop feedstocks and manures will be transferred from the respective storage areas using a bucket loader or similar and then deposited within the AD hopper.
- 4.3.13 There is the potential for bioaerosol release during removal of feedstocks from the storage areas and loading into the hopper. As such, all reasonable measures will be undertaken to minimise disturbance of the material during this operation. In addition, the shortest transfer routes will be utilised in order to limit potential exposure durations.
- 4.3.14 Full training will be provided to the bucket loader operative to avoid material spillage during transfer. Any spilled material will be cleared within the working day.
-

### **Feed Hopper**

- 4.3.15 Bioaerosol emissions may occur during loading and operation of the feed hopper. However, these activities will be limited to approximately 4-hours per day in order to reduce exposure durations.
- 4.3.16 The drop height of material will be minimised as far as practicable during loading in order to reduce release potential. Training in the use of relevant equipment will be provided to all staff.
- 4.3.17 Any spilled material will be cleared by a site operative within the working day.

### **Upgrade Plant Vent**

- 4.3.18 The upgrade system is likely to provide beneficial reductions in bioaerosol concentrations between inlet and vented air due to the impaction of microorganisms onto the carbon media during operation. However, there may be the potential for the release of residual components which pass straight through the filter. As such, impacts associated with emissions from this source have been considered further as part of the assessment.

### **Ekogea System**

- 4.3.19 As stated previously, the Ekogea system will be completely enclosed and operated under negative pressure. Any emissions generated by the system during operation will be treated by dedicated carbon filters prior to discharge to atmosphere. The carbon filters serving the system are likely to provide beneficial reductions in bioaerosol concentrations between inlet and vented air due to the impaction of microorganisms onto the media. However, there may be the potential for the release of residual components which pass straight through the filters. As such, impacts associated with emissions from the system have been considered further as part of the assessment.

### **Solid Digestate**

- 4.3.20 During periods when the Ekogea system is not operational, digestate will be divided into solid and liquid fractions using a screw separator. Solid digestate will be temporarily stockpiled below the separator. Although the AD process will reduce the quantities of

some bioaerosols, particularly pathogens<sup>10</sup>, there is the potential for emissions from this part of the process.

4.3.21 If produced, solid digestate will be removed from site daily to avoid storage of significant amounts. This will help to reduce the exposed surface area of material and limit the potential for surface wind stripping of microorganisms. It is possible that some level of solid digestate will be stored on site. However, the material will remain static during storage with minimal mechanical agitation. This will help to reduce the potential for bioaerosol release.

#### **Digestate Tanker**

4.3.22 Digestate will be pumped from the storage vessel into a tanker for transfer off-site. The pumping arrangement is a closed system and therefore digestate will not be exposed to atmosphere during transfer.

4.3.23 Air displaced from the tanker during filling will be passed through a carbon filter prior to discharge to atmosphere. This system is likely to provide beneficial reductions in bioaerosol concentrations between inlet and outlet air due to the impaction of microorganisms onto the carbon during operation. However, there may be the potential for the release of residual components which pass straight through the media.

#### **Dirty Water Lagoon**

4.3.24 Any surface runoff generated by feedstock storage operations will be transferred to a dirty water lagoon on the eastern section of the site for storage prior to incorporation into the AD process. The liquid nature of materials within the lagoon will limit the potential for bioaerosol release. However, residual emissions from the source may occur. As such, potential releases have been considered further as part of the assessment.

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<sup>10</sup> Anaerobic digestion, storage, oligolysis, lime, heat and aerobic treatment of livestock manures, FEC Services Ltd, 2003.

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#### 4.4 **Receptors**

4.4.1 EA guidance 'M9: environmental monitoring of bioaerosols at regulated facilities'<sup>11</sup> defines a sensitive receptor as follows:

"Nearest sensitive receptor means the nearest place to the permitted activities where people are likely to be for prolonged periods. This term would therefore apply to dwellings (including any associated gardens) and to many types of workplaces. We would not normally regard a place where people are likely to be present for less than 6 hours at one time as being a sensitive receptor. The term does not apply to those controlling the permitted facility, their staff when they are at work or to visitors to the facility, as their health is covered by Health and Safety at Work legislation, but would apply to dwellings occupied by the family of those controlling the facility."

4.4.2 A desk-top study was undertaken in order to identify any sensitive receptor locations in the vicinity of the site that required specific consideration during the assessment. In accordance the requirements of the EA RPS<sup>12</sup>, this focussed on locations within 250m of the facility boundary where people may be present for more than 6-hours at one time. The identified receptors are summarised in Table 3.

**Table 3 Sensitive Receptors**

Receptor		NGR (m)		Distance from Closest Source (m)	Direction from Closest Source
		X	Y		
R1	Lower Drayton Play Barn	393073.4	315667.4	185	North
R2	Residential - Lower Drayton Farm	393059.2	315675.7	195	North
R3	Residential - Lower Drayton Farm	393082.0	315696.6	210	North

<sup>11</sup> M9: environmental monitoring of bioaerosols at regulated facilities, EA, 2017.

<sup>12</sup> Bioaerosol monitoring at regulated facilities - use of M9: RPS 209, EA, 2018.



4.4.3 As shown in Table 3, the sensitive locations are located between approximately 185m and 210m from the identified sources at their closest points. Reference should be made to Figure 3 for a visual representation of the identified receptors.

#### 4.5 Prevailing Meteorological Conditions

4.5.1 The potential for bioaerosol emissions to impact at sensitive locations depends significantly on the meteorology, particularly wind direction, during release. In order to consider prevailing conditions at the site review of historical weather data was undertaken. Shawbury observation station is located at NGR: 354931, 322117, which is approximately 38.7km north-west of the facility. It is anticipated that conditions would be reasonably similar over a distance of this magnitude. The data was therefore considered suitable for an assessment of this nature.

4.5.2 Meteorological data was obtained from Shawbury observation station over the period 1<sup>st</sup> January 2014 to 31<sup>st</sup> December 2018 (inclusive). The frequency of wind from the eight sectors which best describe the directions which may cause impacts in the vicinity of the site is shown in Table 4. Reference should be made to Figure 4 for a wind rose of the meteorological data.

**Table 4 Wind Frequency Data**

Wind Direction (°)	Frequency of Wind (%)
337.5 - 22.5	8.63
22.5 - 67.5	4.14
67.5 - 112.5	10.26
112.5 - 157.5	8.79
157.5 - 202.5	16.97
202.5 - 247.5	19.10
247.5 - 292.5	20.34
292.5 - 337.5	10.08
Sub-Total	98.32
Calms	0.73

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Wind Direction (°)	Frequency of Wind (%)
Missing/Incomplete	0.95

4.5.3 All meteorological data used in the assessment was provided by Atmospheric Dispersion Modelling Ltd, which is an established distributor of meteorological data within the UK.

4.5.4 As shown in Table 4, the prevailing wind direction at the AD plant is from the west, with significant frequencies from the south and south-west. Winds from the north and east are relatively infrequent, which is indicative of conditions throughout the UK.

#### **4.6 Other Sources of Bioaerosols**

4.6.1 The immediate area surrounding the facility is rural, comprising agricultural land. Arable fields may form sources of bioaerosols if fertilised with animal manures or slurries, as well as during crop harvest periods. However, likely impacts associated with these releases are not considered to be significant and would be expected for any rural location within the UK.

## **5.0 RISK ASSESSMENT METHODOLOGY**

### **5.1 Overview**

5.1.1 The Bioaerosol Risk Assessment has been undertaken in accordance with the general principles of EA document 'Guidance on the evaluation of bioaerosol risk assessments for composting facilities'<sup>13</sup>. This included consideration of the following:

- Receptor - what is at risk? What do I wish to protect?
- Source - what is the agent or process with potential to cause harm?
- Harm - what are the harmful consequences if things go wrong?
- Pathway - how might the receptor come into contact with the source?
- Probability of exposure - how likely is this contact?
- Consequence - how severe will the consequences be if this occurs?
- Magnitude of risk - what is the overall magnitude of the risk? and,
- Justification for magnitude - on what did I base my judgement?

5.1.2 Based on the Bioaerosol Risk Assessment outcomes potential mitigation and control options were identified.

5.1.3 Further explanation for the key assessment areas is provided below.

### **5.2 Receptor**

5.2.1 The first step was to consider how the activity could harm the environment. This involved identifying 'receptors' that may be affected and included people, property, and the natural and physical environment.

### **5.3 Probability of Exposure**

5.3.1 The probability of exposure was defined based on the likelihood of exposure of the specific receptor to the identified sources. This depended on several factors, such as:

- Distance between source and receptor;

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<sup>13</sup> Guidance on the evaluation of bioaerosol risk assessments for composting facilities, EA, undated.

- Dispersion potential of emission;
- Duration of emission; and,
- Frequency of emission.

5.3.2 Probability was categorised in accordance with the following criteria:

- High - exposure is probable, direct exposure likely with no/few barriers between source and receptor;
- Medium - exposure is fairly probable, barriers less controllable;
- Low - exposure unlikely, barriers exist to mitigate; or,
- Very low - exposure very unlikely, effective and multiple barriers.

## **5.4 Harm**

5.4.1 The severity of harm from a risk depends on:

- How much a person or part of the environment is exposed; and,
- How sensitive a person or part of the environment is.

5.4.2 Some parts of the environment can be very sensitive. For example, serious health effects can occur if humans are exposed to certain chemicals for only short periods of time.

5.4.3 Harm can be described as follows:

- High - severe consequences, evidence that exposure may result in serious damage;
- Medium - significant consequences, evidence that exposure may result in damage that is not severe and is reversible;
- Low - minor consequences, damage not apparent, reversible adverse changes possible; and,
- Very low - negligible consequences, no evidence for adverse changes.

## **5.5 Magnitude of Risk**

5.5.1 The level of risk is a combination of:

- How likely a problem is to occur; and,

- How serious the harm might be.

5.5.2 Risk is highest where both the likelihood of a problem is high and the potential harm is severe. Risk is lowest where a problem is unlikely to occur and the harm that might result is not serious.

5.5.3 Risk was defined based on the interaction between the probability of exposure and potential harm, as outlined in Table 5.

**Table 5 Magnitude of Risk**

Probability of Exposure	Potential Harm			
	Very Low	Low	Medium	High
High	Low	Medium	High	High
Medium	Low	Medium	Medium	High
Low	Low	Low	Medium	Medium
Very Low	Very Low	Low	Low	Medium

## 5.6 Further Requirements

5.6.1 Based on the outcomes of the risk assessment the EA document provides guidance on further requirements for different risks. These can be summarised as follows:

- High risks - additional assessment and active management;
- Medium risks - likely to require further assessment and may require either active management or monitoring; and,
- Low and very low risk - will only require periodic review.

5.6.2 Mitigation to reduce risk can also be applied to avoid the requirement for further assessment and/or monitoring.



## 6.0 RISK ASSESSMENT

6.1.1 The Bioaerosol Risk Assessment is shown in Table 6.

**Table 6 Risk Assessment**

Source	Probability of exposure	Harm	Magnitude of Risk	Control Measures	Residual Risk	Justification for Residual Risk
Exposed crop feedstocks during delivery and storage within the clamps	<b>Low</b> due to the separation distance between the receptors and source, and containment of feedstocks during storage	<b>Medium</b>	<b>Medium</b>	<p>All reasonable measures will be undertaken to reduce the drop height of materials during unloading of the delivery vehicles</p> <p>Feedstocks will be stored under sheeting following delivery</p> <p>The area of uncovered material will be kept to a minimum during storage and will only be exposed when transfer to the AD plant is required. This will help to limit the potential for surface wind stripping of microorganisms</p> <p>The clamps will be inspected on a daily basis to ensure the sheeting is intact and providing effective containment of emissions</p> <p>Training in the use of relevant equipment will be provided to all staff</p> <p>Any spilled material will be cleared by a site operative on the same working day</p>	<b>Low</b>	The seasonal nature and short duration of delivery activities, as well as full implementation of the stated control measures is considered to result in a <b>low</b> risk of impact occurring

Source	Probability of exposure	Harm	Magnitude of Risk	Control Measures	Residual Risk	Justification for Residual Risk
Exposed manures during delivery and storage within the clamps	<b>Very Low</b> due to the separation distance between the receptors and source, the limited quantity of manures present and the static nature of material during storage	<b>Medium</b>	<b>Low</b>	<p>The delivery vehicles will provide partial containment of manures during transfer to the site</p> <p>All reasonable measures will be undertaken to reduce the drop height of manures during the unloading of delivery vehicles</p> <p>Training in the use of relevant equipment will be provided to all staff</p> <p>The surface areas of manure piles will be kept to a minimum in order to limit the potential for surface wind stripping of microorganisms</p> <p>Manures will remain static during storage and will only be agitated when transfer to the feed hopper is undertaken</p>	<b>Very Low</b>	Full implementation of the stated control measures is considered to result in a <b>very low</b> risk of impact occurring

Source	Probability of exposure	Harm	Magnitude of Risk	Control Measures	Residual Risk	Justification for Residual Risk
Exposed feedstocks during transfer to the AD hopper	<b>Low</b> due to the separation distance between the receptors and source, and the limited duration of transfer operations	<b>Medium</b>	<b>Medium</b>	<p>The feed hopper will only be loaded for approximately 4-hours per day</p> <p>All reasonable measures will be undertaken to minimise disturbance of the feedstocks during removal from the clamp area and transfer to the hopper</p> <p>The shortest transfer routes will be utilised in order to limit potential exposure durations</p> <p>Full training will be provided to the bucket loader operative to avoid material spillage during transfer</p> <p>Any spilled material will be cleared by a site operative within the working day</p>	<b>Low</b>	The distance between source and receptors, as well as and full implementation of the stated control measures, is considered to result in a <b>low</b> risk of impact occurring
Exposed material within the AD hopper	<b>Low</b> due to the separation distance between the receptors and source, and the limited duration of operations	<b>Medium</b>	<b>Medium</b>	<p>The feed hopper will only be loaded for approximately 4-hours per day</p> <p>Where practicable the drop height of material will be minimised in order to reduce release potential</p> <p>Full training will be provided to the bucket loader operative to avoid material spillage during transfer</p> <p>Any spilled material will be cleared by a site operative within the working day</p>	<b>Low</b>	The distance between source and receptors, as well as and full implementation of the stated control measures, is considered to result in a <b>low</b> risk of impact occurring

Source	Probability of exposure	Harm	Magnitude of Risk	Control Measures	Residual Risk	Justification for Residual Risk
Air discharged from the gas upgrading plant CO <sub>2</sub> vent	<b>Very low</b> due the distance between source and receptors and the limited release potential	<b>Medium</b>	<b>Low</b>	The carbon filter serving the gas upgrading system is likely to provide beneficial reductions in bioaerosol concentrations between inlet and vented air due to the impaction of microorganisms onto the media during operation. It is anticipated that the residual release potential will be limited	<b>Very Low</b>	Full application of the proposed control measures is considered to result in a <b>very low</b> risk of impact occurring
Air discharged from the Ekogea system carbon filters	<b>Very low</b> due the distance between source and receptors and the limited release potential	<b>Medium</b>	<b>Low</b>	The Ekogea system will be completely enclosed and operated under negative pressure  It is anticipated that the carbon filters serving the system will provide beneficial reductions in bioaerosol concentrations between inlet and vented air due to the impaction of microorganisms onto the media	<b>Very Low</b>	Full application of the proposed control measures is considered to result in a <b>very low</b> risk of impact occurring

Source	Probability of exposure	Harm	Magnitude of Risk	Control Measures	Residual Risk	Justification for Residual Risk
Solid digestate within the storage area	<b>Very low</b> due the distance between source and the receptors, the limited duration of separation operations and minimal disturbance of material during storage	<b>Medium</b>	<b>Low</b>	<p>If produced, solid digestate will be removed from site daily to avoid storage of significant amounts. This will help to reduce the exposed surface area of material and limit the potential for surface wind stripping of microorganisms</p> <p>The material will remain static during storage with minimal mechanical agitation</p> <p>All reasonable measures will be undertaken to minimise disturbance of the material during loading</p>	<b>Very Low</b>	Full application of the proposed control measures is considered to result in a <b>very low</b> risk of impact occurring
Air expelled from the digestate tanker during filling	<b>Very low</b> due the distance between source and receptors, the short duration of tanker filling operations and the low release potential due to carbon filtration of air	<b>Medium</b>	<b>Low</b>	<p>Air displaced by the vacuum tanker will be treated by a carbon filter prior to release to atmosphere. The system is likely to provide beneficial reductions in bioaerosol concentrations between inlet and outlet air due to the impaction of microorganisms on to the media The infrequent nature and short duration of tanker filling events is likely to limit the potential for impacts</p>	<b>Very Low</b>	The short duration of filling operations and the potential abatement provided by the carbon filter is considered to result in a <b>very low</b> risk of impact occurring



Source	Probability of exposure	Harm	Magnitude of Risk	Control Measures	Residual Risk	Justification for Residual Risk
Exposed material within the dirty water lagoon	<b>Low</b> due to the separation distance between the receptors and source, and the low release potential	<b>Medium</b>	<b>Medium</b>	Material within the lagoon is likely to have a low release potential due to associated moisture content  The filling and extraction regime will be managed to ensure limited agitation of material and associated emissions	<b>Low</b>	The low release potential of residual material within the lagoon is considered to result in a <b>low</b> risk of impact occurring

## 7.0 CONCLUSION

7.1.1 Redmore Environmental Ltd was commissioned Lower Drayton ProjectCo Ltd to produce a Bioaerosol Risk Assessment in support of the proposed Lower Drayton AD plant, Penkridge, Staffordshire.

7.1.2 During the operation of the facility there is the potential for bioaerosol emissions and associated impacts at sensitive receptor locations in the vicinity of the site. A Risk Assessment was therefore undertaken to identify potential emission sources and evaluate effects in the local area.

7.1.3 The following potential bioaerosol emission sources were identified:

- Exposed crop feedstocks during delivery and storage;
- Exposed manures during delivery and temporary storage;
- Exposed feedstocks during transfer to the AD hopper;
- Exposed material within the AD hopper;
- CO<sub>2</sub> vent on the gas upgrade unit;
- Air expelled from the Ekogea system carbon filters during operation;
- Solid digestate below the separator during periods when the Ekogea system is not operational;
- Air expelled from the carbon filter during digestate tanker filling; and,
- Surface runoff within the dirty water lagoon.

7.1.4 The risk of significant bioaerosol impact at sensitive locations in the vicinity of the site was assessed using a source - pathway - receptor approach. This considered the nature of the potential emission, any barriers to dispersion and the severity of harm.

7.1.5 The results of the assessment indicated residual risk from all sources was determined as **low** or **very low**. As such, potential impacts as a result of bioaerosol emissions from the proposed facility are not considered to represent a constraint to the proposals.

## 8.0 **ABBREVIATIONS**

AD	Anaerobic Digestion
BAT	Best Available Technique
CH <sub>4</sub>	Methane
CHP	Combined Heat and Power
CO <sub>2</sub>	Carbon dioxide
DEFRA	Department for Environment, Food and Rural Affairs
EA	Environment Agency
FYM	Farmyard Manure
H <sub>2</sub> S	Hydrogen Sulphide
HGV	Heavy Goods Vehicle
IVC	In-Vessel Composting
NGR	National Grid Reference
RPS	Regulatory Position Statement
SNIFFER	Scotland and Northern Ireland Forum for Environmental Research
VOC	Volatile Organic Compounds

**Figures**

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### Legend



Site Boundary

### Title

Figure 1 - Site Location Plan

### Project

Bioaerosol Risk Assessment  
Lower Drayton AD Plant, Penkridge

### Project Reference

3652

### Client

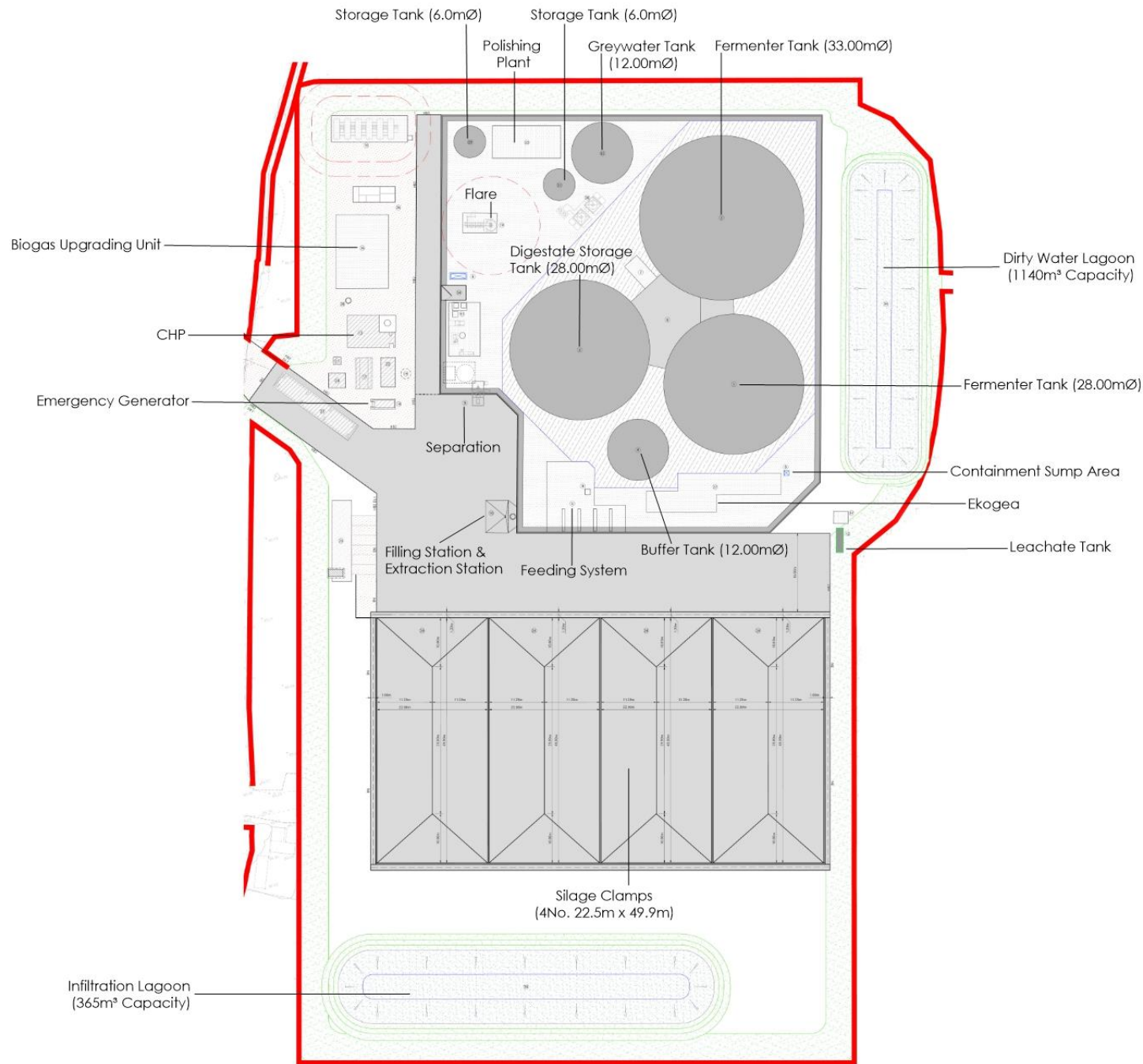
Lower Drayton ProjectCo Ltd

Contains Ordnance Survey Data  
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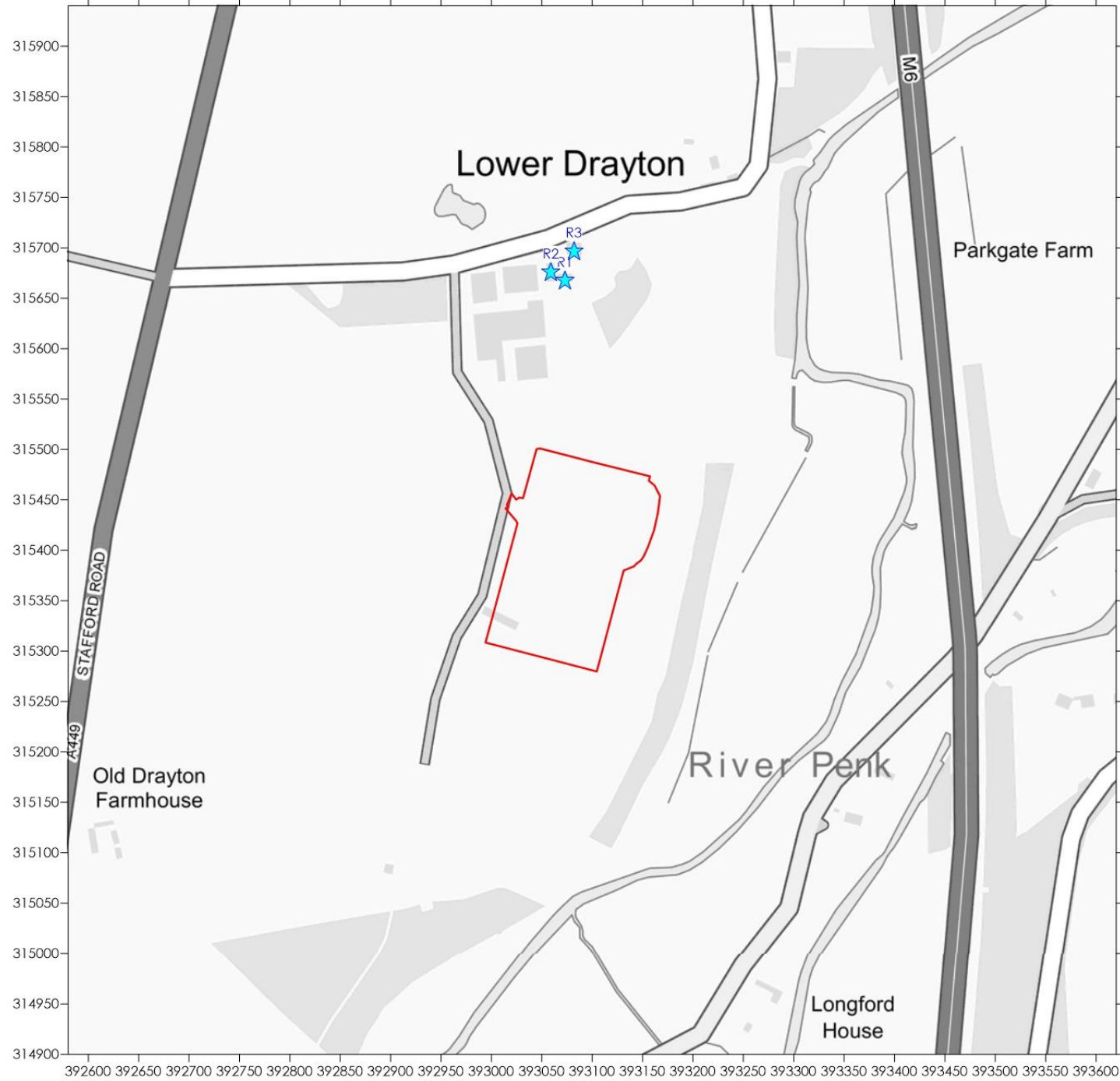
**Legend**

**Title**  
Figure 2 - Site Layout Plan

**Project**  
Bioaerosol Risk Assessment  
Lower Drayton AD Plant, Penkridge

**Project Reference**  
3652

**Client**  
Lower Drayton ProjectCo Ltd



**Legend**



Site Boundary



Receptor

**Title**

Figure 3 - Sensitive Receptors

**Project**

Bioaerosol Risk Assessment  
Lower Drayton AD Plant, Penkridge

**Project Reference**

3652

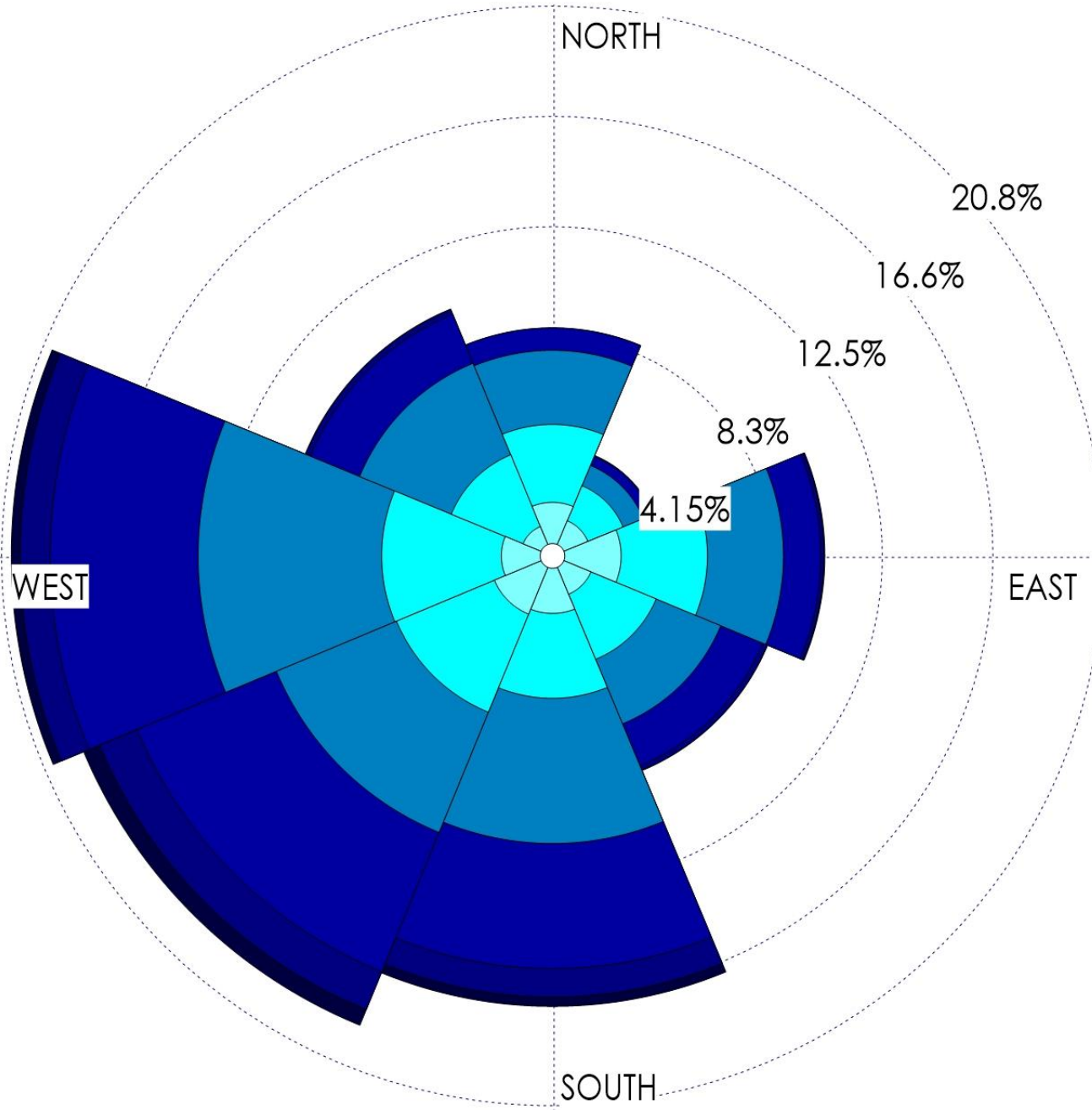
**Client**

Lower Drayton ProjectCo Ltd

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**Legend**

WIND SPEED  
(m/s)

- >= 11.10
- 8.80 - 11.10
- 5.70 - 8.80
- 3.60 - 5.70
- 2.10 - 3.60
- 0.50 - 2.10

Calms: 0.73%

**Title**

Figure 4 - Wind Rose of 2014 to 2018  
Shawbury Meteorological Data

**Project**

Bioaerosol Risk Assessment  
Lower Drayton AD Plant, Penkridge

**Project Reference**

3652

**Client**

Lower Drayton ProjectCo Ltd

