RWE Renewables UK Dogger Bank South (West) Limited

RWE Renewables UK Dogger Bank South (East) Limited

Dogger Bank South Offshore Wind Farms

Outline Drainage Strategy (Revision 4) (Clean)
Volume 8

June 2025

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Unrestricted

Company	**RWE Renewables UK Dogger Bank South (West) Limited and RWE Renewables UK Dogger Bank South (East) Limited**	Asset:	**Development**
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01	June 2024	Final for DCO Application	RWE	RWE	RWE
02	November 2024	Submission in response to ERYC comments on the draft SoCG and updated arboricultural survey information.	RWE	RWE	RWE
03	February 2025	Submission for Deadline 2	RWE/WA	RWE	RWE
04	June 2025	Submission for Deadline 7	RWE/WA	RWE	RWE

Unrestricted

Revision Change Log			
Rev No.	**Page**	**Section**	**Description**
01	N/A	N/A	Submitted for DCO Application
02	14	1.5.1	Reference to the 10.13 Arboricultural Survey Report and Preliminary Arboricultural Impact Assessment (Revision 2) [AS-036 and AS-037] has been added.
02	21, 23, 25, 27	1.5.5, 1.5.6, 1.5.7, 1.6	8.12 Outline Operational Drainage Strategy has been updated to reflect comments received from ERYC on the draft SoCG. Clarification has been added to confirm that the SuDS design would be landscape-led.
03	N/A	N/A	Updates have been made to incorporate Project Change Request 2.
03	11, 12	1.2	Updates in Response to Action point No.31 in Section 5 **The Applicants' Responses to January 2025 Hearing Action Points (Revision 1)** [REP1-051]. To provide further details on outfall locations.
03	13	1.3	Updated to cross reference to section 6.3.2.4 of the **Outline Code of Construction Practice (Revision 3)** [REP1-025] which provides further detail on the scope of the Surface Water Management Plan during construction.
03	14 31	1.4 1.5.9	Updates in Response to Action point No.50 in Section 5 **The Applicants' Responses to January 2025 Hearing Action Points (Revision 1)** [REP1-051]. To provide further details on foul water treatment.
03	15	Table 1-1	Updated site area to reflect updated site area post Project Change Request 2. Updated to add details of the LLFA.
03	18	Plate 1-2	Update of Plate 1-2 to reflect updated converter station footprint post Project Change Request 2.
03	19	1.5.3	Updated to reflect updated platform size and location post Project Change Request 2.
03	19	1.5.3	Update drawing number to show converter station general arrangement post Project Change Request 2.
03	24	1.5.5	Added detail on checks undertaken on watercourses in response to action point No.34 in Section 5 **The Applicants' Responses to January 2024 Hearing Action Points (Revision 1)** [REP1-051].
03	25	1.5.6	Updated to reflect updated SuDS (detention) basin location post Project Change Request 2.

Revision Change Log			
Rev No.	**Page**	**Section**	**Description**
03	22 29 26 27 32	1.5.5 1.5.6 1.5.7 1.6	Added additional text to explain that the final SuDs design will not be a single uniform pond in response to comments from the ERYC in their Local Impact Report and action point No.15 in Section 5 **The Applicants' Responses to January 2025 Hearing Action Points (Revision 1)** [REP1-051].
03	26	1.5.6	Updated to confirm surface water run-off from proposed access road discharges to Watercourses 1, 2 & 3 in response to action point No. 32 in Section 5 **The Applicants' Responses to January 2025 Hearing Action Points (Revision 1)** [REP1-51].
03	26	1.5.6	Reference to OWC (ordinary water course consent) removed and reference to protective provisions added. This was identified as errata when making updates for the change.
03	26, 27	1.5.7	Updated calculated greenfield run off rate, total storage requirements and SuDS (detention) basin plan area for updated converter station footprint size post Project Change Request 2. Additional text added regarding % impermeable areas and discharge rates to be agreed at detailed design.
03	28	1.5.8	Added section detailing Roadside Fiter Trenches Indicative Design in response to action point No. 33 in Section 5 **The Applicants' Responses to January 2025 Hearing Action Points (Revision 1)** [REP1-51].
04	12	1.2	Additional text added on outfall locations outside of the Order Limits in response to I.D HF. 1.17 of **The Applicants' Responses to ExQ1 -** Drainage Matters [REP3-027] – Drainage Matters
04	13	1.2.1	Additional text added to address the response to Action point 42 in **The Applicants' Responses to April 2025 Hearing Action Points** [REP4-096] on maintenance of drainage during operation.
04	21-22	1.5.4.2	Additional text added to confirm the minimum discharge rate would not increase flood risk in response to I.D HF. 1.19 of **The Applicants Responses to the Examining Authority's Second Written Questions (ExQ2)** [REP5-036]
04	25	1.5.5.2	Added additional text detailing results of soil infiltration testing in response to ID. HF.1.14 of **The Applicants' Responses to ExQ1** [REP3-027] **-** Drainage Matters

Revision Change Log			
Rev No.	**Page**	**Section**	**Description**
04	21-22 27-28 31	1.5.4.2, 1.5.5.2 1.5.6 1.5.8	Additional text added to confirm the minimum discharge rate to avoid a blockage in response to I.D HF. 2.4 of **The Applicants' Responses to ExQ1** [REP3-027]] - Drainage Matters
04	N/A	1.2.1 Appendix B	Additional information on the land drainage design has been appended in response to **The Applicants' Responses to April 2025 Hearing Action Points** [REP4-096], Action point No.13 at ISH4.

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Glossary

Term	Definition
Construction	Includes all onshore physical works undertaken to implement the Dogger Bank South (DBS) Offshore Wind Farms, including demolition, waste disposal, but excluding site preparation works, as defined in the draft Development Consent Order (DCO).
Dogger Bank South (DBS) Offshore Wind Farms	The collective name for the two Projects, DBS East and DBS West.
Landfall	The point on the coastline at which the Offshore Export Cables are brought onshore, connecting to the onshore cables at the Transition Joint Bay (TJB) above mean high water.
Management measures	Comprise legislative requirements, current standards and best practice, in addition to primary, tertiary and secondary commitments identified as part of the DBS Offshore Wind Farms Environmental Statement (ES) process. They include strategies, control measures and monitoring procedures for managing the potential impacts of constructing DBS Offshore Wind Farms and limiting disturbance from construction activities as far as reasonably practicable.
Onshore Converter Stations	A compound containing electrical equipment required to transform HVDC and stabilise electricity generated by the Projects so that it can be connected to the electricity transmission network as HVAC. There will be one Onshore Converter Station for each Project.

Term	Definition
Onshore Development Area	The Onshore Development Area for ES is the boundary within which all onshore infrastructure required for the Projects would be located including Landfall Zone, Onshore Export Cable Corridor, accesses, Temporary Construction Compounds and Onshore Converter Stations.
Onshore Export Cable Corridor	This is the area which includes cable trenches, haul roads, spoil storage areas, and limits of deviation for micro-siting. For assessment purposes, the cable corridor does not include the Onshore Converter Stations, Transition Joint Bays or temporary access routes; but includes Temporary Construction Compounds (purely for the cable route).
Onshore Export Cables	Onshore Export Cables take the electric from the Transition Joint Bay to the Onshore Converter Stations.
Onshore Substation Zone	Parcel of land within the Onshore Development Area where the Onshore Converter Station infrastructure (including the haul roads, Temporary Construction Compounds and associated cable routeing) would be located.
Ordinary watercourses	Rivers which are not Main Rivers are called 'ordinary watercourses'. Lead local flood authorities, district councils and internal drainage boards carry out flood risk management work on ordinary watercourses.
Principal Contractor	A contractor appointed under Regulation 5(1) (b) of the Construction (Design and Management) Regulations 2015. They have control over the construction phase of a project with several contractors.

Term	Definition
Project Change Request 2	The changes to the DCO application for the Projects set out in Project Change Request 2 - Onshore Substation Zone [AS-152] which was accepted into Examination on 21st January 2025.
Surface water flooding	Surface water flooding occurs when rainwater does not drain away through normal drainage systems or soak into the ground but lies on or flows over the ground instead.
Sustainable Drainage Systems (SuDS)	A natural approach to managing drainage in and around properties and other developments. SuDS work by slowing and holding back the water that runs off from a site.
The Projects	DBS East and DBS West (collectively referred to as the Dogger Bank South Offshore Wind Farms).
Transition Joint Bay (TJB)	The Transition Joint Bay (TJB) is an underground structure at the landfall that houses the joints between the Offshore Export Cables and the Onshore Export Cables.

Acronyms

Term	Definition
CIRIA	Construction Industry Research and Information Association
DCO	Development Consent Order
ERYC	East Riding of Yorkshire Council
ha	Hectare
IDB	Internal Drainage Boards
LIDAR	Light detection and ranging
LLFA	Lead Local Flood Authority
OCoCP	Outline Code of Construction Practice
OWC	Ordinary Watercourse Consent
RHDHV	Royal HaskoningDHV
SuDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan
UK	United Kingdom
WA	Wardell Armstrong

1 Outline Drainage Strategy

1.1 Introduction

1. RWE Renewables UK Dogger Bank South (East) Limited and RWE Renewables UK Dogger Bank South (West) Limited are proposing construction of two Offshore Wind Farm projects off the East Riding of Yorkshire (EYRC) coast of the United Kingdom (UK) (herein referred to as the Projects).

2. This report gives details of the outline drainage strategy for the Onshore Converter Station(s) and the pre and post construction land drainage, located within the Onshore Development Area. This strategy will form the basis of the detailed drainage plans which would be submitted to the Lead Local Flood Authority (LLFA) at the ERYC for approval prior to the commencement of construction of the Projects, in consultation with the Environment Agency, Internal Drainage Boards (IDB) and the relevant sewerage and drainage authorities.

3. As detailed in **Volume 7, Chapter 1 Introduction (application ref: 7.1)**, the Outline Drainage Strategy has been updated to incorporate the changes to the Projects Design Parameters resulting from the **Project Change Request 2 – Onshore Substation Zone (document reference 10.53)**, and the incorporation of any associated responses, clarifications and corrections provided on the Outline Drainage Strategy throughout the Examination process.

4. Outline pre and post construction land drainage proposals are set out in section 1.2 of this report.

5. The outline operational drainage strategy for the Onshore Converter Station(s) was prepared by Wardell Armstrong (WA) and is included in section 1.5 of this report and shown on the Drawings, located in **Appendix A**. It incorporates the principles of Sustainable Drainage Systems (SuDS) to manage surface water run-off from hardstanding areas at the and demonstrates that existing surface water flows can be managed appropriately on site. Where appropriate, these assessments have been carried out in accordance with relevant national and EYRC's guidance, as referenced in section 1.5 of this report.

6. The outline drainage strategy and calculations in this report are preliminary and indicative only. They may be subject to change post Development Consent Order (DCO) consent, as more information becomes available, and the detailed design is developed. These assessments are based on readily available data and our assessment of site topography, historical drainage patterns, available flood information and available service records.

1.2 Pre and Post-Construction Land Drainage

7. The Projects have commissioned a detailed drainage survey to establish the existing land drainage baseline environment. To fully understand the drainage a suitably qualified land drainage expert with experience of working in the local area has been enlisted to carry out the baseline surveys and to consult with landowners. They would also ensure local, site-specific, and landowner knowledge is effectively captured prior to construction commencing.

8. A detailed pre and post construction land drainage scheme would be developed prior to construction, based on the detailed drainage survey. The drainage scheme would be developed in consultation with landowners, the LLFA at ERYC, the Environment Agency and relevant IDB(s).

9. Where the Projects intercepts land drainage, pre-construction drainage would be installed at the edge(s) of the Onshore Export Cable Corridor. This permanent drainage would intercept existing field drains and ensure the integrity of the existing land drainage is maintained during construction and operation of the Projects. All drains and outfalls would be risk assessed and appropriate control measures used prior to discharge into any watercourses at a controlled rate. Temporary attenuation / storage would be provided, where necessary.

10. At the Onshore Converter Station(s), located within the Onshore Substation Zone a construction drainage system would also be implemented at the beginning of the construction phase. This would cover the drainage requirements for both the temporary and permanent working areas and ensure any land drainage has suitable pollution prevention measures implemented, including filter trenches and fuel interceptors.

11. Where necessary post construction (restoration) drains may also be installed in consultation with landowners, the Environment Agency, LLFA (ERYC) and IDB, as appropriate to aid soil structural restoration and ensure that existing land drainage is reinstated and maintained to at least pre-development land drainage capacity throughout the operation of the Projects. As described above, this would be informed by the detailed drainage survey and utilise existing outfalls, wherever possible.

12. The discharge points for the pre and post-construction land drainage will be identified at the detailed design stage and shall be agreed with the landowner and relevant drainage authority e.g. IDB or LLFA. They would be located within the Order Limits, wherever possible.

13. If a location falls outside the Order Limits because there is an optimal location within the same field, identified through consultation and voluntary agreement with the landowner, or upgrade or repair is required due to re-routed flow, a separate consent would be required with the relevant drainage authority. As stated in **Other Consents and Licenses (Volume 8, application ref: 8.3)** an Environmental Permit for water discharge would be agreed with the Environment Agency. If the discharge was into an ordinary water course an '*ordinary water course consent*' from the IDB or LLFA would be required. Any discharge location, outside of the Order Limits would only be developed if a voluntary agreement with a landowner was likely to be obtained, because the outfall location would have a beneficial impact on the land drainage system on their land, located adjacent to the Order Limits. The Applicants would prepare a consenting strategy identifying any further consents and licences that may be required through consultation with the relevant stakeholders e.g. the ERYC, LLFA, Environment Agency or IDB. Locations outside of the Order Limits would only be proposed if they were advantageous to the overall drainage of a field affected by the Projects, voluntary agreement with the landowner was obtained and there were no significant environmental constraints identified. As a responsible developer the Applicants fully understand, they do not have the ability to undertake any works outside the Order Limits without the relevant consents in place and if they cannot be obtained, the Applicants are confident that a drainage solution could be delivered within the Order Limits if landowner, or any other identified consent was not forthcoming.

14. Land Drainage Consultancy (LDC), the Applicants' specialist land drainage contractor, have provided further details on a 'typical' land drainage system for the Projects to demonstrate how it could fit within the Projects' Order Limits in **Appendix B**. This design is indicative but based on the ongoing work with landowners to develop a conceptual drainage design and includes an indicative cross section.

1.2.1 Land Drainage – Operation and Maintenance

15. Any pre and post construction drainage installed as part of the Projects would be maintained and repaired by the Offshore Transmission Operator (OFTO), who will own and operate the Projects' Onshore Export Cables, following completion of all construction and reinstatement works by the Contractor. However, any existing drainage, not impacted by the Projects Drainage Scheme, inside or outside the Easement strip, would be the responsibility of the relevant landowner.

16. During operation the OFTO will periodically inspect the installed cables, should a landowner report any issues with the installed land drainage that may be affecting their land they could be reported directly to the OFTO via the ALO if the Project is still in the construction or decommissioning phase.

17. Should a landowner wish to install any further drainage above the cable ducts the **Volume 3,Draft DCO (application ref: 3.1)** includes a restrictive covenant to "*prevent anything to be done by way of excavation of any kind in the land nor any activities which would alter, increase or decrease ground cover or soil levels in any manner whatsoever without the consent in writing of the undertaker save as are reasonably required for agricultural activities*". This would include any drainage works deeper than 0.6 to 0.9m being subject to consent (depending on their individual agreement), but this would not prevent any landowner from undertaking remedial drainage works outside the Easement Strip(s) (2x12m) on land not restricted by the DCO.

1.3 Surface Water Management Plan

18. In addition to the pre and post construction land drainage scheme, described in section 1.2 a Surface Water Management Plan, setting out the requirements for temporary surface water drainage during construction would also be prepared by the Contractor. This would be approved under DCO Requirement 19 upon appointment of a Principal Contractor(s). The **Outline Code of Construction Practice (OCoCP) (Volume 8, application ref: 8.9)** provides further detail on the scope of the Surface Water Management Plan during construction in section 6.3.2.4.

19. The Principal Contractor(s) would also be required to prepare an Emergency Response, Evacuation and Pollution Control Plan. This would include flood risk and evacuation procedures for those areas of the Onshore Development Area, located within Flood Risk Zone 2 and 3, as detailed in **Volume 7, Appendix 20-4 Flood Risk Assessment (application ref: 7.20.20.4**).

20. The Surface Water Management Plan and Emergency Response, Evacuation and Pollution Control Plan would also be agreed with the relevant authority as stated in the **Outline Code of Construction Practice (OCoCP) (Volume 8, application ref: 8.9)**. Temporary surface water drainage would be used, where necessary in combination with the pre-construction drains to ensure there is no increase in flood risk.

21. The **Volume 7, Appendix 5-2 Obstacle Crossing Register (application ref: 7.5.5.2)**, identifies where the Projects cross watercourses and minor ditches, existing field drainage may be severed. At these locations, flow would be maintained to ensure there is no increase in flood risk. The temporary crossing methodology would be agreed with the relevant authority Environment Agency, LLFA and / or IDB, and in consultation with landowners, where necessary. Water Crossings are also described in **Volume 7, Chapter 5 Project Description (application ref: 7.5)**.

1.4 Foul Water Drainage

22. Requirement 17 of the **Volume 3, Draft DCO (application ref: 3.1)** requires details of any foul water drainage system required during construction or operation to be submitted to and approved by the lead local flood authority, through consultation with the Environment Agency and relevant sewerage and drainage authorities. The exact details of any construction and operational welfare areas associated with the Onshore Converter Station(s) are still to be determined. However, given the nature of the development, foul flows are likely to be minimal. It is anticipated that any foul water flows from the site will drain to a septic tank and be tankered away or drain to a package treatment plant prior to discharge to a nearby watercourse.

23. Additional treatment may be required at the package treatment plant depending on the relevant drainage and sewerage authority requirements. Design sizing and requirements will be determined at detailed design stage but it is considered that these features would be either accommodated within the permanent Onshore Converter Station footprints or be small scale and able to be incorporated within Order Limits immediately adjacent to the permanent Onshore Converter Station footprints. The foul drainage would be designed and situated appropriately in relation to the other SuDS features and final design agreed with the relevant drainage and sewerage authorities in consultation with LLFA and the Environment Agency as identified within Requirement 17 of the **Volume 3, Draft DCO (application ref: 3.1)**.

1.5 Onshore Converter Station Outline Operational Drainage Strategy

1.5.1 Site Description and Location

24. **Table 1-1** (below) provides a summary of the site and its characteristics.

Table 1-1 Site Location Summary

Site Location Summary	
Site Address	Substation Zone, Beverley Bypass, Bentley, Walkington, East, HU17 8PG
Site Area (hectare [ha])	Approximately 58ha
National Grid Reference	501915E, 436707N
Existing Land Use	Greenfield / Agriculture
Proposed Land Use	Onshore Converter Station and associated landscaping
Local Planning Authority	East Riding of Yorkshire Council
Sewer Undertaker	Yorkshire Water
Environment Authority/Agency	Environment Agency
Lead Local Flood Authority (LLFA)	East Riding of Yorkshire Council

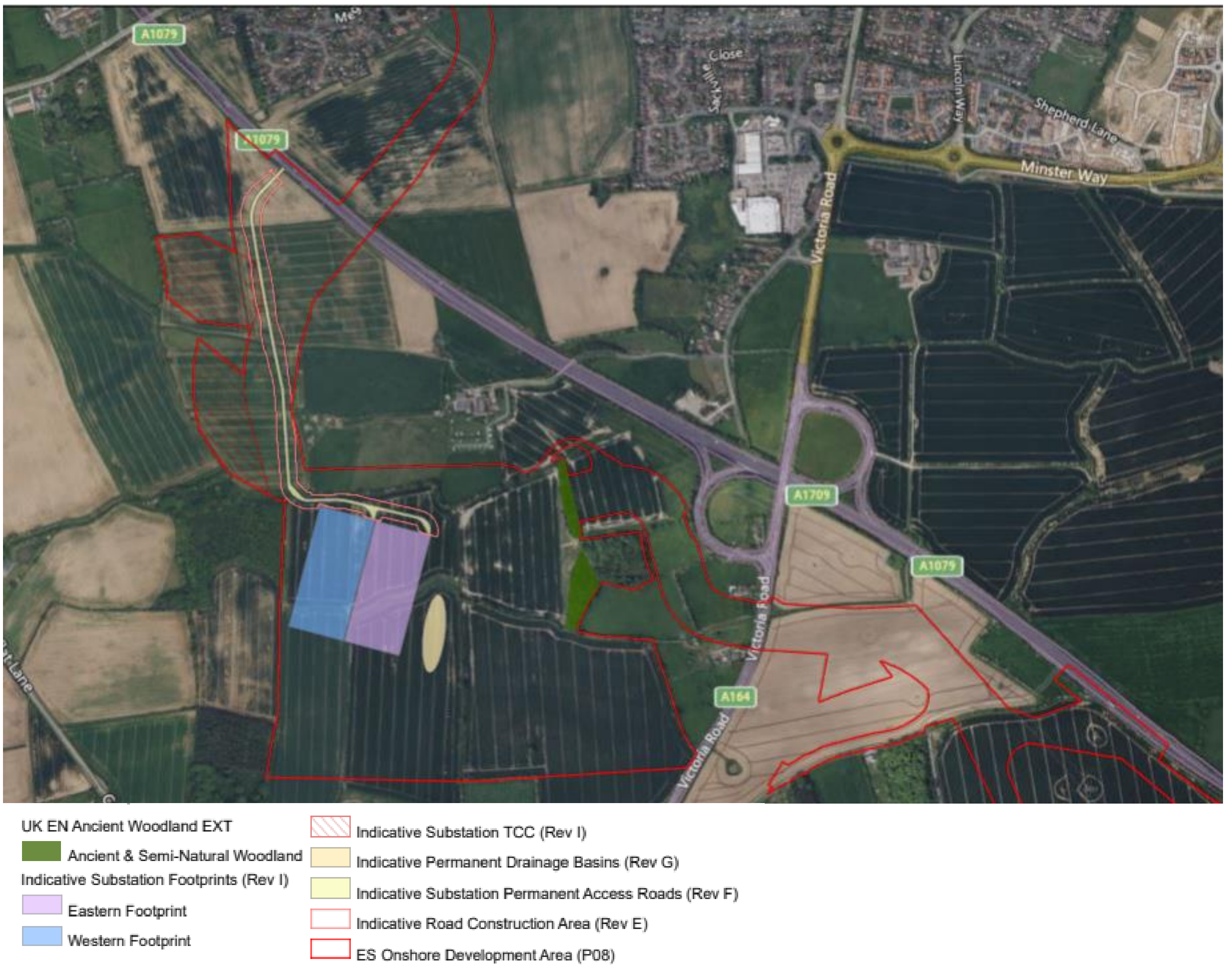
25. The Onshore Substation Zone, within which up to two Onshore Converter Station(s) will be constructed is located on agricultural land approximately 0.75km south west of the town of Beverley in EYRC. The site lies to the south of the A1079 Beverley Bypass, to the west of the A164 road, to the east of Coppleflat Lane and to the north of the hamlet of Beverley, as shown on **Plate 1-1**.

26. Butt Farm Caravan and Camping Site lies to the north of the site boundary, with Bentley Moor Wood to the east and agricultural land to the south and west.

27. An area of ancient woodland is located within the site boundary, just to the east of the proposed location for the Onshore Converter Station(s). Details of the trees within the Onshore Development Area and those which would be impacted by the Projects are included in **Arboricultural Survey Report and Preliminary Arboricultural Impact Assessment (document reference 10.13)**.

28. Permanent access to the site is proposed from the A1079 Beverley Bypass to the north as shown on drawing ED13554-GE-1122 Indicative Substation General Arrangement, located in **Appendix A**.

Plate 1-1 Site Location Plan



1.5.2 Existing Drainage Regime

29. The site is undeveloped agricultural land with an unnamed watercourse / ditch (Watercourse 1 – see **Plate 1-2** below) that passes through the middle of the site, discharging to the east, and passing below the A164 road.

30. Another unnamed watercourse / ditch (Watercourse 2 – see **Plate 1-2** below) crosses the site just north of the proposed Onshore Converter Station location, discharging to the north east and passing below the A1079 Beverley Bypass.

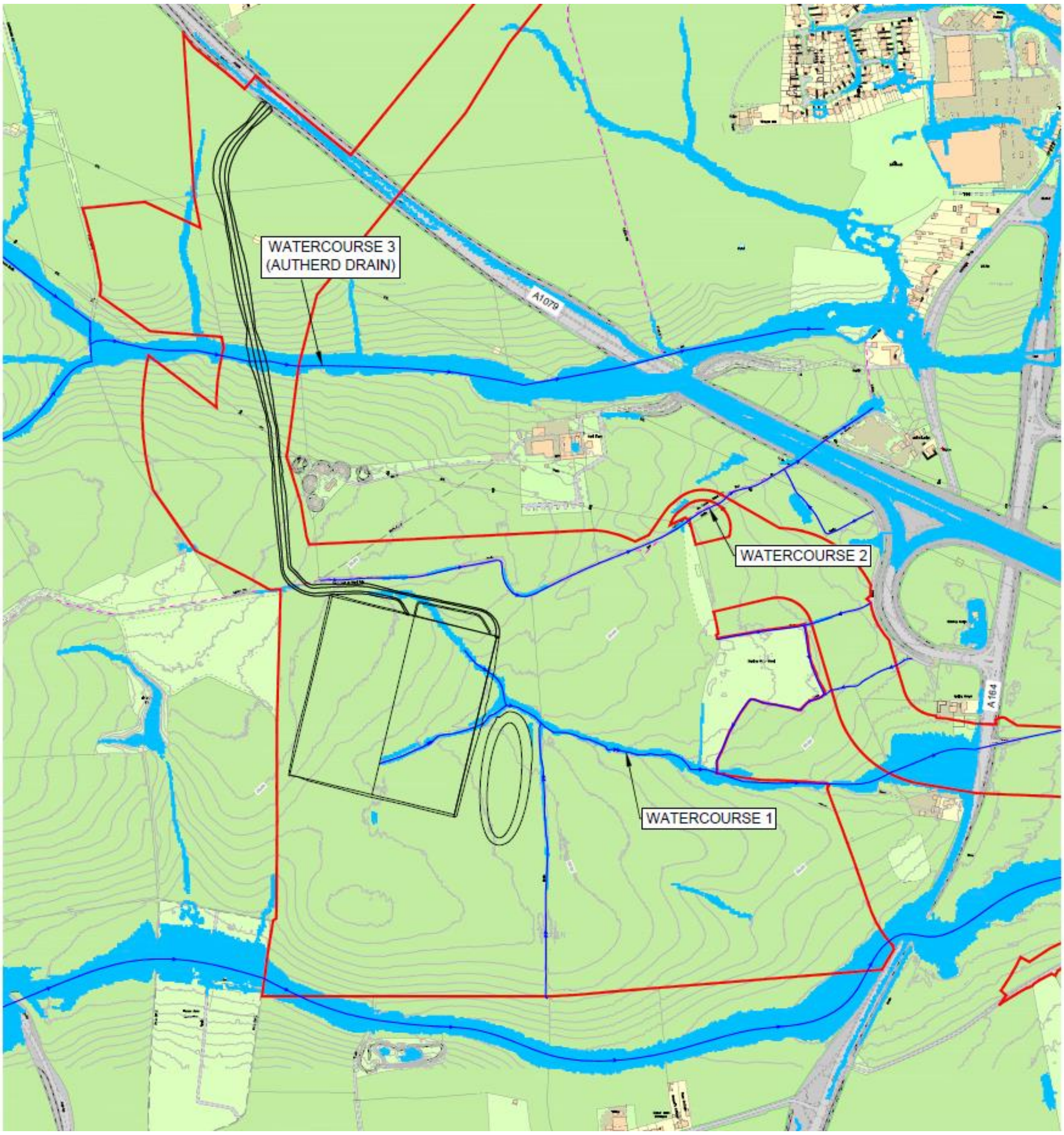
31. To the north of the site, perpendicular to the route of the proposed permanent access, the "Autherd Drain" (Watercourse 3 – see **Plate 1-2** below) crosses the site boundary, discharging to the east and passing below the A1079.

32. All watercourses referenced are classified as ordinary watercourses and not Main Rivers.

33. Light detection and ranging (LIDAR) data obtained for the area shows the topography of the site tending towards these watercourses / ditches, which indicates these are the natural drainage paths for the site.

34. **Plate 1-2** shows the indicative pre-development drainage and overland flow paths, a more detailed drawing can be viewed in **Appendix A** of this report.

Plate 1-2 Existing Watercourses



1.5.3 Onshore Converter Station(s) Development Proposals

35. It is proposed to construct an engineered platform (indicative Onshore Converter Station footprints on **Plate 1-1**) of up to 244m x 264m to support the Onshore Converter Station(s) for the Projects. The platform is to be located in the west of the Onshore Substation Zone as described in section 1.5.1 of this report.

36. A permanent access road running north to south from the A1079 Beverley Bypass is proposed to service the Onshore Converter Station(s) for the operational life of the Projects.

37. Drawing ED13554-GE-1129 showing the indicative Converter Station general arrangement can be viewed in **Appendix A** of this report.

1.5.4 Onshore Converter Station(s) Flood Risk Assessment

38. To inform the development of the surface water drainage design for the Projects the flood risk both to and from the Onshore Converter Station(s) is outlined below, specifically in relation to any potential surface water / overland flow flood risk.

39. A detailed Flood Risk Assessment (**Volume 7, Appendix 20-4 Flood Risk Assessment (application ref: 7.20.20.4)**) has been undertaken by Royal HaskoningDHV (RHDHV) to accompany the DCO application, which provides further information on all sources of flood risk.

1.5.4.1 Flood Risk to the Development

40. In accordance with the National Planning Policy Framework (Department for Levelling Up, Housing & Communities, 2023) and the accompanying Planning Practice Guidance for Flood Risk and Coastal Change (Department for Levelling Up, Housing & Communities, 2022), the main potential sources of flooding requiring consideration are from rivers, tidal waters, high land/overland runoff, high water tables, sewers, and drains, and from other artificial sources such as canals or reservoirs.

41. The nearest potential sources of fluvial (river) flooding are Watercourses 1 – 3 as described in section 1.5.2 of this report. Pluvial (surface water) flooding could occur where overland flows tend to drain towards the proposed Onshore Converter Station platform and access road. All watercourses referenced are classified as ordinary watercourses and not Main Rivers and the site is located in Flood Zone 1 which confirms it is on land with a low probability of flooding from rivers and the sea.

42. Watercourse 1 formally starts from a location which would be below the proposed Onshore Converter Station platforms and discharges east. Nearby topography tends towards this watercourse however, it is proposed to mitigate any flood risk from this watercourse (and any overland flows) by installing cut-off drains at the platform perimeter, diverting overland flows around the Onshore Converter Station(s) and back into the watercourse further east. Cut off drains will be designed to mimic existing overland flows. The exact design and depth of these cut off drains will be determined at detailed design stage to ensure the Onshore Converter Station platforms are adequately protected from overland flows or springs. Any re-direction of existing ordinary watercourses will be subject to Ordinary Watercourse Consent (OWC).

43. Watercourse 2 crosses the site just north of the proposed Onshore Converter Station platforms, discharging west to east. The watercourse is described as a ditch / drain, is outside the footprint of the platform and a review of the Environment Agency flood maps indicates there is minimal surface water flooding associated with this watercourse. The watercourse passes below the route of the permanent access road and a suitably sized culvert will be provided to maintain existing flows. The exact design and size of any culverts will be determined at detailed design stage and agreed with the relevant authority.

44. The “Autherd Drain” (Watercourse 3) crosses the route of the permanent access road at a location to the north of the site. The watercourse is at a location and level (approximately 5m below proposed platform levels) that poses no risk to the site. Where the watercourse passes below the route of the permanent access road, a suitably sized culvert will be provided to maintain existing flows. The exact design and size of any culverts will be determined at detailed design stage.

1.5.4.2 Flood Risk - as a result of the Projects

45. The development will incorporate a SuDS. As such, surface water run-off from any hardstanding areas associated with the development will be collected, treated, attenuated, and discharged to the nearby watercourses at the greenfield run-off rate, unless otherwise agreed with the relevant Drainage Authority at the detailed design stage in relation to an identified blockage risk. The Applicants have agreed that either a discharge rate calculated on the greenfield run off rate of 1.4l/s/ha would be applied or, a minimum discharge rate of 1litre per second would be applied to prevent blockages. The ERYC as the LLFA and the Drainage Board do not consider the minimum discharge rate of 1litre per second would increase food risk.

46. Typically, increasing very low discharge rates to 1l/s (the minimum specified by the Beverley and North Holderness Internal Drainage Board (BNH IDB)), which is a very low rate, would have no impact during more extreme storm events (for example the 1:30-year and 1:100-year events). This is because the run-off from these events is proposed to be restricted to a discharge rate lesser than the equivalent greenfield run-off rate for these storm events (e.g. the 1:100-year event is limited to the greenfield (pre-development) 1:1-year run-off rate, not the 1:100- year run-off rate). Increasing discharge rates to 1 l/s would result in a minor increase in flows to the receiving watercourse(s) during the 1:1-year and 1:2-year storm events but any increase in flood risk is expected to be low, and considerably lower than the risk of overflow from regular blockages. Proposals will be discussed and agreed fully with all relevant parties throughout the detailed design and approval stages to ensure flood risk is managed appropriately and effectively. Therefore, the development will not increase any flood risk downstream.

1.5.4.3 Onshore Converter Station(s) Flood Risk Management

47. As noted in the previous section, there is the potential for surface water run-off - due to an increase in hardstanding - to result in an increase in flood risk. As such, the management of flood risk to the development is outlined below.

48. A detailed Flood Risk Assessment (**Volume 7, Appendix 20-4 Flood Risk Assessment (application ref: 7.20.20.4)**) has been undertaken, this includes further details on flood risk and associated management measures.

1.5.4.4 Onshore Converter Station Surface Water Management

49. Surface water run-off from surrounding areas where topography tends towards the Onshore Converter Station platform, will be diverted as summarised in section 1.5.4.1 of this report.

50. Surface water run-off from surrounding areas, tending towards the permanent access road will be diverted as summarised in section 1.5.4.1 of this report.

51. Surface water run-off from any hardstanding areas associated with the development will be managed as summarised in section 1.5.4.2 and discussed in further detail in section 1.5.6 of this report.

1.5.4.5 Floodplain Storage

52. The existing and proposed access roads are located outside any predicted fluvial floodplain areas and will be positively drained. Therefore, requirements for safe access and egress are met, and no further mitigation measures are required.

1.5.4.6 Residual Risk

53. For storm events greater than a 1:100-year event (plus climate change), an additional sensitivity check for a subsequent 1:10-year storm event (plus climate change - within 24 hours) has been undertaken for the SuDS design of the proposed Onshore Converter Station platform.

54. For storm events up to and including a 1:1,000-year event (plus climate change), a sensitivity check has been undertaken for the SuDS design for the proposed Onshore Converter Station platform(s).

55. See section 1.5.7 for more details.

1.5.5 Onshore Converter Station(s) SuDS Requirements

56. National Planning Policy Framework (Department for Levelling Up, Housing & Communities, 2023) and the accompanying Planning Practice Guidance for Flood Risk and Costal Change (Department for Levelling Up, Housing & Communities, 2022) enquires that all major developments incorporate SuDS unless there is clear evidence that this would be inappropriate. Overarching National Policy Statement for Energy (EN-1) (Department for Energy Security & Net Zero) also sets out that the Secretary of State, in their decision making, should be satisfied that SuDS are incorporated in line with the above.

57. EYRC's Combined Planning Note and Standing Advice on SuDS & Surface Water Drainage Requirements for New Development (2016) provides guidance on the design and maintenance of SuDS schemes for new developments.

58. The Construction Industry Research and Information Association (CIRIA) SuDS Manual C753 (CIRIA, 2015) provides best practice guidance for the design and implementation of SuDS components.

59. Based on the above noted guidance, it is considered that SuDS are required for the type, size and location of this development and therefore have been incorporated in this outline operational drainage strategy.

60. The detailed SuDS design approach will be landscape-led, as set out in the **Outline Landscape Management Plan (Volume 8, application ref: 8.11)**. This would be beneficial for both the landscape design and biodiversity. Landscape professionals will work collaboratively with the SuDS engineers to produce a design which maximises landscape benefits and meets the requirements of the drainage design for the surface water run-off from the proposed Onshore Converter Station(s), set out in section 1.5.7 of this report.

61. Although the SuDs design set out in section 1.5.7 and shown on drawing ED13554-GE-1100, in Appendix A of this report shows a single and uniformly shaped pond, it is the Applicants intention that this would be designed into a number of smaller more naturalistic swales or ponds which will be agreed with the East Riding of Yorkshire Council (ERYC) as part of the drainage design and landscape management plan, at the detailed design stage as secured by Requirements 10 and 16 of the **Volume 3, Draft DCO (application ref: 3.1)**. An illustrative and indicative example of a SuDS design is included in the **Design and Access Statement (Volume 8, application ref: 8.8)**.

1.5.5.1 SuDS Treatment Train

62. The SuDS treatment train is a logical sequence for implementing SuDS, and is based on the following principles:

- Prevention
- Source Control
- Site Control
- Regional Control

63. For the purposes of this outline drainage strategy, a combination of source control and site control has been selected for the development. This will be reviewed at detailed design stage, post DCO consent.

1.5.5.2 SuDS Discharge Hierarchy

64. The SuDS discharge hierarchy describes the priority for selecting a method of surface water discharge, and is based on the following sequence:

- Priority 1 - Surface water runoff is collected for re-use.
- Priority 2 - Surface water runoff is infiltrated to ground.
- Priority 3 - Surface water runoff is discharged to a surface water body.
- Priority 4 - Surface water runoff is discharged to a surface water sewer, highway drain, or another drainage system.

- Priority 5 - Surface water runoff is discharged to a combined sewer.

65. Priority 1 – due to the nature of the Projects, there is likely to be a limited opportunity for the re-use of surface water, however this will be reviewed at detailed design stage.

66. Priority 2 – Site investigation and infiltration tests for the site have been undertaken and identify a soil infiltration rate of $8.84x10^{-8}$m/s, the results are included in **Appendix D**. Infiltration rates less than $1x10^{-6}$m/s are considered unsuitable for disposal of surface water to ground via infiltration. These results are considered representative of the firm to stiff cohesive deposits that were encountered across the Onshore Converter Station Zone within the site investigation.

67. Priority 3 – As described in section 1.5.2 of this report, there are three watercourses crossing the site. As such, these have been identified as the primary points of discharge for the disposal of surface water. Site checks have been completed on these watercourses post submission by Land Drainage Consultancy (LDC) when undertaking work to review existing land drainage at the Substation Zone. Watercourse 1 is recorded as being 1.8m deep to the base of the ditch which is 3m wide at surface and 1m wide at the base. Watercourse 2 is recorded as 1.3m deep to the base of the ditch which is 3.5m wide at surface and 0.5m wide at base. Watercourse 3 is recorded as 1.3m to the base of the ditch which is 3.5m wide at surface and 0.7m wide at base. These existing drainage ditches take all current drainage for the area and discharge from the site will be restricted to greenfield run-off rates, unless otherwise agreed with the relevant Drainage Authority at the detailed design stage in relation to an identified blockage risk. The Applicants have agreed that either discharge rate calculated on the worst case greenfield run off rate of 1.4l/s/ha would be applied or, a minimum discharge rate of 1litre per second would be applied to prevent blockages. The watercourses are therefore deemed suitable for a point discharge via a simple headwall, i.e. a pipe exiting into the ditch with a concrete headwall with discharge rates restricted to greenfield run-off rates or, the minimum discharge rate of 1 litre per second

68. Priority 4 – There are no surface water sewers identified near the site. Highway drains for the A1079 / A164 may present an opportunity for discharge of surface water but other options above take priority for the discharge of surface water from the Projects.

69. Priority 5 – There are no combined sewers near the site and the options above take priority for the discharge of surface water from the Projects.

70. Therefore, based on the site conditions and the currently available information, the adopted method of surface water discharge has been selected as high up the SuDS Hierarchy as possible.

1.5.5.3 SuDS Water Quality Criteria

71. SuDS guidance requires that treatment is provided to surface water run-off to ensure preventative measures are in place to mitigate any negative impacts to the water quality of the receiving water bodies and/or downstream drainage systems.

72. A SuDS management train will be developed to ensure surface water run-off from specific areas on site is dealt with appropriately by removing the causes of pollution and intercepting and treating run-off.

73. The extent of treatment required depends on the land use proposed however SuDS components such as swales, filter drains, and pervious surfaces could be used to intercept and treat access roads and other hardstanding areas. Additional measures such as petrol / oil interceptors may also be required in areas at risk of leaks and spills.

74. The SuDS management train will be developed during the detailed design stage to ensure the water quality criteria for SuDS are met.

1.5.6 Surface Water Drainage Outline Strategy

75. Based on the SuDS treatment train and SuDS discharge hierarchy, it is anticipated that surface water run-off from the proposed Onshore Converter Station(s) will be collected by perimeter drains and attenuated within an adjacent SuDS (detention) basin (site control), prior to discharge to the nearby watercourse (Watercourse 1). Additional SuDS components will be incorporated as necessary (source control) – to comply with water quality criteria. This will be reviewed at the detailed design stage. Preliminary design of the SuDS (detention) basin is outlined in section 1.5.7 below.

The proposed SuDS (detention) basin is located immediately to the east of the Onshore Converter station footprints, to the south of Watercourse 1 and west of minor connecting drainage ditch. The position and shape of the basin will be reviewed at the detailed stage. . As detailed in section 1.5.5 the SuDs design will be a landscape-led approach considering biodiversity and existing woodland, wherever possible. Although a single basin has been designed it is the intention of the Applicants that this would be designed into a number of smaller more naturalistic swales or ponds which will be agreed with the East Riding of Yorkshire Council (ERYC) as part of the drainage design and landscape management plan, at the detailed design stage as secured by Requirements 10 and 16 of the **Volume 3, Draft DCO (application ref: 3.1)**. An illustrative and indicative example of a SuDS design is included in the **Design and Access Statement (Volume 8, application ref: 8.8)**.

76. Surface water run-off from the proposed access road will be collected and attenuated in filter trenches adjacent to the road (source control) prior to discharge to Watercourses 1, 2 & 3. Drainage from each section of the road will be directed to discharge into the relevant watercourse as per existing topography and overland site flows. Discharge into these watercourses would be at greenfield run off rates, unless otherwise agreed with the relevant Drainage Authority at the detailed design stage in relation to an identified blockage risk. The Applicants have agreed that either a run off rate calculated on the greenfield run off rate of 1.4l/s/ha would be applied or, a minimum discharge rate of 1litre per second would be applied to prevent blockages. Therefore there will be no alteration of the hydrology of the three watercourses identified at this location. Filter trenches are subject to detailed design and may incorporate additional SuDS components as necessary – to be reviewed at detailed design stage.

77. Surface water run-off from topography tending towards the proposed location of the Onshore Converter Station platforms shall be redirected by installing cut-off drains / ditches at the platform perimeter, thus diverting overland flows around the Onshore Converter Station(s) and back into Watercourse 1 immediately to the east of the proposed development. Cut off drains / ditches will be designed at detailed design stage to mimic existing overland flows. Any re-direction of existing ordinary watercourses will be subject to agreement with the relevant drainage authority under their protective provisions included in Part 4 of the **Volume 3, Draft DCO (application ref: 3.1)** and through agreement of the operational drainage strategy at the detailed design stage.

78. Where watercourses are crossed by the proposed access road, culverts will be installed to maintain existing flow paths. Culverts will be designed at detailed design stage to mimic existing overland flows.

79. Drawing ED13554-GE-1100 showing the indicative Onshore Converter Station platform and SuDS engineering layout, located in **Appendix A** of this report.

1.5.7 SuDS (Detention) Basin Indicative Design

80. ERYC's Combined Planning Note and Standing Advice on SuDS & Surface Water Drainage Requirements for New Development (2016) provides guidance on the design and maintenance of SuDS schemes for new developments.

81. Preliminary drainage calculations (including greenfield run-off estimates, Micro Drainage calculations and a SuDS Design Summary and Assumptions spreadsheet) have been provided in **Appendix C** of this report.

82. To comply with ERYC's minimum design requirements, and to cater for a "worst case" scenario, the following design parameters have been adopted:

- *Hardstanding areas: Onshore Converter Station footprints are assumed to be 100% hardstanding – worst case design. The designed top area of the SuDS basin is also included in the design. It is envisaged that the final converter station layout will have a mixture of permeable and impermeable surfaces with this to be confirmed at detailed design stage. The drainage calculations and SuDS design would be updated to reflect the final design proposals at the detailed design stage.*
- *Greenfield run-off rate: Restricted to the 1:1-year rainfall event (ERYC guidance: Section 3(b)) up to the selected design storm event (see below). Greenfield run-off rates have been calculated using several methods - including the 1.4 l/s/ha rate (in accordance with IDB guidance), and the IH124 and FEH methods (using the HR Wallingford Online Tool) - and the lowest (worst case) rate selected. The preliminary worst case 1:1-year greenfield run-off rate has been calculated as approximately 9.16 l/s. Low discharge rates may cause a blockage risk and suitable discharge rates are to be agreed with the relevant parties at detailed design stage. The blockage risk will be fully assessed at detailed design stage and minimum orifice sizes / discharge rates / mitigation measures to be agreed with the Local Authority at this time. A minimum discharge rate of 1 litre per second will be applied to avoid blockage.*

- *<u>Design storm event</u>: Designed to cater for up to the 1:100-year storm event (ERYC guidance: Section 3(c) & (d)). FEH13 rainfall figures have been used within the design.*
- *<u>Climate change allowance</u>: ERYC guidance: Section 7(a)) requires a minimum 30% increase in peak rainfall in hydraulic calculations for climate change. A 40% increase has been adopted in line with the upper end allowances (up to the 2070s) from GOV.uk / Environment Agency guidance (Department for Environment Food & Rural Affairs – Climate Change Allowances Maps).*
- *<u>Design depth</u>: A maximum design depth of 1m has been adopted up to the design storm event as a worst case scenario for estimating the SuDS basin footprint. An overall construction depth of 1.5m has been adopted for the SuDS basin to allow 0.5m freeboard within the design.*
- *<u>Sensitivity checks</u>: Additional sensitivity checks have been undertaken to assess the impact of the 1:1,000-year storm event (+40% climate change) and the impact of a 1:10 year storm event (+40% climate change) occurring within 24 hours of the design storm event (1:100-year storm event +40% climate change).*

83. Preliminary Micro Drainage calculations, using the above parameters, have confirmed the total storage required for the 1:100-year design event (+40% climate change) – with a design depth of 1m – is approximately 6,942.5m^3.

84. Sensitivity checks confirm there is also sufficient freeboard within the overall 1.5m construction depth of the SuDS (detention) basin to cater for the 1:1,000 year (+40% climate change).

85. Furthermore, the sensitivity checks also confirm there is sufficient freeboard within the overall 1.5m construction depth of the SuDS (detention) basin to cater for a 1:10-year (+40% climate change) event within 24 hours of the design event (1:100-year +40% climate change).

86. Based on the above, a SuDS (detention) basin with an overall construction depth of 1.5m and a plan area of approximately 9,780m^2 is sufficient for the design. As detailed in section 1.5.5 the SuDs design will be a landscape-led approach considering biodiversity and existing woodland, wherever possible. An illustrative and indicative example of a SuDS design is included in the **Design and Access Statement (Volume 8, application ref: 8.8)**.

1.5.8 Roadside Filter Trenches Indicative Design

87. The proposed access road has been subdivided into four sections (based on the location, direction of existing topography and the proposed drainage discharge point) as follows:

- North Access Road (Watercourse 3);
- South Access Road (Watercourse 3);
- South Access Road (Watercourse 2); and
- South Access Road (Watercourse 1).

88. Preliminary drainage calculations (including greenfield run-off estimates, Micro Drainage calculations and a SuDS Design Summary and Assumptions spreadsheet) have been provided in **Appendix C** of this report.

89. To comply with ERYC's minimum design requirements, and to cater for a "worst case" scenario, the following design parameters have been adopted:

- *Permanent access road footprint area: Permanent access road footprint areas consider conservative permanent access road width and design presented within drawing ED13554-GE-1100, located in **Appendix A** of this report. The measured areas are as follows*:
  - North Access Road (Watercourse 3) = 7,226m^2
  - South Access Road (Watercourse 3) = 2,929m2
  - South Access Road (Watercourse 2) = 2,433m2
  - South Access Road (Watercourse 1) = 4,709m^2
- *Hardstanding areas: Access road footprints are assumed to be 100% hardstanding – worst case design.*
- *Greenfield run-off rate: Restricted to the 1.4 l/s/ha rate (in accordance with IDB guidance) up to the selected design storm event (see below). Greenfield run-off rates have been calculated using several methods - including the 1:1-year rainfall event (in accordance with ERYC guidance: Section 3(b)), and the IH124 and FEH methods (using the HR Wallingford Online Tool) - and the lowest (worst case) rate selected. The preliminary worst case 1.4 l/s/ha greenfield run-off rate has been calculated approximately as follows*:
  - North Access Road (Watercourse 3) = 1.01 l/s
  - South Access Road (Watercourse 3) = 0.41 l/s
  - South Access Road (Watercourse 2) = 0.34 l/s

- South Access Road (Watercourse 1) = 0.66 l/s

Low discharge rates may cause a blockage risk and suitable discharge rates are to be agreed with the relevant parties at the detailed design stage. A minimum discharge rate of 1 litre per second will be applied to avoid blockage.

- *Design storm event: Designed to cater for up to the 1:100-year storm event (ERYC guidance: Section 3(c) & (d)). FEH13 rainfall figures have been used within the design.*
- *Climate change allowance: ERYC guidance: Section 7(a)) requires a minimum 30% increase in peak rainfall in hydraulic calculations for climate change. A 40% increase has been adopted in line with the upper end allowances (up to the 2070s) from GOV.uk / Environment Agency guidance (Department for Environment Food & Rural Affairs – Climate Change Allowances Maps).*
- *Design depth: Maximum design depths (adopted up to the design storm event) for estimating the filter trench footprints and overall construction depths to allow freeboard within the design are as follows*:
  - North Access Road (Watercourse 3) = 1.5m design depth / 2m overall construction (0.5m freeboard)
  - South Access Road (Watercourse 3) = 1.5m design depth / 2m overall construction (0.5m freeboard)
  - South Access Road (Watercourse 2) = 0.9m design depth / 1.3m overall construction (0.4m freeboard)
  - South Access Road (Watercourse 1) = 1.5m design depth / 2m overall construction (0.5m freeboard)
- *Sensitivity checks: Additional sensitivity checks have been undertaken to assess the impact of the 1:1,000-year storm event (+40% climate change) and the impact of a 1:10 year storm event (+40% climate change) occurring within 24 hours of the design storm event (1:100-year storm event +40% climate change).*

90. Preliminary Micro Drainage calculations, using the above parameters, have confirmed the total storage required for the 1:100-year design event (+40% climate change) – with a design depth of 1.5m – is approximately as follows:

- North Access Road (Watercourse 3) = 321.3m^3
- South Access Road (Watercourse 3) = 134.9m^3
- South Access Road (Watercourse 2) = 102.3m^3

- South Access Road (Watercourse 1) = 218.2m^3

Volumes are estimated based on filter trenches either side of the road, each taking half the hardstanding area and limited to half the greenfield run-off rate. The volumes noted above would be required to both sides of the road. Filter trenches should be stepped to suit road gradients to utilise the available capacity along their entire length.

91. Sensitivity checks confirm there is also sufficient freeboard within the overall 2.0m construction depth of the filter trenches to cater for the 1:1,000 year (+40% climate change).

92. Furthermore, the sensitivity checks also confirm there is sufficient freeboard within the overall 2.0m construction depth of the filter trenches to cater for a 1:10-year (+40% climate change) event within 24 hours of the design event (1:100-year +40% climate change).

93. Based on the above, filter trenches to both sides of the road with overall construction depths set out above and widths as set out below are sufficient for the design.

- North Access Road (Watercourse 3) = 4.8m
- South Access Road (Watercourse 3) = 3.1m
- South Access Road (Watercourse 2) = 4.5m
- South Access Road (Watercourse 1) = 3.3m

94. As detailed in section 1.5.5 the SuDs design will be a landscape-led approach considering biodiversity and existing woodland, wherever possible. An illustrative and indicative example of a SuDS design is included in the **Design and Access Statement (Volume 8, application ref: 8.8)** .

1.5.9 Foul Water Drainage Outline Strategy

95. The exact details of any welfare areas associated with the Onshore Converter Station(s) are still to be determined, however, given the nature of the development, foul flows are likely to be minimal. It is anticipated that any foul water flows from the site will drain to a septic tank and be tankered away or drain to a package treatment plant prior to discharge to a nearby watercourse. Additional treatment may be required at the package treatment plant depending on the relevant drainage and sewerage authority requirements. Design sizing and requirements will be determined at the detailed design stage but it is considered that these features would be either accommodated within the permanent Onshore Converter Station footprints or be small scale and able to be incorporated within Order Limits immediately adjacent to the permanent Onshore Converter Station footprints. The foul drainage would be designed and situated appropriately in relation to the other SuDS features and final design agreed with the relevant drainage and sewerage authorities in consultation with LLFA and the Environment Agency as identified within Requirement 17 of the **Volume 3, Draft DCO (application ref: 3.1)**.

1.5.10 Onshore Converter Station(s) Drainage Future Maintenance

96. Any proposed surface water / foul water drainage systems within the curtilage of the Onshore Development Area will remain the responsibility of the respective asset owner / operator or a factor on their behalf.

97. Regular inspections and maintenance should be carried out following periods of inclement weather and at regular intervals appropriate to each drainage element.

1.6 Conclusion

98. This report gives details of the outline operational drainage strategy for the Onshore Converter Station(s) as prepared in accordance with national and EYRC's guidance.

99. A Pre and Post Construction Land Drainage scheme will be developed to detail works required where the Projects intercepts land drainage during construction. Pre-construction drainage would be installed at the edge(s) of the Onshore Export Cable Corridor.

100. Post construction drainage would be installed following the completions of the works providing restoration of drainage capacity in temporary works areas and aiding soil structural restoration.

101. Existing surface water flows can be managed appropriately on site, and the proposals incorporate the principles of SuDS to manage surface water run-off from hardstanding areas on site. As detailed in section 1.5.5 the detailed SuDs design will be a landscape-led approach considering biodiversity and existing woodland, wherever possible.

102. Although a single basin has been designed it is the intention of the of the Applicants that this would be designed into a number of smaller more naturalistic swales or ponds which will be agreed with the East Riding of Yorkshire Council (ERYC) as part of the drainage design and landscape management plan, at the detailed design stage as secured by Requirements 10 and 16 of the **Volume 3, Draft DCO (application ref: 3.1)**. An illustrative and indicative example of a SuDS design is included in the **Design and Access Statement (Volume 8, application ref: 8.8)**.

103. Cut-off drains / ditches are provided to re-direct overland flows away from the proposed Onshore Converter Station footprint and appropriately sized culverts are to be provided where watercourses are crossed by the proposed access road (to maintain existing flow paths).

104. Sufficient space is available for a SuDS (detention) basin catering for run-off from the Onshore Converter Station platforms (100% hardstanding) up to the 1:100-year design storm (+40% climate change) when discharge is limited to the 1:1-year greenfield run-off rate.

105. Sufficient freeboard is also allowed for within the design to store run-off during the 1:1,000-year storm event (+40% climate change) or a 1:10-year storm event (+40% climate change) occurring within 24 hours of the design storm event (1:100 year + 40% climate change).

106. The proposed outline drainage strategy effectively mitigates the risk of surface water flooding both to and from the development and the incorporation of SuDS techniques will aid in meeting the criteria for water quality.

107. The drainage strategy and calculations outlined in this report are preliminary and indicative only to aid in the development of the outline design. These will be subject to change and refinement as more information becomes available and the detailed design for the site is developed.

References

Construction Industry Research and Information Association (2015), SuDS Manual C753

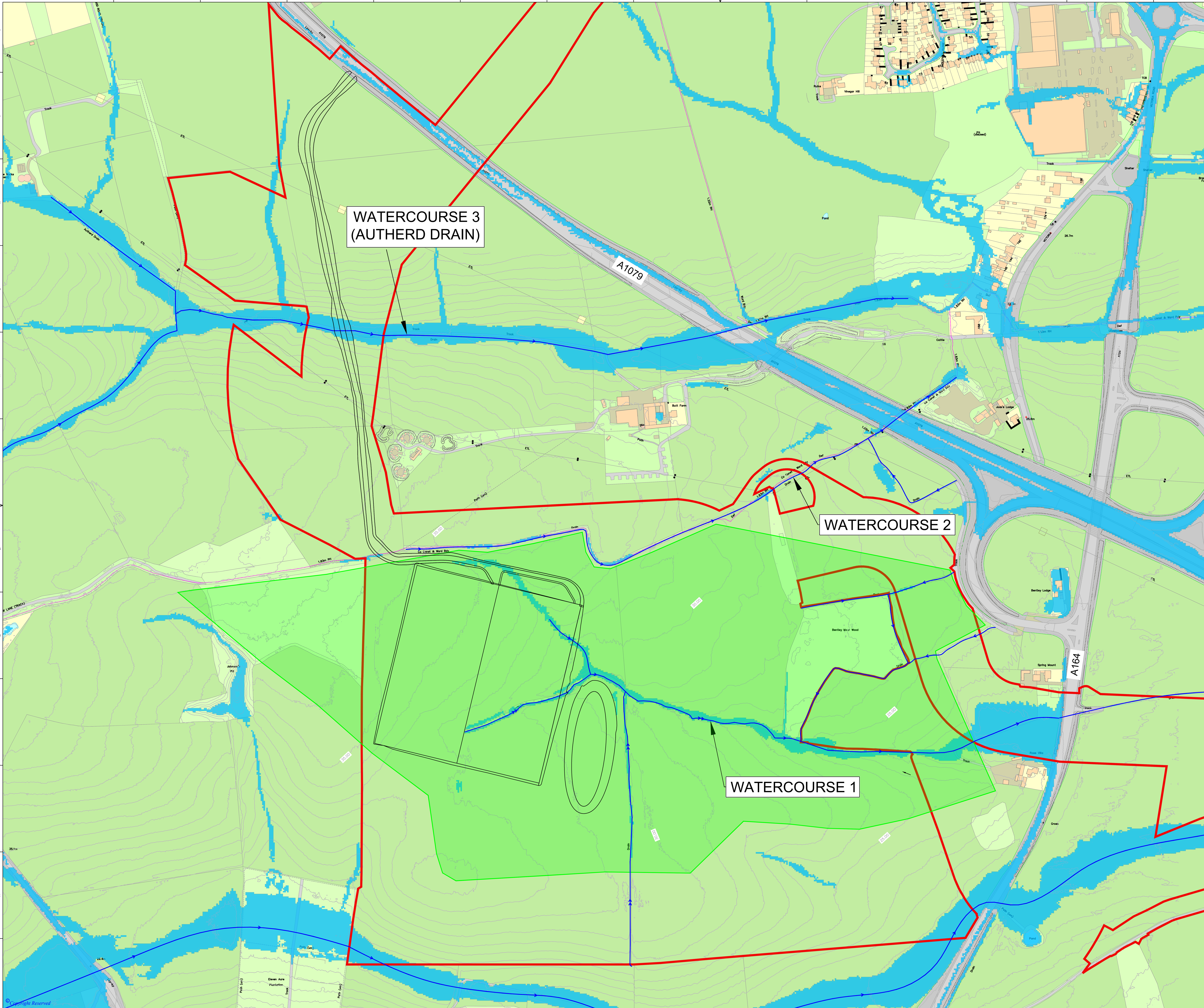
Department for Energy Security and Net Zero (January, 2024), National Policy Statement for Energy (EN-1), https://www.gov.uk/government/publications/overarching-national-policy-statement-for-energy-en-1

Department for Levelling Up, Housing & Communities (Dec, 2023), National Planning Policy Framework, https://www.gov.uk/government/publications/national-planning-policy-framework--2

Department for Levelling Up, Housing & Communities (2022), Planning Practice Guidance for Flood Risk and Coastal Change, https://www.gov.uk/government/collections/planning-practice-guidance

Standing Advice on SuDS & Surface Water Drainage Requirements for New Development (2016)

APPENDIX A – SCHEME DRAWINGS



DO NOT SCALE FROM THIS DRAWING

LEGEND

- ONSHORE ORDER LIMITS
- EXISTING WATERCOURSE / DITCH
- 1 IN 1000 YEAR SURFACE WATER FLOOD EXTENTS
- INDICATIVE CATCHMENT OF WATERCOURSE 1

NOTES

1. DO NOT SCALE FROM THIS DRAWING.
2. DRAWING IS NOT FOR CONSTRUCTION.
3. RISK OF FLOODING FROM SURFACE WATER 1 IN 1000 YEAR DATA PROVIDED BY THE ENVIRONMENT AGENCY.

REV	DATE	REASON FOR ISSUE	BY	CHK	APP
04	04/02/2025	UPDATED FOOTPRINT CONVERTER STATION	ZF	PM	AH
03	16/05/2024	FINAL FOR ENVIRONMENTAL STATEMENT	PM	AH	AH

DBS Offshore Wind

wardell armstrong

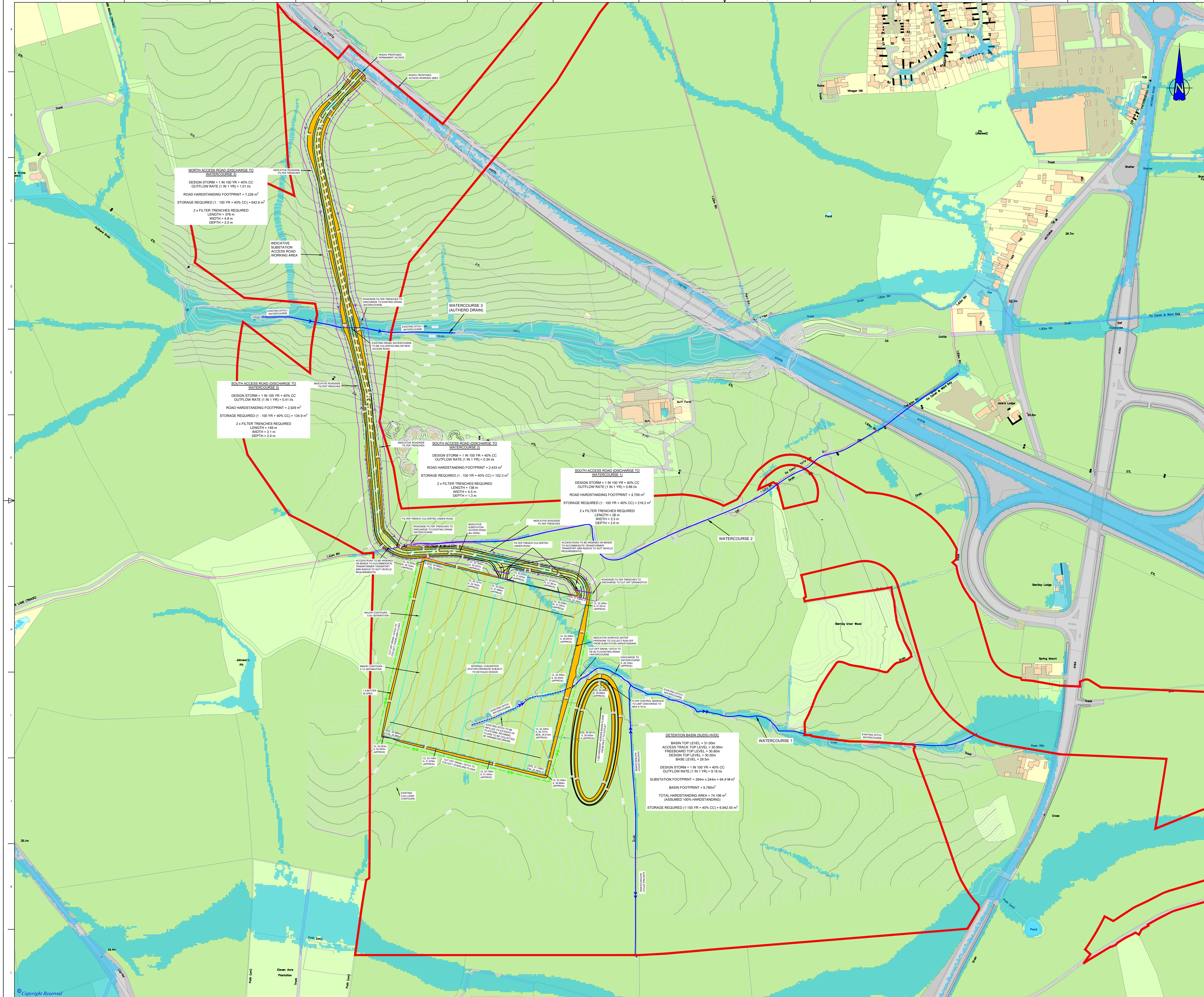
PROJECT TITLE
DOGGER BANK SOUTH OFFSHORE WIND FARM

DRAWING TITLE
SUBSTATION ZONE TWO HVDC OPTION INDICATIVE PRE-DEVELOPMENT DRAINAGE

DRAWING STATUS
FINAL

SHEET SIZE	DESIGNED	DRAWN	CHECKED	APPROVED
A1	CS	PM	AH	AH
SHEET SCALE	DATE	DATE	DATE	DATE
1:2500	15/11/2023	15/11/2023	15/11/2023	15/11/2023

WA DRAWING NUMBER: ED13554-GE-1127	REVISION: 04
DBS DOCUMENT NUMBER: DBS-WAR-V2-XX-M2-C-0057-D	REVISION: 04
RWE ECODOC NUMBER: 005205305-02	SHEET No: 001 OF 001	REVISION: 02



DO NOT SCALE FROM THIS DRAWING

LEGEND

- ONSHORE ORDER LIMITS
- PROPOSED SURFACE WATER DRAINAGE
- PROPOSED ROADSIDE FILTER TRENCH
- PROPOSED CUT OFF DRAIN / DITCH
- EXISTING WATERCOURSE / DITCH
- EXISTING WATERCOURSE TO BE REMOVED
- INDICATIVE SUBSTATION ACCESS ROAD WORKING AREA
- 1 IN 1000 YEAR SURFACE WATER FLOOD EXTENTS

NOTES

1. DO NOT SCALE FROM THIS DRAWING.
2. DRAWING IS NOT FOR CONSTRUCTION.
3. DRAWING IS INDICATIVE ONLY AND FEATURES SHOWN MAY VARY FROM FINAL DESIGN. ACTUAL DESIGN TO BE CONFIRMED AT DETAILED DESIGN STAGE. CONSTRUCTION TO BE COMPLETED IN ACCORDANCE WITH RELEVANT STANDARDS DEFINED IN DETAILED DESIGN.
4. SEE FIGURE APPENDIX 5-3 SUBSTATION ZONE CO-LOCATED HVDC OPTION INDICATIVE SUBSTATION GENERAL ARRANGEMENT FOR LOCATIONS OF TEMPORARY CONSTRUCTION COMPOUNDS, CONSTRUCTION HAUL ROADS, PERMANENT ACCESS ROADS AND ONSHORE CABLE ROUTE ALIGNMENTS.
5. KEY OF ABBREVIATIONS
   EGL - EXISTING GROUND LEVEL
   FGL - FINAL GROUND LEVEL
   IL - INVERT LEVEL (DRAINAGE)
   CL - COVER LEVEL (DRAINAGE MANHOLE)*

   *WHERE DRAINAGE COVER LEVEL IS SHOWN WITH NO EGL, CL IS AT APPROXIMATE EGL LEVEL.
6. RECORDED LOCATION OF UTILITIES OMITTED FOR CLARITY.
7. RISK OF FLOODING FROM SURFACE WATER 1 IN 1000 YEAR DATA PROVIDED BY THE ENVIRONMENT AGENCY.
8. THE OCS ZONE WAS PREVIOUSLY IDENTIFIED AS SUBSTATION ZONE 4 DURING THE SITE SELECTION PROCESS.

REV	DATE	REASON FOR ISSUE	BY	CHK	APP
07	10/02/2025	UPDATES TO ROADSIDE FILTER TRENCHES	ZF	PM	AH
06	10/10/2024	UPDATED FOR REDUCED CONVERTER STATION FOOTPRINT	PAG	GC+ PM	AH
05	16/05/2024	FINAL FOR ENVIRONMENTAL STATEMENT	PM	AH	AH

DBS Offshore Wind

wardell armstrong

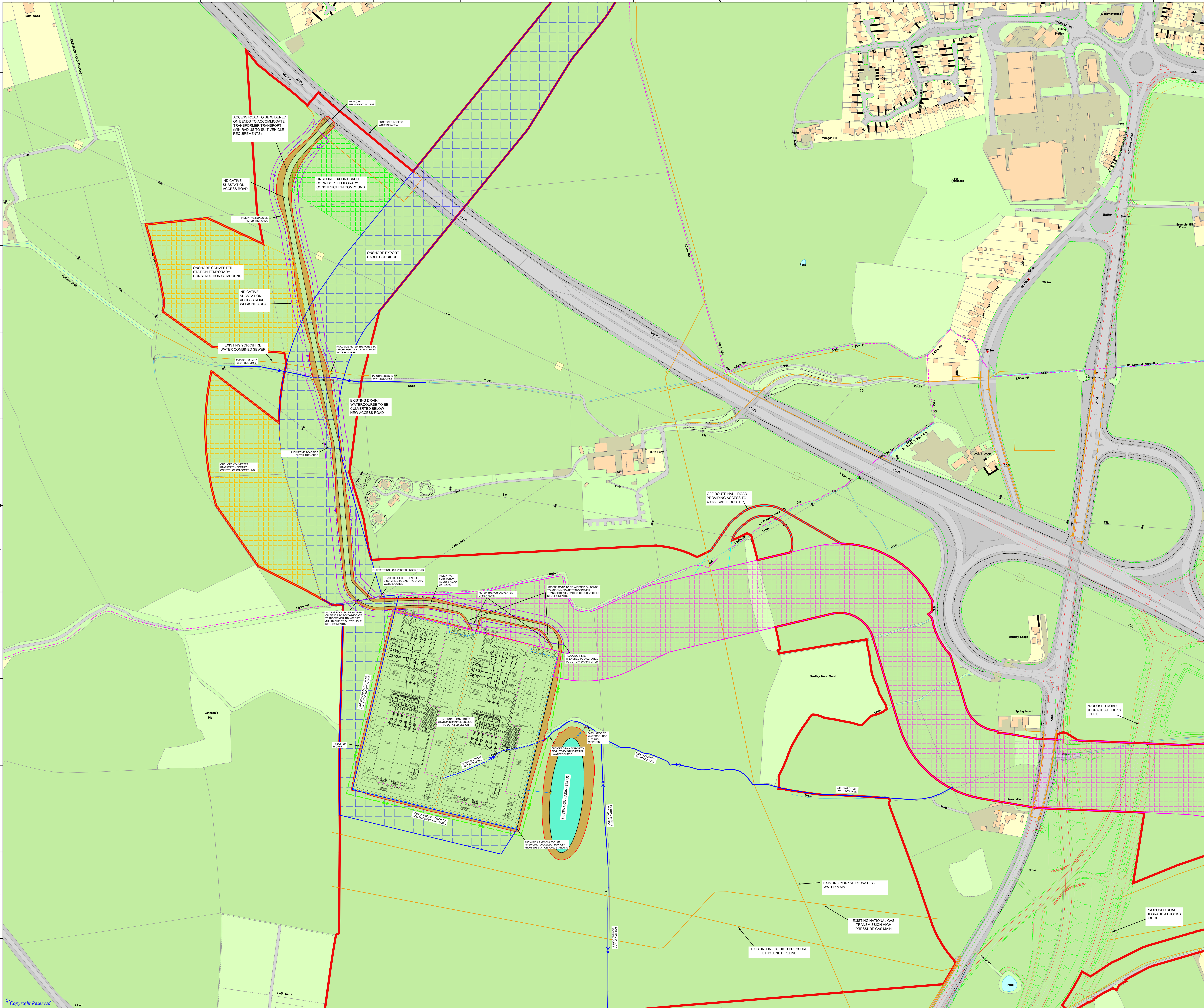
PROJECT TITLE
DOGGER BANK SOUTH OFFSHORE WIND FARM

DRAWING TITLE
DBS ONSHORE CONVERTER STATIONS ZONE PLATFORM AND SUDS ENGINEERING DESIGN

DRAWING STATUS
FINAL

SHEET SIZE	DESIGNED	DRAWN	CHECKED	APPROVED
A1	CS	CS	PM	AH
SHEET SCALE 1:2500	DATE 22/08/2022	DATE 22/08/2022	DATE 22/08/2022	DATE 22/08/2022

WA DRAWING NUMBER ED13554-GE-1100	REVISION 07
DBS DOCUMENT NUMBER DBS-WAR-V2-XX-M2-C-0023-G	REVISION 07
RWE ECODOC NUMBER 004491154-07 — SHEET No 001 OF 001	REVISION 07



DO NOT SCALE FROM THIS DRAWING

LEGEND

- ONSHORE ORDER LIMITS
- ONSHORE EXPORT CABLE CORRIDOR
- ONSHORE EXPORT CABLE CORRIDOR TEMPORARY CONSTRUCTION COMPOUND
- ONSHORE CONVERTER STATION TEMPORARY CONSTRUCTION COMPOUND
- ONWARD 400kV CONNECTION TO NATIONAL GRID
- INDICATIVE EARTHWORKS EXTENTS
- INDICATIVE SURFACE WATER DETENTION BASIN (SUDS)
- OFF ROUTE HAUL ROAD
- PROPOSED ACCESS WORKING AREA
- INDICATIVE PERMANENT ACCESS ROAD
- INDICATIVE SUBSTATION ACCESS ROAD WORKING AREA
- INDICATIVE ROADSIDE FILTER TRENCHES
- INDICATIVE CUT OFF DRAIN / DITCH
- INDICATIVE PLATFORM SURFACE WATER DRAINAGE
- EXISTING WATERCOURSE / DITCH
- EXISTING UNDERGROUND UTILITY

NOTES

1. DO NOT SCALE FROM THIS DRAWING.
2. DRAWING IS NOT FOR CONSTRUCTION.
3. DRAWING IS INDICATIVE ONLY AND FEATURES SHOWN MAY VARY FROM FINAL DESIGN. ACTUAL DESIGN TO BE CONFIRMED AT DETAILED DESIGN STAGE. CONSTRUCTION TO BE COMPLETED IN ACCORDANCE WITH RELEVANT STANDARDS DEFINED IN DETAILED DESIGN.
4. HVDC RBP CONVERTOR STATION ELECTRICAL LAYOUT PRESENTED PROVIDED BY MOTT MACDONALD AND IS INDICATIVE ONLY.

REV	DATE	REASON FOR ISSUE	BY	CHK	APP
03	29/01/2025	UPDATES TO ROADSIDE FILTER TRENCHES	ZF	PM	AH
02	12/11/2024	UPDATE TITLE FOR CHANGE REQUEST	ZF	PM	AH
01	08/11/2024	FINAL FOR DCO	ZF	PM	AH

DBS Offshore Wind

wardell armstrong

PROJECT TITLE
DOGGER BANK SOUTH (EAST AND WEST) OFFSHORE WIND FARMS

DRAWING TITLE
INDICATIVE GENERAL ARRANGEMENT DRAWINGS FOR THE ONSHORE CONVERTER STATION(S)

DRAWING STATUS
FINAL

SHEET SIZE	DESIGNED	DRAWN	CHECKED	APPROVED
A1	PM	ZF	PM	AH
SHEET SCALE	DATE	DATE	DATE	DATE
NTS	08.11.2024	08.11.2024	08.11.2024	08.11.2024

WA DRAWING NUMBER: ED13554-GE-1129	REVISION: 03
DBS DOCUMENT NUMBER: DBS-WAR-V2-XX-M2-C-0064-C	REVISION: 03
RWE ECODOC NUMBER: 005453454-03 / SHEET No: 001 OF 001	REVISION: 03

APPENDIX B – INDICATIVE LAND DRAINAGE DESIGN

Land Drainage Consultancy Ltd
Cowslip Offices
Fimber
DRIFFIELD
East Yorkshire
YO25 9LY
Tel: 01377 236010
Email: mail@ldcl.co.uk
www.ldcl.co.uk

23rd April 2025

To the Dogger Bank South Offshore Wind Farm DCO Examining Authority,

I write with regards to the queries made about the proposed land drainage systems on the Dogger Bank South (DBS) Offshore Windfarm (Hereafter referred to as 'the Projects')Onshore Export Cable Corridor.

Land Drainage Consultancy Ltd (LDC) are a specialist land drainage and soils consultancy working primarily on the impact of large-scale construction projects on agricultural land. We have experience advising on thousands of kilometres of buried HV cable projects throughout the UK and Ireland.

LDC were employed by RWE in the early stages of the planning process to enable the Projects to properly assess the impact of the proposed works on existing land drainage systems, to advise on appropriate mitigation measures and to help develop relationships with landowners and agents along the route.

For clarity, when we speak about land drainage, we refer primarily to buried pipe systems which are a standard agricultural necessity in most areas of the UK. Eighty to three hundred millimetre pipes are laid where soils are heavy and are installed by specialist land drainage contractors at a depth of between six hundred millimetres and two metres. These drains are designed to manage ground water levels, increase agricultural crop productivity, reduce risk of waterlogging and to increase the period of time in which the land is accessible and workable, thus in some cases, enabling the farmer to grow a more profitable crop than they otherwise would be capable of.

Along the length of the Projects Onshore Export Cable Corridor, land drainage is known to be present in abundance. Meetings with landowners and previous knowledge of the area tells us that almost every affected plot contains an intensive system of drains, sometimes at spacings as regular as five metre centres.

If these land drains are not catered for, the Project cable ducts will sever these intensive systems of drains, causing a backup of water in the existing schemes and resulting in flooding/siltation and soil degradation. Existing land drains within the working area will also be damaged through the regular trafficking of heavy machinery and should be replaced.

Given this knowledge, it is critical for the Projects to provide mitigation measures, and the industry standard is to install a system of high side 'interceptor', or 'header' drains. These are generally installed at a depth which is below that of the existing land drainage systems. Following landowner meetings, LDC have surveyed the entire route and to feed into the development of Conceptual Pre-Construction Land Drainage Design plans, prior to construction. These plans will be finalised prior to construction but are likely to include an interceptor drain on the high side/s in affected fields.

Interceptor drains would normally be installed approximately 1.5m from the outer fenceline, with permeable fill and junctions fitted wherever existing drains are encountered. The topsoil should then be stripped, and stored above the land drain, protecting it from damage caused by construction trafficking. It should be noted these measures are indicative and the design will be developed further by the clients chosen Contractor.

As well as the interceptor drains, we have proposed a series of post-construction land drains to aid with soil structural restoration and replace drains damaged within the working area.

A suitable regime of subsoil loosening works would also be required, to break up the subsoil and create channels for water to percolate through any compacted subsoil. Post-construction ‘restoration drains’ are proposed at a depth of approximately one metre. These should be backfilled with permeable fill to the top of the subsoil surface, providing somewhere for the water to percolate to.

Post-construction land drainage designs are, at this point indicative, and will be refined prior to construction by the clients chosen Designer.
Following these basic principles allows us to ensure that the land can be returned to its original agricultural land quality in an efficient and agriculturally friendly manner.

Construction land drains are designed to replace existing systems, retaining the same catchments as previous, thus not increasing the amount of water flowing into ditches and watercourses.

It may be necessary for silt socks and bails to be used for environmental mitigation during the works. Any exposed permeable fill bands within the working area will be temporarily ‘capped’ with native subsoil to ensure dirty water cannot enter the systems.

While the construction land drains will have some impact on surface water management, it should not be relied upon and is not designed as a stand alone surface water management measure.

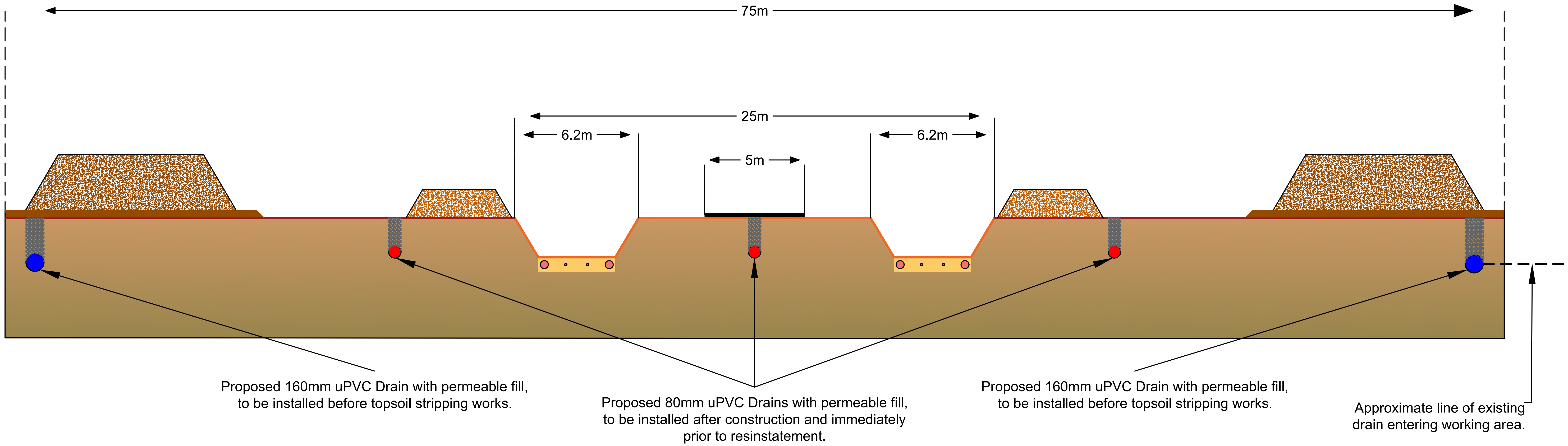
Attached to this letter is an indicative cross-section diagram showing a generic site layout. We have also included a plan view for clarity.

Your Sincerely,

Luke Lambert

Position: Director

Scale: 1:200



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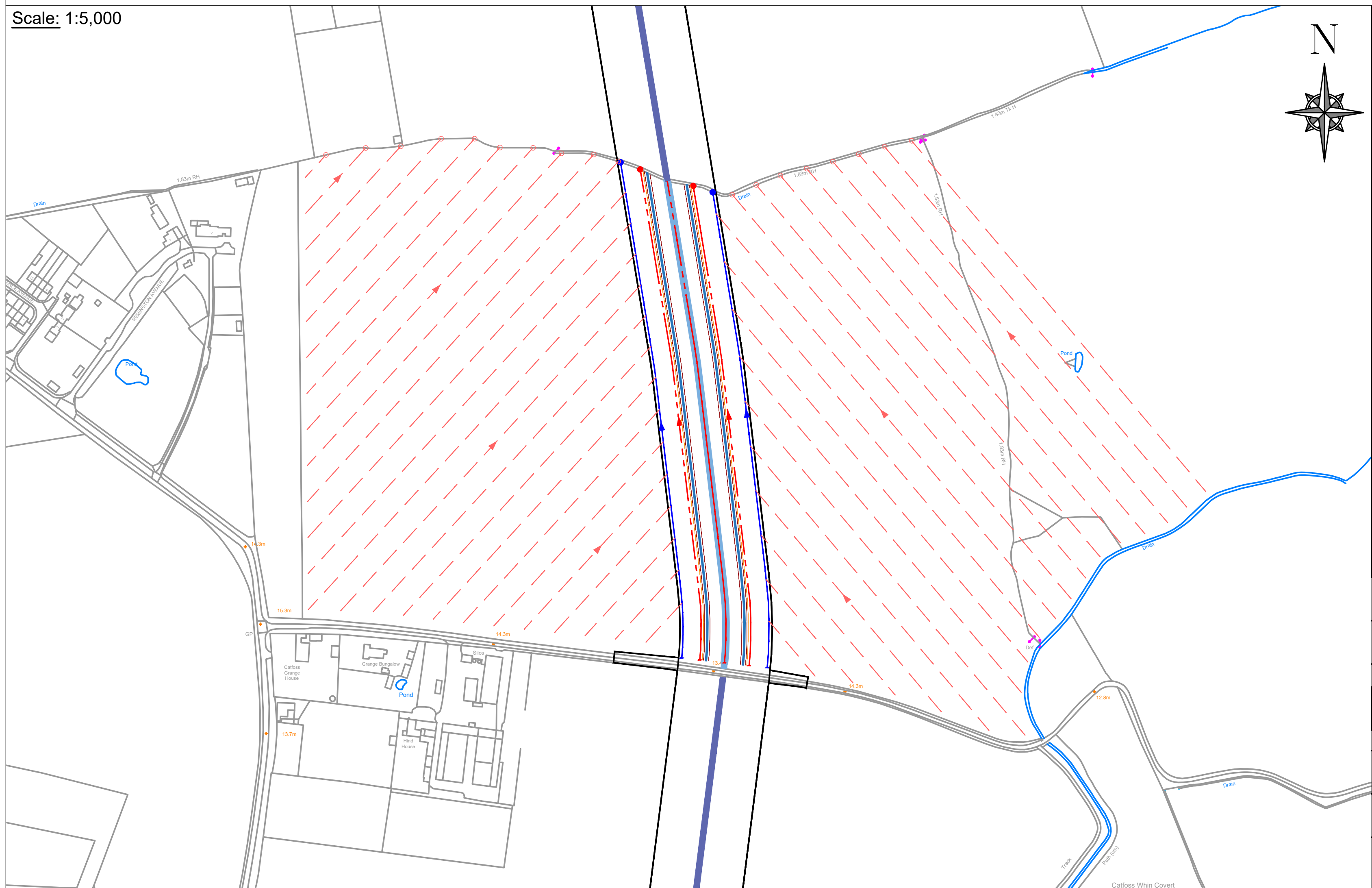


Project:	Dogger Bank South
Title:	Indicative Working Area Cross Section
Client:	RWE
Drawn:	Land Drainage Consultancy Ltd Cowslip Offices Fimber DRIFFIELD East Yorkshire YO25 9LY Tel: 01377 236010 Email: mail@ldcl.co.uk

Revision	Amendment	Date
1	First Issue	23/04/2025
2	Annotation and Plan Amendments	25/04/2025

Scale:	Varies	Size:	A3	Sheet:	1
Drawn:	GS	Checked:	LL	Approved:	LL
Revision:	2	Date:	25/04/2025	Co-ordinates:	BNG (27700)
Drawing:	LDC_DBS_IndicativeCableRoute_Drainage.dwg				

Key:

- Proposed Fence
- 2x HVDC Power Cores
- Permanent Easement
- Haul Road
- Subsoil
- Proposed 80mm uPVC Drain
- Permeable Fill
- Proposed Outfall (Colour Denotes Size)
- Proposed 160mm uPVC Drain
- Fibre Optic Duct
- Existing Drain
- Topsoil
- Existing Outfall

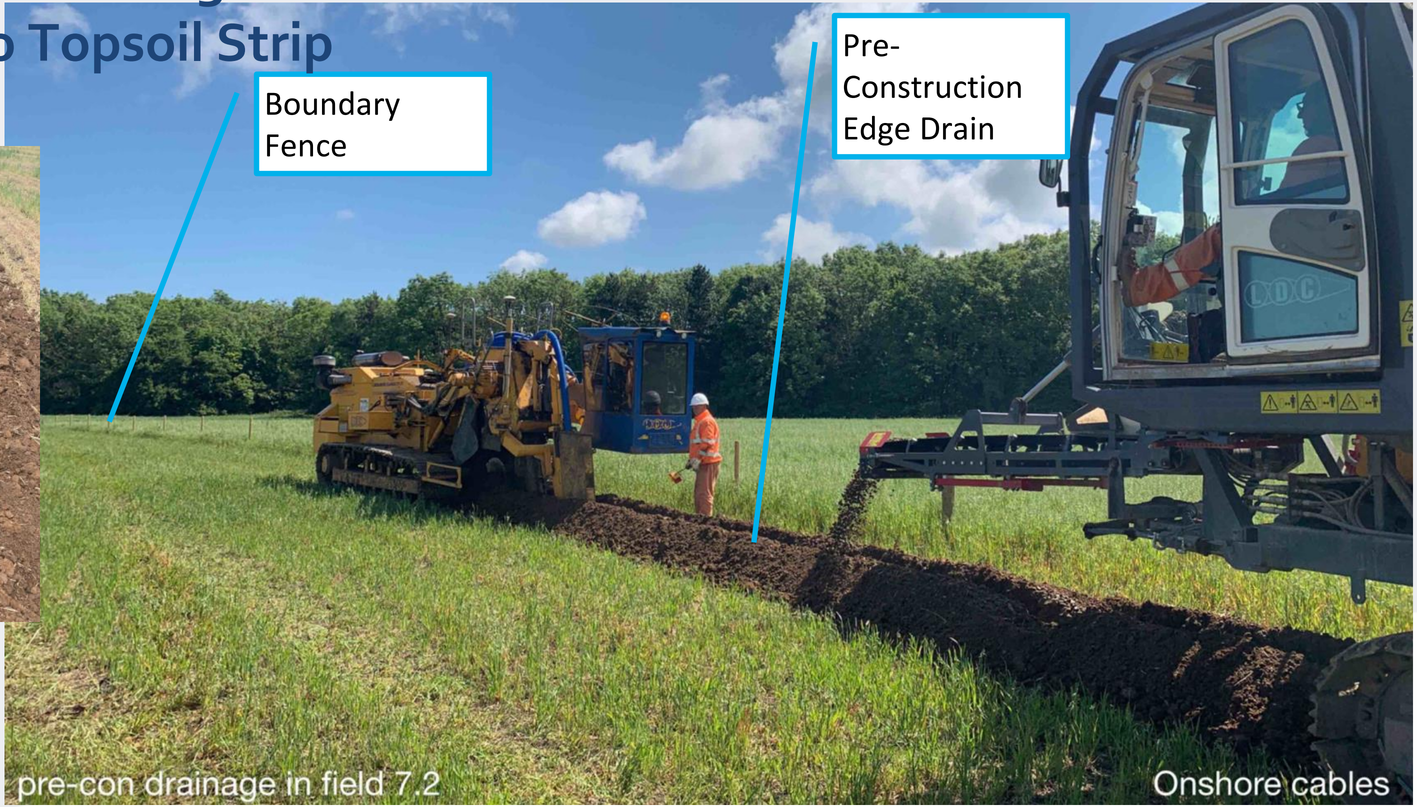
DBS Offshore Wind

DBS Onshore Civils Cable Route Construction Examples

April 2025

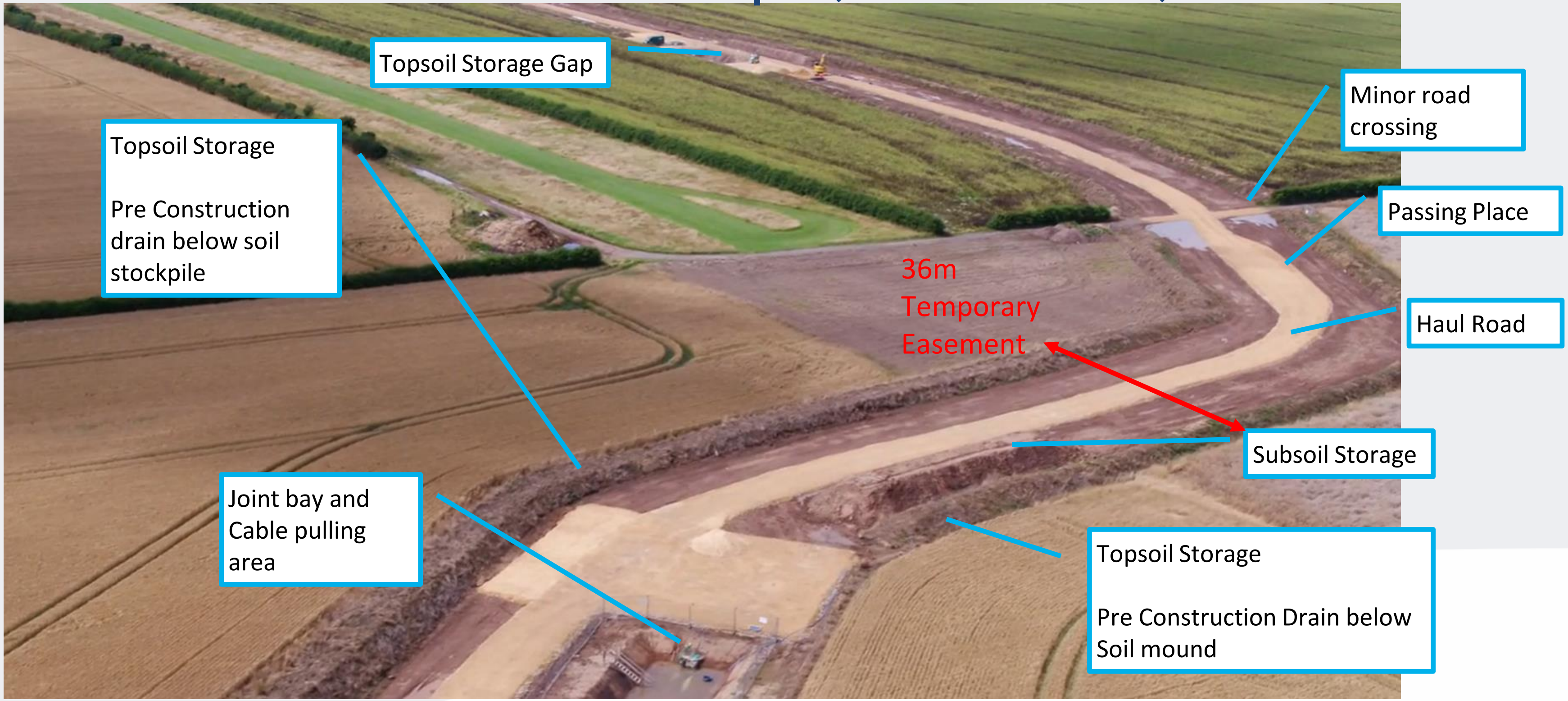
RWE MASDAR

Pre Construction Drainage Installed prior to Topsoil Strip



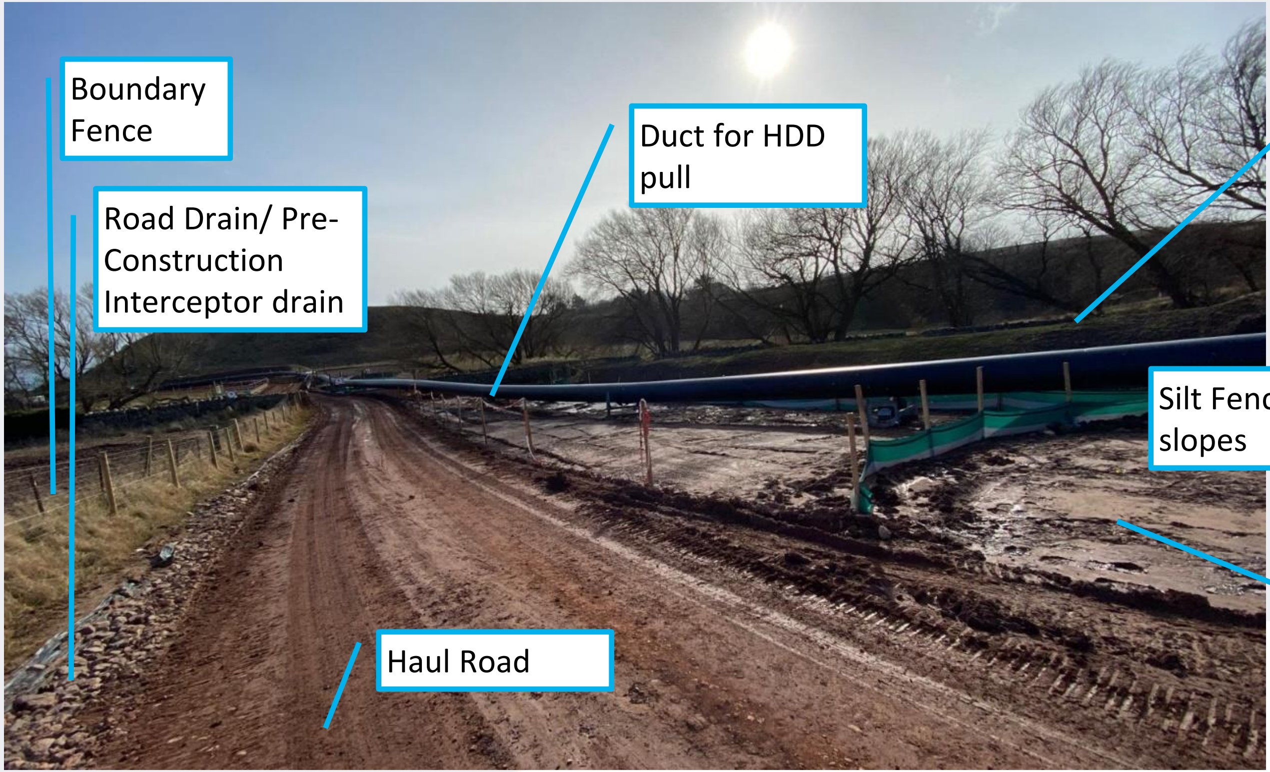
Indicative Information for DCO-
Actual Construction Methodology will be developed by the Principal Contractor / Contractors during detailed design in line with site specific conditions and design requirements

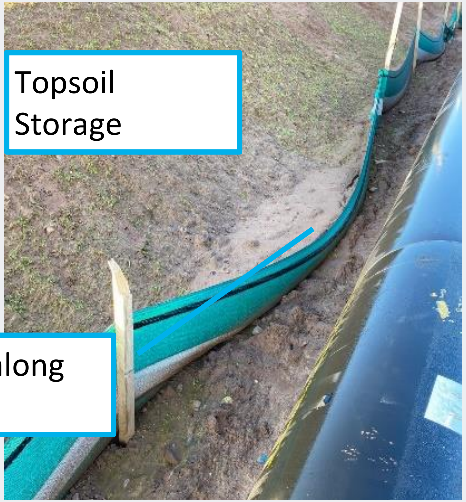
HVDC Cable route Aerial View example (ducts installed)



Indicative Information for DCO-
Actual Construction Methodology will be developed by the Principal Contractor / Contractors during detailed design in line with site specific conditions and design requirements

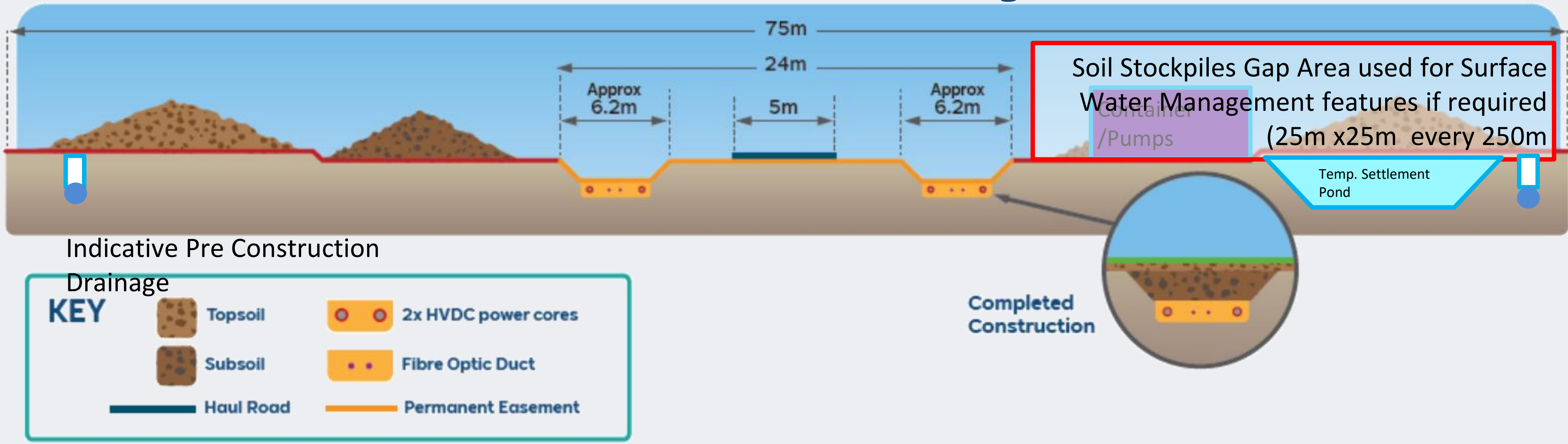
HVDC Cable route General Surface Water Management Examples





Indicative Information for DCO-
Actual Construction Methodology will be developed by the Principal Contractor / Contractors during detailed design in line with site specific conditions and design requirements

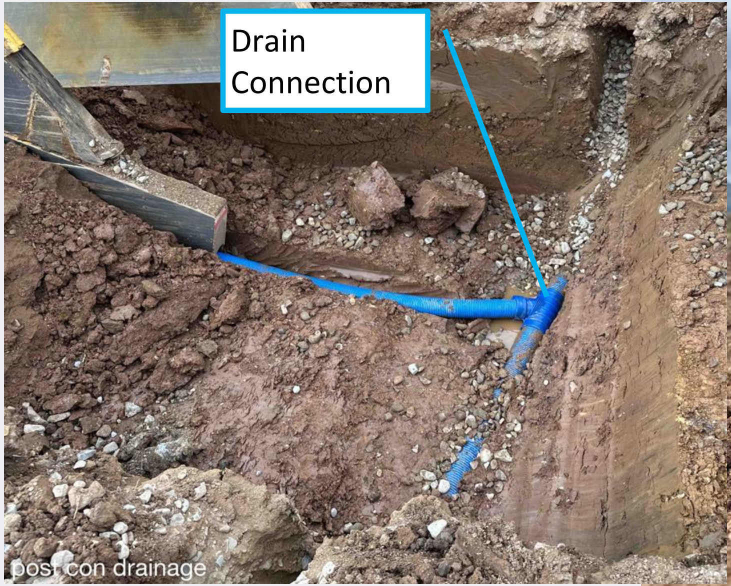
Indicative Area available for Surface Water Management



Additional area can be made available through relocating Soil Storage away from the work area, if required.

Indicative Information for DCO-
Actual Construction Methodology will be developed by the Principal Contractor / Contractors during detailed design in line with site specific conditions and design requirements

Post Construction Drainage- installed prior to Topsoil reinstatement



Indicative Information for DCO-
Actual Construction Methodology will be developed by the Principal Contractor / Contractors during detailed design in line with site specific conditions and design requirements

APPENDIX C – PRELIMINARY DRAINAGE CALCULATIONS

SUDS Design Summary - Dogger Bank - Substation Zone 4			
Notes: 1. SUDS design proposal to attenuate surface water flows from substation hardstanding areas associated with Dogger Bank substations (not including access roads, cable sealing compounds or any other unknown / undefined hardstanding areas). 2. Substation Zone 4 - 2 x HVDC (AIS) option proposed. HVDC (AIS) footprint = 264m x 122m. 3. Substation footprints assumed to be 100% hardstanding for design. 4. Drainage from substations to discharge to SUDS Basin then to an existing watercourse at the pre-development run-off rate. To mimic existing drainage regime and achieve no net increase in flows to receiving watercourse. 5. SUDS design undertaken in line with national and local guidance and as set out in The SUDS Manual (C753). 6. Pre Development discharge rates estimated using FEH method - HR Wallingford Greenfield Runoff Rate Estimation Online Tool. 7. SUDS sizing estimated using FEH13 Rainfall and Micro Drainage design software. 8. Additional SUDS to be provided as source control / treatment during detailed design.			
Design Parameters / Assumptions	**HVDC (AIS)**	**HVDC (AIS)**	**Change Notes**
Hardstanding (all footprints assumed 100% impermeable)			
Substation operational footprint (m2)	32,208	32,208	
SUDS Basin Footprint (including perimeter access track) (m2)	9,780		
Total (m2)	**74,196**		
Pre-Development Run-Off Rates (calculated from HR Wallingford Greenfield Runoff Rate Estimation Online Tool) (l/s)			Changed 2 l/s/ha rate to 1.4 l/s/ha rate
1.4 l/s/ha (l/s)	10.39		
	<u>IH124 Method</u>		
<u>1 Year Return (l/s)</u>	**<u>9.16</u>**		
2 Year Return (Q_{BAR}) (l/s)	10.65		
30 Year Return (l/s)	18.63		
100 Year Return (l/s)	22.15		
200 Year Return (l/s)	25.24		
	<u>FEH Method</u>		
1 Year Return (l/s)	16.31		
2 Year Return (Q_{BAR}) (l/s)	18.96		
30 Year Return (l/s)	33.19		
100 Year Return (l/s)	39.45		
200 Year Return (l/s)	44.95		
Attenuated Post Development Run-Off Rates	**Limited to pre-development (1-year IH124) run-off rate. Provides betterment over 1.4 l/s/ha rate and FEH rate.**		Changed 2 l//ha rate to 1.4 l/s/ha rate
Design Storm Event	**1 in 100 year + 40% climate change as per ERYC guidance.**		
Attenuation Storage Required (calculated from FEH13 Rainfall using Micro Drainage design software) (m3)			
All Hardstanding Areas (m3)	6,942.50		
Total storage required (m3)	**6942.5**		
Design Check - Attenuation Dimensions (m)			

Design Top area (m2) Freeboard Top area (m2) Perimeter access track top area (m2) Basin Top area (m2) Base area (m2) Design storage depth (m) Design freeboard (design depth + 0.3m) (m) Overall depth (design depth + 0.5m) (m) Side slopes (m)	7,720 8,190 9,613 9,780 6,219 1.0 1.3 1.5 1 in 4	
Design Check - Attenuation Storage Provided **Detention Basins** Basin Design Freeboard Perimeter access track Additional storage between track and basin top Total (design) Total (inc. freeboard, access track etc) **Design storage required < attenuation storage provided?**	 6,970 2386.5 890.15 969.65 **6,970** 11,216 **YES = OK**	
Discharge Location	**Existing watercourse.**	**Design flows up to 1:100 year + 40% CC are attenuated within the basin design depth.** **Additional 300mm freeboard provided provided over and above design capacity with another 200mm to the top of the basin from the bottom edge of the access track (total 1.5m depth).**
Sensitivity Check - Attenuation Storage Provided **Storage Requirements** 1 in 200 year + 40% climate change 1 in 1000 year + 40% climate change **Storage Available** Total (inc. freeboard, access track etc) **Sensitivity check storage required < attenuation storage provided?**	 **8012.1** **11173.5** **11,216** **YES = OK**	
Sensitivity Check - Half Drain Down Time **Half Drain Down Time = < 24 hours?** **Surplus Storage Available (Over and Above Design Storm)** Total storage required (m3) - 1 in 100 year + 40% climate change Total storage available (inc. freeboard, access track etc) Surplus (freeboard minus design) 1 in 10 year + 40% climate change Subsequent storm surplus storage can cater for **Sensitivity check storage required < attenuation storage provided?**	 **NO** 6942.5 11215.8 **4273.3** **4256** **Up to 1 in 10 year** **YES = OK**	

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Christopher Sneddon
Site name:	Dogger Bank
Site location:	HVDC (AIS)

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	53.81805° N
Longitude:	0.43559° W
Reference:	2996656647
Date:	Sep 13 2023 10:27

Runoff estimation approach

FEH Statistical

Site characteristics

Total site area (ha): 6.4416

Methodology

Q_{MED} estimation method:	Calculate from BFI and SAAR
BFI and SPR method:	Specify BFI manually
HOST class:	N/A
BFI / BFIHOST:	0.440
Q_{MED} (l/s):	
Q_{BAR} / Q_{MED} factor:	1.06

Hydrological characteristics

	Default	Edited
SAAR (mm):	644	644
Hydrological region:	3	3
Growth curve factor 1 year:	0.86	0.86
Growth curve factor 30 years:	1.75	1.75
Growth curve factor 100 years:	2.08	2.08
Growth curve factor 200 years:	2.37	2.37

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):		18.96
1 in 1 year (l/s):		16.31
1 in 30 years (l/s):		33.19
1 in 100 year (l/s):		39.45
1 in 200 years (l/s):		44.95

Greenfield runoff rate estimation for sites

hr wallingford

www.uksuds.com | Greenfield runoff tool

Calculated by:	Christopher Sneddon
Site name:	Dogger Bank
Site location:	HVDC (AIS)

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	53.81805° N
Longitude:	0.43559° W
Reference:	1447946360
Date:	Sep 13 2023 10:25

Runoff estimation approach: IH124

Site characteristics

Total site area (ha): 6.4416

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	2	2
HOST class:	N/A	N/A
SPR/SPRHOST:	0.3	0.3

Hydrological characteristics

	Default	Edited
SAAR (mm):	644	644
Hydrological region:	3	3
Growth curve factor 1 year:	0.86	0.86
Growth curve factor 30 years:	1.75	1.75
Growth curve factor 100 years:	2.08	2.08
Growth curve factor 200 years:	2.37	2.37

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	10.65	10.65
1 in 1 year (l/s):	9.16	9.16
1 in 30 years (l/s):	18.63	18.63
1 in 100 year (l/s):	22.15	22.15
1 in 200 years (l/s):	25.24	25.24

Summary of Results for 10 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.172	0.172	8.7	1093.3	O K
30 min Summer	0.221	0.221	9.0	1406.8	O K
60 min Summer	0.270	0.270	9.2	1732.3	O K
120 min Summer	0.326	0.326	9.2	2101.0	O K
180 min Summer	0.359	0.359	9.2	2324.8	O K
240 min Summer	0.383	0.383	9.2	2486.3	O K
360 min Summer	0.417	0.417	9.2	2716.2	O K
480 min Summer	0.441	0.441	9.2	2881.1	O K
600 min Summer	0.459	0.459	9.2	3008.8	O K
720 min Summer	0.474	0.474	9.2	3112.0	O K
960 min Summer	0.497	0.497	9.2	3272.0	O K
1440 min Summer	0.525	0.525	9.2	3462.4	O K
2160 min Summer	0.543	0.543	9.2	3591.9	O K
2880 min Summer	0.550	0.550	9.2	3637.4	O K
4320 min Summer	0.553	0.553	9.2	3662.4	O K
5760 min Summer	0.555	0.555	9.2	3675.6	O K
7200 min Summer	0.557	0.557	9.2	3691.1	O K
8640 min Summer	0.559	0.559	9.2	3701.5	O K
10080 min Summer	0.560	0.560	9.2	3708.5	O K
15 min Winter	0.193	0.193	8.9	1224.8	O K
30 min Winter	0.246	0.246	9.1	1576.3	O K
60 min Winter	0.302	0.302	9.2	1941.5	O K
120 min Winter	0.364	0.364	9.2	2356.3	O K
180 min Winter	0.401	0.401	9.2	2608.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	78.937	0.0	560.5	19
30 min Summer	50.914	0.0	700.0	34
60 min Summer	31.486	0.0	1261.6	64
120 min Summer	19.243	0.0	1455.7	124
180 min Summer	14.296	0.0	1513.6	184
240 min Summer	11.544	0.0	1520.4	244
360 min Summer	8.516	0.0	1506.2	364
480 min Summer	6.856	0.0	1484.2	482
600 min Summer	5.794	0.0	1460.3	602
720 min Summer	5.050	0.0	1436.0	722
960 min Summer	4.068	0.0	1388.6	962
1440 min Summer	2.991	0.0	1301.3	1442
2160 min Summer	2.195	0.0	2755.0	2160
2880 min Summer	1.766	0.0	2630.9	2880
4320 min Summer	1.308	0.0	2398.9	3584
5760 min Summer	1.064	0.0	5123.4	4328
7200 min Summer	0.913	0.0	5088.6	5120
8640 min Summer	0.809	0.0	4876.8	5968
10080 min Summer	0.734	0.0	4647.5	6856
15 min Winter	78.937	0.0	627.6	19
30 min Winter	50.914	0.0	744.8	34
60 min Winter	31.486	0.0	1382.9	64
120 min Winter	19.243	0.0	1527.0	122
180 min Winter	14.296	0.0	1538.3	182

Summary of Results for 10 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
240 min Winter	0.428	0.428	9.2	2791.4	O K
360 min Winter	0.466	0.466	9.2	3052.9	O K
480 min Winter	0.493	0.493	9.2	3241.5	O K
600 min Winter	0.514	0.514	9.2	3388.8	O K
720 min Winter	0.531	0.531	9.2	3508.8	O K
960 min Winter	0.558	0.558	9.2	3697.4	O K
1440 min Winter	0.591	0.591	9.2	3932.1	O K
2160 min Winter	0.617	0.617	9.2	4112.8	O K
2880 min Winter	0.630	0.630	9.2	4203.3	O K
4320 min Winter	0.637	0.637	9.2	4256.0	O K
5760 min Winter	0.633	0.633	9.2	4230.8	O K
7200 min Winter	0.633	0.633	9.2	4229.3	O K
8640 min Winter	0.632	0.632	9.2	4221.2	O K
10080 min Winter	0.630	0.630	9.2	4204.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
240 min Winter	11.544	0.0	1531.8	240
360 min Winter	8.516	0.0	1508.5	360
480 min Winter	6.856	0.0	1482.3	478
600 min Winter	5.794	0.0	1456.4	596
720 min Winter	5.050	0.0	1431.4	714
960 min Winter	4.068	0.0	1384.0	950
1440 min Winter	2.991	0.0	1298.7	1414
2160 min Winter	2.195	0.0	2733.8	2100
2880 min Winter	1.766	0.0	2607.9	2792
4320 min Winter	1.308	0.0	2392.0	4104
5760 min Winter	1.064	0.0	5302.2	5240
7200 min Winter	0.913	0.0	5103.4	5624
8640 min Winter	0.809	0.0	4898.7	6576
10080 min Winter	0.734	0.0	4706.7	7560

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	10	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 503065 437026 TA 03065 37026	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 7.420

Time From:	(mins) To:	Area (ha)
0	4	7.420

Model Details

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	6219.0	1.000	7720.0	1.300	8190.0	1.400	9613.0	1.500	9780.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0140-9200-1000-9200
Design Head (m)	1.000
Design Flow (l/s)	9.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	140
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	9.2	Kick-Flo®	0.669	7.6
Flush-Flo™	0.301	9.2	Mean Flow over Head Range	-	7.9

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.1	0.800	8.3	2.000	12.8	4.000	17.7	7.000	23.2
0.200	8.9	1.000	9.2	2.200	13.3	4.500	18.8	7.500	24.0
0.300	9.2	1.200	10.0	2.400	13.9	5.000	19.7	8.000	24.7
0.400	9.1	1.400	10.8	2.600	14.4	5.500	20.7	8.500	25.5
0.500	8.8	1.600	11.5	3.000	15.5	6.000	21.5	9.000	26.2
0.600	8.4	1.800	12.1	3.500	16.6	6.500	22.4	9.500	26.9

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

Outflow is too low. Design is unsatisfactory.

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.293	0.293	9.2	1886.9	O K
30 min Summer	0.382	0.382	9.2	2480.1	O K
60 min Summer	0.471	0.471	9.2	3092.3	O K
120 min Summer	0.538	0.538	9.2	3553.9	O K
180 min Summer	0.579	0.579	9.2	3842.4	O K
240 min Summer	0.609	0.609	9.2	4054.3	O K
360 min Summer	0.652	0.652	9.2	4360.6	O K
480 min Summer	0.683	0.683	9.2	4586.6	O K
600 min Summer	0.708	0.708	9.2	4765.1	O K
720 min Summer	0.728	0.728	9.2	4911.9	O K
960 min Summer	0.759	0.759	9.2	5144.0	O K
1440 min Summer	0.801	0.801	9.2	5450.6	O K
2160 min Summer	0.836	0.836	9.2	5709.3	O K
2880 min Summer	0.855	0.855	9.2	5854.3	O K
4320 min Summer	0.872	0.872	9.2	5977.8	O K
5760 min Summer	0.874	0.874	9.2	5996.5	O K
7200 min Summer	0.877	0.877	9.2	6019.4	O K
8640 min Summer	0.880	0.880	9.2	6038.7	O K
10080 min Summer	0.882	0.882	9.2	6053.8	O K
15 min Winter	0.327	0.327	9.2	2113.8	O K
30 min Winter	0.426	0.426	9.2	2778.6	O K
60 min Winter	0.525	0.525	9.2	3465.2	O K
120 min Winter	0.599	0.599	9.2	3984.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	136.059	0.0	778.1	19
30 min Summer	89.543	0.0	785.0	34
60 min Summer	55.972	0.0	1561.3	64
120 min Summer	32.333	0.0	1532.0	124
180 min Summer	23.419	0.0	1503.0	184
240 min Summer	18.617	0.0	1475.1	244
360 min Summer	13.461	0.0	1420.1	364
480 min Summer	10.701	0.0	1366.1	484
600 min Summer	8.962	0.0	1325.9	604
720 min Summer	7.756	0.0	1297.2	724
960 min Summer	6.183	0.0	1264.1	962
1440 min Summer	4.495	0.0	1247.4	1442
2160 min Summer	3.273	0.0	2582.8	2160
2880 min Summer	2.620	0.0	2540.5	2880
4320 min Summer	1.928	0.0	2470.2	4320
5760 min Summer	1.559	0.0	5202.2	5352
7200 min Summer	1.330	0.0	5045.9	5984
8640 min Summer	1.171	0.0	4929.0	6824
10080 min Summer	1.054	0.0	4828.7	7560
15 min Winter	136.059	0.0	785.9	19
30 min Winter	89.543	0.0	781.6	34
60 min Winter	55.972	0.0	1548.4	64
120 min Winter	32.333	0.0	1503.3	124

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
180 min Winter	0.645	0.645	9.2	4310.5	O K
240 min Winter	0.678	0.678	9.2	4551.0	O K
360 min Winter	0.726	0.726	9.2	4898.3	O K
480 min Winter	0.761	0.761	9.2	5153.4	O K
600 min Winter	0.788	0.788	9.2	5355.5	O K
720 min Winter	0.811	0.811	9.2	5522.5	O K
960 min Winter	0.846	0.846	9.2	5788.9	O K
1440 min Winter	0.894	0.894	9.2	6147.0	O K
2160 min Winter	0.936	0.936	9.2	6462.7	O K
2880 min Winter	0.960	0.960	9.2	6651.9	O K
4320 min Winter	0.986	0.986	9.2	6849.2	O K
5760 min Winter	0.996	0.996	9.2	6921.3	O K
7200 min Winter	0.998	0.998	9.2	6937.5	O K
8640 min Winter	0.996	0.996	9.2	6927.7	O K
10080 min Winter	0.998	0.998	9.2	6942.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180 min Winter	23.419	0.0	1458.2	182
240 min Winter	18.617	0.0	1411.9	242
360 min Winter	13.461	0.0	1351.8	360
480 min Winter	10.701	0.0	1322.6	480
600 min Winter	8.962	0.0	1311.7	598
720 min Winter	7.756	0.0	1313.6	716
960 min Winter	6.183	0.0	1322.4	952
1440 min Winter	4.495	0.0	1315.2	1426
2160 min Winter	3.273	0.0	2691.2	2120
2880 min Winter	2.620	0.0	2684.3	2820
4320 min Winter	1.928	0.0	2608.0	4152
5760 min Winter	1.559	0.0	5353.3	5480
7200 min Winter	1.330	0.0	5300.7	6704
8640 min Winter	1.171	0.0	5238.0	7096
10080 min Winter	1.054	0.0	5135.2	7960

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 503065 437026 TA 03065 37026	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 7.420

Time From:	(mins) To:	Area (ha)
0	4	7.420

Model Details

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	6219.0	1.000	7720.0	1.300	8190.0	1.400	9613.0	1.500	9780.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0140-9200-1000-9200
Design Head (m)	1.000
Design Flow (l/s)	9.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	140
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	9.2	Kick-Flo®	0.669	7.6
Flush-Flo™	0.301	9.2	Mean Flow over Head Range	-	7.9

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.1	0.800	8.3	2.000	12.8	4.000	17.7	7.000	23.2
0.200	8.9	1.000	9.2	2.200	13.3	4.500	18.8	7.500	24.0
0.300	9.2	1.200	10.0	2.400	13.9	5.000	19.7	8.000	24.7
0.400	9.1	1.400	10.8	2.600	14.4	5.500	20.7	8.500	25.5
0.500	8.8	1.600	11.5	3.000	15.5	6.000	21.5	9.000	26.2
0.600	8.4	1.800	12.1	3.500	16.6	6.500	22.4	9.500	26.9

Summary of Results for 200 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.335	0.335	9.2	2164.3	O K
30 min Summer	0.437	0.437	9.2	2853.5	O K
60 min Summer	0.541	0.541	9.2	3575.8	O K
120 min Summer	0.615	0.615	9.2	4101.2	O K
180 min Summer	0.662	0.662	9.2	4433.9	O K
240 min Summer	0.696	0.696	9.2	4678.2	O K
360 min Summer	0.743	0.743	9.2	5024.8	O K
480 min Summer	0.778	0.778	9.2	5283.8	O K
600 min Summer	0.806	0.806	9.2	5488.8	O K
720 min Summer	0.829	0.829	9.2	5657.0	O K
960 min Summer	0.864	0.864	9.2	5916.9	O K
1440 min Summer	0.910	0.910	9.2	6270.7	O K
2160 min Summer	0.951	0.951	9.2	6580.4	O K
2880 min Summer	0.974	0.974	9.2	6757.8	O K
4320 min Summer	0.994	0.994	9.2	6912.0	O K
5760 min Summer	0.997	0.997	9.2	6929.3	O K
7200 min Summer	0.996	0.996	9.2	6928.9	O K
8640 min Summer	0.996	0.996	9.2	6927.4	O K
10080 min Summer	0.996	0.996	9.2	6922.6	O K
15 min Winter	0.374	0.374	9.2	2424.5	O K
30 min Winter	0.487	0.487	9.2	3196.9	O K
60 min Winter	0.602	0.602	9.2	4007.0	O K
120 min Winter	0.685	0.685	9.2	4598.3	O K
180 min Winter	0.736	0.736	9.2	4972.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	156.014	0.0	786.8	19
30 min Summer	102.974	0.0	780.0	34
60 min Summer	64.669	0.0	1542.0	64
120 min Summer	37.256	0.0	1491.3	124
180 min Summer	26.962	0.0	1439.1	184
240 min Summer	21.417	0.0	1391.6	244
360 min Summer	15.452	0.0	1340.2	364
480 min Summer	12.277	0.0	1318.9	484
600 min Summer	10.277	0.0	1316.2	604
720 min Summer	8.890	0.0	1323.8	724
960 min Summer	7.071	0.0	1331.2	964
1440 min Summer	5.132	0.0	1322.7	1442
2160 min Summer	3.732	0.0	2711.4	2164
2880 min Summer	2.984	0.0	2702.8	2880
4320 min Summer	2.186	0.0	2621.3	4320
5760 min Summer	1.761	0.0	5367.0	5584
7200 min Summer	1.495	0.0	5307.8	6192
8640 min Summer	1.311	0.0	5229.6	6920
10080 min Summer	1.175	0.0	5110.4	7760
15 min Winter	156.014	0.0	788.5	19
30 min Winter	102.974	0.0	772.2	34
60 min Winter	64.669	0.0	1511.4	64
120 min Winter	37.256	0.0	1423.3	124
180 min Winter	26.962	0.0	1370.8	182

Summary of Results for 200 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
240 min Winter	0.773	0.773	9.2	5247.4	O K
360 min Winter	0.826	0.826	9.2	5638.0	O K
480 min Winter	0.865	0.865	9.2	5931.4	O K
600 min Winter	0.896	0.896	9.2	6164.7	O K
720 min Winter	0.922	0.922	9.2	6357.1	O K
960 min Winter	0.961	0.961	9.2	6656.6	O K
1440 min Winter	1.015	1.015	9.3	7070.6	O K
2160 min Winter	1.063	1.063	9.5	7446.7	O K
2880 min Winter	1.092	1.092	9.6	7676.0	O K
4320 min Winter	1.123	1.123	9.7	7913.9	O K
5760 min Winter	1.133	1.133	9.8	7999.6	O K
7200 min Winter	1.135	1.135	9.8	8012.1	O K
8640 min Winter	1.131	1.131	9.7	7980.2	O K
10080 min Winter	1.129	1.129	9.7	7961.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
240 min Winter	21.417	0.0	1349.0	242
360 min Winter	15.452	0.0	1349.8	360
480 min Winter	12.277	0.0	1371.6	480
600 min Winter	10.277	0.0	1385.9	598
720 min Winter	8.890	0.0	1395.0	716
960 min Winter	7.071	0.0	1402.0	952
1440 min Winter	5.132	0.0	1391.2	1426
2160 min Winter	3.732	0.0	2860.2	2120
2880 min Winter	2.984	0.0	2847.3	2824
4320 min Winter	2.186	0.0	2755.3	4192
5760 min Winter	1.761	0.0	5657.3	5528
7200 min Winter	1.495	0.0	5619.0	6776
8640 min Winter	1.311	0.0	5533.3	7872
10080 min Winter	1.175	0.0	5407.9	8072

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	200	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 503065 437026 TA 03065 37026	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 7.420

Time From:	(mins) To:	Area (ha)
0	4	7.420

Model Details

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	6219.0	1.000	7720.0	1.300	8190.0	1.400	9613.0	1.500	9780.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0140-9200-1000-9200
Design Head (m)	1.000
Design Flow (l/s)	9.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	140
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	9.2	Kick-Flo®	0.669	7.6
Flush-Flo™	0.301	9.2	Mean Flow over Head Range	-	7.9

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.1	0.800	8.3	2.000	12.8	4.000	17.7	7.000	23.2
0.200	8.9	1.000	9.2	2.200	13.3	4.500	18.8	7.500	24.0
0.300	9.2	1.200	10.0	2.400	13.9	5.000	19.7	8.000	24.7
0.400	9.1	1.400	10.8	2.600	14.4	5.500	20.7	8.500	25.5
0.500	8.8	1.600	11.5	3.000	15.5	6.000	21.5	9.000	26.2
0.600	8.4	1.800	12.1	3.500	16.6	6.500	22.4	9.500	26.9

Summary of Results for 1000 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.466	0.466	9.2	3051.9	O K
30 min Summer	0.611	0.611	9.2	4067.9	O K
60 min Summer	0.758	0.758	9.2	5131.7	O K
120 min Summer	0.869	0.869	9.2	5957.4	O K
180 min Summer	0.935	0.935	9.2	6458.8	O K
240 min Summer	0.982	0.982	9.2	6817.2	O K
360 min Summer	1.046	1.046	9.4	7315.7	O K
480 min Summer	1.091	1.091	9.6	7668.0	O K
600 min Summer	1.126	1.126	9.7	7939.2	O K
720 min Summer	1.153	1.153	9.8	8158.1	O K
960 min Summer	1.196	1.196	10.0	8495.5	O K
1440 min Summer	1.252	1.252	10.2	8951.0	Flood Risk
2160 min Summer	1.300	1.300	10.4	9341.8	Flood Risk
2880 min Summer	1.326	1.326	10.5	9556.9	Flood Risk
4320 min Summer	1.345	1.345	10.6	9722.2	Flood Risk
5760 min Summer	1.343	1.343	10.6	9706.6	Flood Risk
7200 min Summer	1.332	1.332	10.5	9609.0	Flood Risk
8640 min Summer	1.321	1.321	10.5	9514.0	Flood Risk
10080 min Summer	1.310	1.310	10.4	9424.9	Flood Risk
15 min Winter	0.518	0.518	9.2	3418.7	O K
30 min Winter	0.679	0.679	9.2	4557.4	O K
60 min Winter	0.841	0.841	9.2	5749.2	O K
120 min Winter	0.964	0.964	9.2	6675.7	O K
180 min Winter	1.037	1.037	9.4	7239.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	219.837	0.0	778.6	19
30 min Summer	146.633	0.0	736.1	34
60 min Summer	92.634	0.0	1375.9	64
120 min Summer	53.959	0.0	1398.5	124
180 min Summer	39.131	0.0	1446.7	184
240 min Summer	31.078	0.0	1477.7	244
360 min Summer	22.374	0.0	1514.9	364
480 min Summer	17.697	0.0	1535.9	484
600 min Summer	14.746	0.0	1548.1	604
720 min Summer	12.702	0.0	1554.6	724
960 min Summer	10.035	0.0	1556.9	964
1440 min Summer	7.206	0.0	1537.2	1442
2160 min Summer	5.178	0.0	3163.2	2164
2880 min Summer	4.099	0.0	3132.7	2880
4320 min Summer	2.954	0.0	3007.7	4320
5760 min Summer	2.347	0.0	6189.6	5760
7200 min Summer	1.968	0.0	6104.1	6840
8640 min Summer	1.707	0.0	5974.3	7432
10080 min Summer	1.515	0.0	5807.0	8168
15 min Winter	219.837	0.0	768.4	19
30 min Winter	146.633	0.0	690.9	34
60 min Winter	92.634	0.0	1381.7	64
120 min Winter	53.959	0.0	1473.4	124
180 min Winter	39.131	0.0	1523.2	182

Summary of Results for 1000 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
240 min Winter	1.088	1.088	9.6	7643.5	O K
360 min Winter	1.159	1.159	9.9	8206.5	O K
480 min Winter	1.209	1.209	10.1	8606.2	Flood Risk
600 min Winter	1.248	1.248	10.2	8915.3	Flood Risk
720 min Winter	1.278	1.278	10.3	9165.8	Flood Risk
960 min Winter	1.325	1.325	10.5	9555.1	Flood Risk
1440 min Winter	1.385	1.385	10.7	10088.7	Flood Risk
2160 min Winter	1.434	1.434	10.9	10562.9	Flood Risk
2880 min Winter	1.463	1.463	11.0	10842.8	Flood Risk
4320 min Winter	1.490	1.490	11.1	11107.7	Flood Risk
5760 min Winter	1.497	1.497	11.1	11173.5	Flood Risk
7200 min Winter	1.494	1.494	11.1	11141.1	Flood Risk
8640 min Winter	1.484	1.484	11.1	11046.0	Flood Risk
10080 min Winter	1.471	1.471	11.0	10913.6	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
240 min Winter	31.078	0.0	1555.1	242
360 min Winter	22.374	0.0	1593.0	362
480 min Winter	17.697	0.0	1613.9	480
600 min Winter	14.746	0.0	1625.4	598
720 min Winter	12.702	0.0	1631.1	716
960 min Winter	10.035	0.0	1631.2	954
1440 min Winter	7.206	0.0	1605.4	1428
2160 min Winter	5.178	0.0	3315.7	2136
2880 min Winter	4.099	0.0	3274.1	2824
4320 min Winter	2.954	0.0	3126.9	4196
5760 min Winter	2.347	0.0	6505.2	5544
7200 min Winter	1.968	0.0	6401.2	6848
8640 min Winter	1.707	0.0	6254.3	8128
10080 min Winter	1.515	0.0	6072.2	9280

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	1000	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 503065 437026 TA 03065 37026	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 7.420

Time From:	**(mins) To:**	**Area (ha)**
0	4	7.420

Model Details

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	6219.0	1.000	7720.0	1.300	8190.0	1.400	9613.0	1.500	9780.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0140-9200-1000-9200
Design Head (m)	1.000
Design Flow (l/s)	9.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	140
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	9.2	Kick-Flo®	0.669	7.6
Flush-Flo™	0.301	9.2	Mean Flow over Head Range	-	7.9

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.1	0.800	8.3	2.000	12.8	4.000	17.7	7.000	23.2
0.200	8.9	1.000	9.2	2.200	13.3	4.500	18.8	7.500	24.0
0.300	9.2	1.200	10.0	2.400	13.9	5.000	19.7	8.000	24.7
0.400	9.1	1.400	10.8	2.600	14.4	5.500	20.7	8.500	25.5
0.500	8.8	1.600	11.5	3.000	15.5	6.000	21.5	9.000	26.2
0.600	8.4	1.800	12.1	3.500	16.6	6.500	22.4	9.500	26.9

SUDS Design Summary - Dogger Bank - Zone 4 - Road Drainage - 06.02.25

Notes:

1. SUDS design proposal to attenuate surface water flows from access road hardstanding areas.

2. Road hardstanding assumed to be 100% hardstanding for design.

3. Drainage from access roads to discharge to adjacent filter trenches then to an existing watercourse at the pre-development run-off rate. To mimic existing drainage regime and achieve no net increase in flows to receiving watercourse.

4. SUDS design undertaken in line with national and local guidance and as set out in The SUDS Manual (C753).

5. Pre Development discharge rates estimated using FEH method - HR Wallingford Greenfield Runoff Rate Estimation Online Tool.

6. SUDS sizing estimated using FEH13 Rainfall and Micro Drainage design software.

Design Parameters / Assumptions	HVDC (AIS)	Change Notes
Hardstanding (all footprints assumed 100% impermeable)		
North Access Road (Discharge to Watercourse 3)	7,226	
Total (m2)	**7,226**	
Pre-Development Run-Off Rates (calculated from HR Wallingford Greenfield Runoff Rate Estimation Online Tool) (l/s)		
1.4 l/s/ha (l/s)	**1.01**	
	IH124 Method	
1 Year Return (l/s)	1.04	
2 Year Return (Q_{BAR}) (l/s)	1.21	
30 Year Return (l/s)	2.11	Low discharge rates may cause a blockage risk. Suitable discharge rates to be agreed with the local authority at detailed design stage.
100 Year Return (l/s)	2.51	
200 Year Return (l/s)	2.86	
	FEH Method	
1 Year Return (l/s)	2.18	
2 Year Return (Q_{BAR}) (l/s)	1.87	
30 Year Return (l/s)	3.81	
100 Year Return (l/s)	4.53	
200 Year Return (l/s)	5.16	
Attenuated Post Development Run-Off Rates	**Limited to pre-development (1.4 l/s/ha) run-off rate. Provides betterment over IH124 rate and FEH rate.**	Low discharge rates may cause a blockage risk. Suitable discharge rates to be agreed with the local authority at detailed design stage.
Design Storm Event	**1 in 100 year + 40% climate change as per ERYC guidance.**	
Attenuation Storage Required (calculated from FEH13 Rainfall using Micro Drainage design software) (m3)		
All Hardstanding Areas (m3)	321.3	Based on filter trenches either side of road, each taking half the hardstanding area (3613 m2) and limited to half the greenfield run-off rate (0.5 l/s)
Total storage required (m3)	**321.3**	
Filter Trench Dimensions (m)		
Length	378	
Width	4.80	
Gradient (1:X)	200	
Gravel Voids	0.3	
Design storage depth (m)	1.5	
Design freeboard (m)	0.5	
Overall depth (design depth + freeboard) (m)	2.0	
Design Check - Attenuation Storage Provided		
Filter Trenches		
Filter Trench Design	324	
Freeboard	252	
Total (design)	**324**	
Total (inc. freeboard)	576	
Design storage required < attenuation storage provided?	**YES = OK**	
Discharge Location	**Existing watercourse 3.**	**Design flows up to 1:100 year + 40% CC are attenuated within the filter trench design depth (1.5m).** **Additional 500mm freeboard provided provided over and above design capacity (total 2.0m depth).** **Filter trenches to be stepped to suit road gradients to utilise capacity along entire length.**
Sensitivity Check - Attenuation Storage Provided		
Storage Requirements		
1 in 200 year + 40% climate change	**375.4**	
1 in 1000 year + 40% climate change	**534.4**	
Storage Available		
Total (inc. freeboard, access track etc)	**576**	
Sensitivity check storage required < attenuation storage provided?	**YES = OK**	
Sensitivity Check - Half Drain Down Time		
Half Drain Down Time = < 24 hours?	**NO**	
Surplus Storage Available (Over and Above Design Storm)		
Total storage required (m3) - 1 in 100 year + 40% climate change	321.3	
Total storage available (inc. freeboard, access track etc)	576	
Surplus (freeboard minus design)	**254.7**	
1 in 10 year + 40% climate change	**196.3**	
Subsequent storm surplus storage can cater for	**Up to 1 in 10 year**	
Sensitivity check storage required < attenuation storage provided?	**YES = OK**	

hr wallingford

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Christopher Sneddon
Site name:	Dogger Bank
Site location:	North Access Road WC3

Site Details

Latitude:	53.81527° N
Longitude:	0.45088° W
Reference:	2526977329
Date:	Feb 05 2025 12:52

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Runoff estimation approach

FEH Statistical

Site characteristics

Total site area (ha): 0.7226

Methodology

Q_{MED} estimation method:	Calculate from BFI and SAAR
BFI and SPR method:	Specify BFI manually
HOST class:	N/A
BFI / BFIHOST:	0.44
Q_{MED} (l/s):	
Q_{BAR} / Q_{MED} factor:	1.06

Hydrological characteristics

	Default	Edited
SAAR (mm):	649	649
Hydrological region:	3	3
Growth curve factor 1 year:	0.86	0.86
Growth curve factor 30 years:	1.75	1.75
Growth curve factor 100 years:	2.08	2.08
Growth curve factor 200 years:	2.37	2.37

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):		2.18
1 in 1 year (l/s):		1.87
1 in 30 years (l/s):		3.81
1 in 100 year (l/s):		4.53
1 in 200 years (l/s):		5.16

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Christopher Sneddon
Site name:	Dogger Bank
Site location:	North Access Road WC3

Site Details

Latitude:	53.81527° N
Longitude:	0.45088° W
Reference:	2582686226
Date:	Feb 05 2025 12:49

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Runoff estimation approach: IH124

Site characteristics

Total site area (ha): 0.7226

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	2	2
HOST class:	N/A	N/A
SPR/SPRHOST:	0.3	0.3

Hydrological characteristics

	Default	Edited
SAAR (mm):	649	649
Hydrological region:	3	3
Growth curve factor 1 year:	0.86	0.86
Growth curve factor 30 years:	1.75	1.75
Growth curve factor 100 years:	2.08	2.08
Growth curve factor 200 years:	2.37	2.37

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	1.21	1.21
1 in 1 year (l/s):	1.04	1.04
1 in 30 years (l/s):	2.11	2.11
1 in 100 year (l/s):	2.51	2.51
1 in 200 years (l/s):	2.86	2.86

Summary of Results for 10 year Return Period (+40%)

Half Drain Time : 3934 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.607	0.607	0.0	0.3	0.3	53.1	O K
30 min Summer	0.689	0.689	0.0	0.4	0.4	68.3	O K
60 min Summer	0.764	0.764	0.0	0.4	0.4	84.1	O K
120 min Summer	0.841	0.841	0.0	0.4	0.4	101.8	O K
180 min Summer	0.884	0.884	0.0	0.4	0.4	112.5	O K
240 min Summer	0.914	0.914	0.0	0.4	0.4	120.2	O K
360 min Summer	0.954	0.954	0.0	0.4	0.4	131.0	O K
480 min Summer	0.981	0.981	0.0	0.4	0.4	138.6	O K
600 min Summer	1.002	1.002	0.0	0.4	0.4	144.5	O K
720 min Summer	1.018	1.018	0.0	0.4	0.4	149.1	O K
960 min Summer	1.041	1.041	0.0	0.4	0.4	156.2	O K
1440 min Summer	1.067	1.067	0.0	0.4	0.4	164.0	O K
2160 min Summer	1.081	1.081	0.0	0.4	0.4	168.2	O K
2880 min Summer	1.082	1.082	0.0	0.4	0.4	168.4	O K
4320 min Summer	1.076	1.076	0.0	0.4	0.4	166.6	O K
5760 min Summer	1.069	1.069	0.0	0.4	0.4	164.5	O K
7200 min Summer	1.066	1.066	0.0	0.4	0.4	163.7	O K
8640 min Summer	1.066	1.066	0.0	0.4	0.4	163.6	O K
10080 min Summer	1.067	1.067	0.0	0.4	0.4	163.8	O K
15 min Winter	0.643	0.643	0.0	0.3	0.3	59.5	O K
30 min Winter	0.729	0.729	0.0	0.4	0.4	76.6	O K
60 min Winter	0.809	0.809	0.0	0.4	0.4	94.3	O K
120 min Winter	0.891	0.891	0.0	0.4	0.4	114.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	78.937	0.0	27.3	19
30 min Summer	50.914	0.0	29.2	34
60 min Summer	31.486	0.0	58.2	64
120 min Summer	19.243	0.0	61.7	124
180 min Summer	14.296	0.0	63.4	184
240 min Summer	11.544	0.0	64.5	244
360 min Summer	8.516	0.0	65.8	364
480 min Summer	6.856	0.0	66.6	482
600 min Summer	5.794	0.0	67.0	602
720 min Summer	5.050	0.0	67.2	722
960 min Summer	4.068	0.0	67.3	962
1440 min Summer	2.991	0.0	66.6	1442
2160 min Summer	2.195	0.0	133.0	2160
2880 min Summer	1.766	0.0	132.1	2852
4320 min Summer	1.308	0.0	127.8	3540
5760 min Summer	1.064	0.0	249.3	4320
7200 min Summer	0.913	0.0	248.6	5112
8640 min Summer	0.809	0.0	244.6	5960
10080 min Summer	0.734	0.0	238.1	6768
15 min Winter	78.937	0.0	28.1	19
30 min Winter	50.914	0.0	30.0	34
60 min Winter	31.486	0.0	60.3	64
120 min Winter	19.243	0.0	63.7	122

Summary of Results for 10 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	0.937	0.937	0.0	0.4	0.4	126.4	O K
240 min Winter	0.969	0.969	0.0	0.4	0.4	135.2	O K
360 min Winter	1.012	1.012	0.0	0.4	0.4	147.6	O K
480 min Winter	1.042	1.042	0.0	0.4	0.4	156.4	O K
600 min Winter	1.065	1.065	0.0	0.4	0.4	163.2	O K
720 min Winter	1.082	1.082	0.0	0.4	0.4	168.7	O K
960 min Winter	1.109	1.109	0.0	0.4	0.4	177.2	O K
1440 min Winter	1.140	1.140	0.0	0.4	0.4	187.2	O K
2160 min Winter	1.160	1.160	0.0	0.4	0.4	193.9	O K
2880 min Winter	1.167	1.167	0.0	0.4	0.4	196.3	O K
4320 min Winter	1.165	1.165	0.0	0.4	0.4	195.4	O K
5760 min Winter	1.158	1.158	0.0	0.4	0.4	193.3	O K
7200 min Winter	1.155	1.155	0.0	0.4	0.4	191.9	O K
8640 min Winter	1.150	1.150	0.0	0.4	0.4	190.3	O K
10080 min Winter	1.145	1.145	0.0	0.4	0.4	188.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180 min Winter	14.296	0.0	65.4	182
240 min Winter	11.544	0.0	66.5	242
360 min Winter	8.516	0.0	67.8	360
480 min Winter	6.856	0.0	68.5	478
600 min Winter	5.794	0.0	68.9	596
720 min Winter	5.050	0.0	69.1	714
960 min Winter	4.068	0.0	69.2	950
1440 min Winter	2.991	0.0	68.3	1412
2160 min Winter	2.195	0.0	137.2	2096
2880 min Winter	1.766	0.0	136.0	2768
4320 min Winter	1.308	0.0	131.0	4020
5760 min Winter	1.064	0.0	260.3	4552
7200 min Winter	0.913	0.0	259.0	5480
8640 min Winter	0.809	0.0	255.2	6408
10080 min Winter	0.734	0.0	249.3	7368

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	10	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 503065 437026 TA 03065 37026	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.361

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.361

Model Details

Storage is Online Cover Level (m) 2.000

Infiltration Trench Structure

Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	4.8
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	378.0
Safety Factor	1.0	Slope (1:X)	200.0
Porosity	0.30	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000	Cap Infiltration Depth (m)	0.000

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0029-5000-1500-5000
Design Head (m)	1.500
Design Flow (l/s)	0.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	29
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.500	0.5	Kick-Flo®	0.262	0.2
Flush-Flo™	0.129	0.3	Mean Flow over Head Range	-	0.4

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	0.3	0.800	0.4	2.000	0.6	4.000	0.8	7.000	1.0
0.200	0.3	1.000	0.4	2.200	0.6	4.500	0.8	7.500	1.0
0.300	0.3	1.200	0.5	2.400	0.6	5.000	0.9	8.000	1.1
0.400	0.3	1.400	0.5	2.600	0.6	5.500	0.9	8.500	1.1
0.500	0.3	1.600	0.5	3.000	0.7	6.000	0.9	9.000	1.1
0.600	0.3	1.800	0.5	3.500	0.7	6.500	1.0	9.500	1.1

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

Half Drain Time : 5804 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.798	0.798	0.0	0.4	0.4	91.7	O K
30 min Summer	0.915	0.915	0.0	0.4	0.4	120.6	O K
60 min Summer	1.021	1.021	0.0	0.4	0.4	150.2	O K
120 min Summer	1.094	1.094	0.0	0.4	0.4	172.5	O K
180 min Summer	1.137	1.137	0.0	0.4	0.4	186.3	O K
240 min Summer	1.168	1.168	0.0	0.4	0.4	196.3	O K
360 min Summer	1.210	1.210	0.0	0.5	0.5	210.7	O K
480 min Summer	1.239	1.239	0.0	0.5	0.5	221.1	O K
600 min Summer	1.262	1.262	0.0	0.5	0.5	229.2	O K
720 min Summer	1.280	1.280	0.0	0.5	0.5	235.8	O K
960 min Summer	1.307	1.307	0.0	0.5	0.5	246.0	O K
1440 min Summer	1.341	1.341	0.0	0.5	0.5	259.1	O K
2160 min Summer	1.367	1.367	0.0	0.5	0.5	269.2	O K
2880 min Summer	1.379	1.379	0.0	0.5	0.5	273.9	O K
4320 min Summer	1.384	1.384	0.0	0.5	0.5	275.6	O K
5760 min Summer	1.382	1.382	0.0	0.5	0.5	275.0	O K
7200 min Summer	1.381	1.381	0.0	0.5	0.5	274.7	O K
8640 min Summer	1.380	1.380	0.0	0.5	0.5	274.0	O K
10080 min Summer	1.378	1.378	0.0	0.5	0.5	273.3	O K
15 min Winter	0.845	0.845	0.0	0.4	0.4	102.8	O K
30 min Winter	0.969	0.969	0.0	0.4	0.4	135.1	O K
60 min Winter	1.081	1.081	0.0	0.4	0.4	168.4	O K
120 min Winter	1.159	1.159	0.0	0.4	0.4	193.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	136.059	0.0	31.5	19
30 min Summer	89.543	0.0	33.6	34
60 min Summer	55.972	0.0	68.7	64
120 min Summer	32.333	0.0	71.1	124
180 min Summer	23.419	0.0	72.4	184
240 min Summer	18.617	0.0	73.2	244
360 min Summer	13.461	0.0	74.1	364
480 min Summer	10.701	0.0	74.6	484
600 min Summer	8.962	0.0	74.8	604
720 min Summer	7.756	0.0	74.8	724
960 min Summer	6.183	0.0	74.6	962
1440 min Summer	4.495	0.0	73.3	1442
2160 min Summer	3.273	0.0	148.8	2160
2880 min Summer	2.620	0.0	147.0	2880
4320 min Summer	1.928	0.0	141.2	4196
5760 min Summer	1.559	0.0	287.0	4848
7200 min Summer	1.330	0.0	283.5	5624
8640 min Summer	1.171	0.0	278.1	6400
10080 min Summer	1.054	0.0	271.1	7256
15 min Winter	136.059	0.0	32.3	19
30 min Winter	89.543	0.0	34.5	34
60 min Winter	55.972	0.0	70.8	64
120 min Winter	32.333	0.0	73.2	124

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	1.205	1.205	0.0	0.5	0.5	209.1	O K
240 min Winter	1.237	1.237	0.0	0.5	0.5	220.5	O K
360 min Winter	1.282	1.282	0.0	0.5	0.5	236.8	O K
480 min Winter	1.314	1.314	0.0	0.5	0.5	248.8	O K
600 min Winter	1.339	1.339	0.0	0.5	0.5	258.1	O K
720 min Winter	1.359	1.359	0.0	0.5	0.5	265.8	O K
960 min Winter	1.389	1.389	0.0	0.5	0.5	277.9	O K
1440 min Winter	1.428	1.428	0.0	0.5	0.5	293.8	O K
2160 min Winter	1.460	1.460	0.0	0.5	0.5	307.0	O K
2880 min Winter	1.477	1.477	0.0	0.5	0.5	314.3	O K
4320 min Winter	1.492	1.492	0.0	0.5	0.5	320.6	O K
5760 min Winter	1.494	1.494	0.0	0.5	0.5	321.3	O K
7200 min Winter	1.491	1.491	0.0	0.5	0.5	320.0	O K
8640 min Winter	1.491	1.491	0.0	0.5	0.5	320.2	O K
10080 min Winter	1.490	1.490	0.0	0.5	0.5	319.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180 min Winter	23.419	0.0	74.5	182
240 min Winter	18.617	0.0	75.3	242
360 min Winter	13.461	0.0	76.2	360
480 min Winter	10.701	0.0	76.6	478
600 min Winter	8.962	0.0	76.8	596
720 min Winter	7.756	0.0	76.9	716
960 min Winter	6.183	0.0	76.6	952
1440 min Winter	4.495	0.0	75.2	1416
2160 min Winter	3.273	0.0	153.2	2116
2880 min Winter	2.620	0.0	151.2	2796
4320 min Winter	1.928	0.0	145.0	4148
5760 min Winter	1.559	0.0	297.3	5416
7200 min Winter	1.330	0.0	293.1	6408
8640 min Winter	1.171	0.0	287.0	6824
10080 min Winter	1.054	0.0	279.4	7760

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 503065 437026 TA 03065 37026	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.361

Time From:	(mins) To:	Area (ha)
0	4	0.361

Model Details

Storage is Online Cover Level (m) 2.000

Infiltration Trench Structure

Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	4.8
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	378.0
Safety Factor	1.0	Slope (1:X)	200.0
Porosity	0.30	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000	Cap Infiltration Depth (m)	0.000

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0029-5000-1500-5000
Design Head (m)	1.500
Design Flow (l/s)	0.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	29
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.500	0.5	Kick-Flo®	0.262	0.2
Flush-Flo™	0.129	0.3	Mean Flow over Head Range	-	0.4

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	0.3	0.800	0.4	2.000	0.6	4.000	0.8	7.000	1.0
0.200	0.3	1.000	0.4	2.200	0.6	4.500	0.8	7.500	1.0
0.300	0.3	1.200	0.5	2.400	0.6	5.000	0.9	8.000	1.1
0.400	0.3	1.400	0.5	2.600	0.6	5.500	0.9	8.500	1.1
0.500	0.3	1.600	0.5	3.000	0.7	6.000	0.9	9.000	1.1
0.600	0.3	1.800	0.5	3.500	0.7	6.500	1.0	9.500	1.1

Summary of Results for 200 year Return Period (+40%)

Half Drain Time : 6540 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.855	0.855	0.0	0.4	0.4	105.2	O K
30 min Summer	0.981	0.981	0.0	0.4	0.4	138.7	O K
60 min Summer	1.098	1.098	0.0	0.4	0.4	173.7	O K
120 min Summer	1.176	1.176	0.0	0.4	0.4	199.1	O K
180 min Summer	1.222	1.222	0.0	0.5	0.5	215.0	O K
240 min Summer	1.254	1.254	0.0	0.5	0.5	226.5	O K
360 min Summer	1.299	1.299	0.0	0.5	0.5	242.8	O K
480 min Summer	1.330	1.330	0.0	0.5	0.5	254.9	O K
600 min Summer	1.355	1.355	0.0	0.5	0.5	264.4	O K
720 min Summer	1.375	1.375	0.0	0.5	0.5	272.1	O K
960 min Summer	1.404	1.404	0.0	0.5	0.5	283.9	O K
1440 min Summer	1.442	1.442	0.0	0.5	0.5	299.5	O K
2160 min Summer	1.473	1.473	0.0	0.5	0.5	312.4	O K
2880 min Summer	1.489	1.489	0.0	0.5	0.5	319.1	O K
4320 min Summer	1.498	1.498	0.0	0.5	0.5	323.0	O K
5760 min Summer	1.495	1.495	0.0	0.5	0.5	321.7	O K
7200 min Summer	1.493	1.493	0.0	0.5	0.5	320.8	O K
8640 min Summer	1.489	1.489	0.0	0.5	0.5	319.5	O K
10080 min Summer	1.486	1.486	0.0	0.5	0.5	317.8	O K
15 min Winter	0.905	0.905	0.0	0.4	0.4	117.9	O K
30 min Winter	1.039	1.039	0.0	0.4	0.4	155.4	O K
60 min Winter	1.163	1.163	0.0	0.4	0.4	194.7	O K
120 min Winter	1.245	1.245	0.0	0.5	0.5	223.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	156.014	0.0	32.5	19
30 min Summer	102.974	0.0	34.7	34
60 min Summer	64.669	0.0	71.4	64
120 min Summer	37.256	0.0	73.8	124
180 min Summer	26.962	0.0	75.0	184
240 min Summer	21.417	0.0	75.8	244
360 min Summer	15.452	0.0	76.7	364
480 min Summer	12.277	0.0	77.1	484
600 min Summer	10.277	0.0	77.3	604
720 min Summer	8.890	0.0	77.3	724
960 min Summer	7.071	0.0	77.0	962
1440 min Summer	5.132	0.0	75.6	1442
2160 min Summer	3.732	0.0	154.1	2160
2880 min Summer	2.984	0.0	152.0	2880
4320 min Summer	2.186	0.0	145.8	4320
5760 min Summer	1.761	0.0	298.5	5128
7200 min Summer	1.495	0.0	293.9	5840
8640 min Summer	1.311	0.0	287.7	6656
10080 min Summer	1.175	0.0	280.1	7368
15 min Winter	156.014	0.0	33.5	19
30 min Winter	102.974	0.0	35.7	34
60 min Winter	64.669	0.0	73.5	64
120 min Winter	37.256	0.0	75.9	124

Summary of Results for 200 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	1.294	1.294	0.0	0.5	0.5	241.2	O K
240 min Winter	1.329	1.329	0.0	0.5	0.5	254.3	O K
360 min Winter	1.376	1.376	0.0	0.5	0.5	272.8	O K
480 min Winter	1.411	1.411	0.0	0.5	0.5	286.7	O K
600 min Winter	1.438	1.438	0.0	0.5	0.5	297.6	O K
720 min Winter	1.459	1.459	0.0	0.5	0.5	306.6	O K
960 min Winter	1.492	1.492	0.0	0.5	0.5	320.4	O K
1440 min Winter	1.535	1.535	0.0	0.5	0.5	339.1	O K
2160 min Winter	1.571	1.571	0.0	0.5	0.5	355.6	O K
2880 min Winter	1.592	1.592	0.0	0.5	0.5	365.0	O K
4320 min Winter	1.611	1.611	0.0	0.5	0.5	373.7	O K
5760 min Winter	1.615	1.615	0.0	0.5	0.5	375.4	O K
7200 min Winter	1.612	1.612	0.0	0.5	0.5	374.0	O K
8640 min Winter	1.607	1.607	0.0	0.5	0.5	371.9	O K
10080 min Winter	1.605	1.605	0.0	0.5	0.5	370.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180 min Winter	26.962	0.0	77.2	182
240 min Winter	21.417	0.0	78.0	242
360 min Winter	15.452	0.0	78.8	360
480 min Winter	12.277	0.0	79.3	480
600 min Winter	10.277	0.0	79.4	598
720 min Winter	8.890	0.0	79.4	716
960 min Winter	7.071	0.0	79.1	952
1440 min Winter	5.132	0.0	77.6	1426
2160 min Winter	3.732	0.0	158.6	2120
2880 min Winter	2.984	0.0	156.4	2820
4320 min Winter	2.186	0.0	149.8	4152
5760 min Winter	1.761	0.0	308.9	5472
7200 min Winter	1.495	0.0	303.8	6696
8640 min Winter	1.311	0.0	297.0	7000
10080 min Winter	1.175	0.0	288.7	7864

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	200	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 503065 437026 TA 03065 37026	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.361

Time From:	(mins) To:	Area (ha)
0	4	0.361

Model Details

Storage is Online Cover Level (m) 2.000

Infiltration Trench Structure

Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	4.8
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	378.0
Safety Factor	1.0	Slope (1:X)	200.0
Porosity	0.30	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000	Cap Infiltration Depth (m)	0.000

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0029-5000-1500-5000
Design Head (m)	1.500
Design Flow (l/s)	0.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	29
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.500	0.5	Kick-Flo®	0.262	0.2
Flush-Flo™	0.129	0.3	Mean Flow over Head Range	-	0.4

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	0.3	0.800	0.4	2.000	0.6	4.000	0.8	7.000	1.0
0.200	0.3	1.000	0.4	2.200	0.6	4.500	0.8	7.500	1.0
0.300	0.3	1.200	0.5	2.400	0.6	5.000	0.9	8.000	1.1
0.400	0.3	1.400	0.5	2.600	0.6	5.500	0.9	8.500	1.1
0.500	0.3	1.600	0.5	3.000	0.7	6.000	0.9	9.000	1.1
0.600	0.3	1.800	0.5	3.500	0.7	6.500	1.0	9.500	1.1

Summary of Results for 1000 year Return Period (+40%)

Half Drain Time : 8591 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	1.015	1.015	0.0	0.4	0.4	148.4	O K
30 min Summer	1.172	1.172	0.0	0.4	0.4	197.8	O K
60 min Summer	1.316	1.316	0.0	0.5	0.5	249.4	O K
120 min Summer	1.417	1.417	0.0	0.5	0.5	289.3	O K
180 min Summer	1.475	1.475	0.0	0.5	0.5	313.5	O K
240 min Summer	1.516	1.516	0.0	0.5	0.5	330.7	O K
360 min Summer	1.569	1.569	0.0	0.5	0.5	354.6	O K
480 min Summer	1.606	1.606	0.0	0.5	0.5	371.5	O K
600 min Summer	1.634	1.634	0.0	0.5	0.5	384.3	O K
720 min Summer	1.656	1.656	0.0	0.5	0.5	394.7	O K
960 min Summer	1.689	1.689	0.0	0.5	0.5	410.6	O K
1440 min Summer	1.732	1.732	0.0	0.5	0.5	431.8	Flood Risk
2160 min Summer	1.767	1.767	0.0	0.5	0.5	449.5	Flood Risk
2880 min Summer	1.785	1.785	0.0	0.5	0.5	458.8	Flood Risk
4320 min Summer	1.796	1.796	0.0	0.5	0.5	464.7	Flood Risk
5760 min Summer	1.791	1.791	0.0	0.5	0.5	462.0	Flood Risk
7200 min Summer	1.780	1.780	0.0	0.5	0.5	456.2	Flood Risk
8640 min Summer	1.770	1.770	0.0	0.5	0.5	451.1	Flood Risk
10080 min Summer	1.760	1.760	0.0	0.5	0.5	446.1	Flood Risk
15 min Winter	1.075	1.075	0.0	0.4	0.4	166.3	O K
30 min Winter	1.240	1.240	0.0	0.5	0.5	221.6	O K
60 min Winter	1.393	1.393	0.0	0.5	0.5	279.4	O K
120 min Winter	1.501	1.501	0.0	0.5	0.5	324.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	219.837	0.0	35.4	19
30 min Summer	146.633	0.0	37.8	34
60 min Summer	92.634	0.0	78.2	64
120 min Summer	53.959	0.0	80.9	124
180 min Summer	39.131	0.0	82.3	184
240 min Summer	31.078	0.0	83.1	244
360 min Summer	22.374	0.0	83.9	364
480 min Summer	17.697	0.0	84.2	484
600 min Summer	14.746	0.0	84.3	604
720 min Summer	12.702	0.0	84.2	724
960 min Summer	10.035	0.0	83.7	964
1440 min Summer	7.206	0.0	81.9	1442
2160 min Summer	5.178	0.0	167.7	2164
2880 min Summer	4.099	0.0	164.9	2880
4320 min Summer	2.954	0.0	157.3	4320
5760 min Summer	2.347	0.0	325.6	5760
7200 min Summer	1.968	0.0	318.9	6560
8640 min Summer	1.707	0.0	310.7	7256
10080 min Summer	1.515	0.0	301.3	7968
15 min Winter	219.837	0.0	36.3	19
30 min Winter	146.633	0.0	38.8	34
60 min Winter	92.634	0.0	80.5	64
120 min Winter	53.959	0.0	83.2	124

Summary of Results for 1000 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	1.563	1.563	0.0	0.5	0.5	351.6	O K
240 min Winter	1.605	1.605	0.0	0.5	0.5	371.0	O K
360 min Winter	1.663	1.663	0.0	0.5	0.5	398.1	O K
480 min Winter	1.702	1.702	0.0	0.5	0.5	417.3	Flood Risk
600 min Winter	1.732	1.732	0.0	0.5	0.5	432.0	Flood Risk
720 min Winter	1.756	1.756	0.0	0.5	0.5	443.9	Flood Risk
960 min Winter	1.792	1.792	0.0	0.5	0.5	462.4	Flood Risk
1440 min Winter	1.840	1.840	0.0	0.5	0.5	487.4	Flood Risk
2160 min Winter	1.881	1.881	0.0	0.6	0.6	509.3	Flood Risk
2880 min Winter	1.904	1.904	0.0	0.6	0.6	521.8	Flood Risk
4320 min Winter	1.924	1.924	0.0	0.6	0.6	532.8	Flood Risk
5760 min Winter	1.927	1.927	0.0	0.6	0.6	534.4	Flood Risk
7200 min Winter	1.921	1.921	0.0	0.6	0.6	531.4	Flood Risk
8640 min Winter	1.911	1.911	0.0	0.6	0.6	525.6	Flood Risk
10080 min Winter	1.897	1.897	0.0	0.6	0.6	518.1	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180 min Winter	39.131	0.0	84.6	182
240 min Winter	31.078	0.0	85.4	242
360 min Winter	22.374	0.0	86.2	362
480 min Winter	17.697	0.0	86.5	480
600 min Winter	14.746	0.0	86.6	598
720 min Winter	12.702	0.0	86.5	716
960 min Winter	10.035	0.0	85.9	954
1440 min Winter	7.206	0.0	84.0	1428
2160 min Winter	5.178	0.0	172.5	2136
2880 min Winter	4.099	0.0	169.6	2824
4320 min Winter	2.954	0.0	161.7	4196
5760 min Winter	2.347	0.0	336.3	5536
7200 min Winter	1.968	0.0	329.3	6848
8640 min Winter	1.707	0.0	320.8	8120
10080 min Winter	1.515	0.0	311.1	9176

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	1000	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 503065 437026 TA 03065 37026	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.361

Time From:	(mins) To:	Area (ha)
0	4	0.361

Model Details

Storage is Online Cover Level (m) 2.000

Infiltration Trench Structure

Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	4.8
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	378.0
Safety Factor	1.0	Slope (1:X)	200.0
Porosity	0.30	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000	Cap Infiltration Depth (m)	0.000

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0029-5000-1500-5000
Design Head (m)	1.500
Design Flow (l/s)	0.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	29
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.500	0.5	Kick-Flo®	0.262	0.2
Flush-Flo™	0.129	0.3	Mean Flow over Head Range	-	0.4

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	0.3	0.800	0.4	2.000	0.6	4.000	0.8	7.000	1.0
0.200	0.3	1.000	0.4	2.200	0.6	4.500	0.8	7.500	1.0
0.300	0.3	1.200	0.5	2.400	0.6	5.000	0.9	8.000	1.1
0.400	0.3	1.400	0.5	2.600	0.6	5.500	0.9	8.500	1.1
0.500	0.3	1.600	0.5	3.000	0.7	6.000	0.9	9.000	1.1
0.600	0.3	1.800	0.5	3.500	0.7	6.500	1.0	9.500	1.1

SUDS Design Summary - Dogger Bank - Zone 4 - Road Drainage - 06.02.25

Notes:

1. SUDS design proposal to attenuate surface water flows from access road hardstanding areas.

2. Road hardstanding assumed to be 100% hardstanding for design.

3. Drainage from access roads to discharge to adjacent filter trenches then to an existing watercourse at the pre-development run-off rate. To mimic existing drainage regime and achieve no net increase in flows to receiving watercourse.

4. SUDS design undertaken in line with national and local guidance and as set out in The SUDS Manual (C753).

5. Pre Development discharge rates estimated using FEH method - HR Wallingford Greenfield Runoff Rate Estimation Online Tool.

6. SUDS sizing estimated using FEH13 Rainfall and Micro Drainage design software.

Design Parameters / Assumptions	HVDC (AIS)	Notes
Hardstanding (all footprints assumed 100% impermeable)		
South Access Road (Discharge to Watercourse 3)	2,929	
Total (m2)	**2,929**	
Pre-Development Run-Off Rates (calculated from HR Wallingford Greenfield Runoff Rate Estimation Online Tool) (l/s)		
1.4 l/s/ha (l/s)	**0.41**	
	IH124 Method	
1 Year Return (l/s)	0.42	
2 Year Return (Q_{BAR}) (l/s)	0.49	
30 Year Return (l/s)	0.86	Low discharge rates may cause a blockage risk. Suitable discharge rates to be agreed with the local authority at detailed design stage.
100 Year Return (l/s)	1.02	
200 Year Return (l/s)	1.16	
	FEH Method	
1 Year Return (l/s)	0.76	
2 Year Return (Q_{BAR}) (l/s)	0.88	
30 Year Return (l/s)	1.54	
100 Year Return (l/s)	1.83	
200 Year Return (l/s)	2.09	
Attenuated Post Development Run-Off Rates	**Limited to pre-development (1.4 l/s/ha) run-off rate. Provides betterment over IH124 rate and FEH rate.**	Low discharge rates may cause a blockage risk. Suitable discharge rates to be agreed with the local authority at detailed design stage.
Design Storm Event	**1 in 100 year + 40% climate change as per ERYC guidance.**	
Attenuation Storage Required (calculated from FEH13 Rainfall using Micro Drainage design software) (m3)		Based on filter trenches either side of road, each taking half the hardstanding area (1465 m2) and limited to half the greenfield run-off rate (0.21 l/s)
All Hardstanding Areas (m3)	134.9	
Total storage required (m3)	**134.9**	
Filter Trench Dimensions (m)		
Length	149	
Width	3.10	
Gradient (1:X)	200	
Gravel Voids	0.3	
Design storage depth (m)	1.5	
Design freeboard (m)	0.5	
Overall depth (design depth + freeboard) (m)	2.0	
Design Check - Attenuation Storage Provided		
Filter Trenches		
Filter Trench Design	156	
Freeboard	69	
Total (design)	**156**	
Total (inc. freeboard)	226	
Design storage required < attenuation storage provided?	**YES = OK**	
Discharge Location	**Existing watercourse 3.**	**Design flows up to 1:100 year + 40% CC are attenuated within the filter trench design depth (1.5m).** **Additional 500mm freeboard provided provided over and above design capacity (total 2.0m depth).** **Filter trenches to be stepped to suit road gradients to utilise capacity along entire length.**
Sensitivity Check - Attenuation Storage Provided		
Storage Requirements		
1 in 200 year + 40% climate change	**155.8**	
1 in 1000 year + 40% climate change	**219.2**	
Storage Available		
Total (inc. freeboard, access track etc)	**226**	
Sensitivity check storage required < attenuation storage provided?	**YES = OK**	
Sensitivity Check - Half Drain Down Time		
Half Drain Down Time = < 24 hours?	**NO**	
Surplus Storage Available (Over and Above Design Storm)		
Total storage required (m3) - 1 in 100 year + 40% climate change	134.9	
Total storage available (inc. freeboard, access track etc)	226	
Surplus (freeboard minus design)	**91**	
1 in 10 year + 40% climate change	**82.4**	
Subsequent storm surplus storage can cater for	**Up to 1 in 10 year**	
Sensitivity check storage required < attenuation storage provided?	**YES = OK**	

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Christopher Sneddon
Site name:	Dogger Bank
Site location:	South Access Road WC3

Site Details

Latitude:	53.81527° N
Longitude:	0.45088° W
Reference:	4180898014
Date:	Feb 05 2025 16:54

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Runoff estimation approach

FEH Statistical

Site characteristics

Total site area (ha):	0.2929

Methodology

Q_{MED} estimation method:	Calculate from BFI and SAAR
BFI and SPR method:	Specify BFI manually
HOST class:	N/A
BFI / BFIHOST:	0.44
Q_{MED} (l/s):	
Q_{BAR} / Q_{MED} factor:	1.06

Hydrological characteristics

	Default	Edited
SAAR (mm):	649	649
Hydrological region:	3	3
Growth curve factor 1 year:	0.86	0.86
Growth curve factor 30 years:	1.75	1.75
Growth curve factor 100 years:	2.08	2.08
Growth curve factor 200 years:	2.37	2.37

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):		0.88
1 in 1 year (l/s):		0.76
1 in 30 years (l/s):		1.54
1 in 100 year (l/s):		1.83
1 in 200 years (l/s):		2.09

hr wallingford

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Christopher Sneddon
Site name:	Dogger Bank
Site location:	South Access Road WC3

Site Details

Latitude:	53.81527° N
Longitude:	0.45088° W
Reference:	301578689
Date:	Feb 05 2025 16:51

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Runoff estimation approach: IH124

Site characteristics

Total site area (ha): 0.2929

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	2	2
HOST class:	N/A	N/A
SPR/SPRHOST:	0.3	0.3

Hydrological characteristics

	Default	Edited
SAAR (mm):	649	649
Hydrological region:	3	3
Growth curve factor 1 year:	0.86	0.86
Growth curve factor 30 years:	1.75	1.75
Growth curve factor 100 years:	2.08	2.08
Growth curve factor 200 years:	2.37	2.37

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	0.49	0.49
1 in 1 year (l/s):	0.42	0.42
1 in 30 years (l/s):	0.86	0.86
1 in 100 year (l/s):	1.02	1.02
1 in 200 years (l/s):	1.16	1.16

Summary of Results for 10 year Return Period (+40%)

Half Drain Time : 4460 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.481	0.481	0.0	0.1	0.1	21.5	O K
30 min Summer	0.545	0.545	0.0	0.1	0.1	27.7	O K
60 min Summer	0.605	0.605	0.0	0.1	0.1	34.1	O K
120 min Summer	0.666	0.666	0.0	0.1	0.1	41.3	O K
180 min Summer	0.701	0.701	0.0	0.1	0.1	45.7	O K
240 min Summer	0.725	0.725	0.0	0.1	0.1	48.8	O K
360 min Summer	0.757	0.757	0.0	0.1	0.1	53.3	O K
480 min Summer	0.780	0.780	0.0	0.2	0.2	56.5	O K
600 min Summer	0.798	0.798	0.0	0.2	0.2	59.0	O K
720 min Summer	0.812	0.812	0.0	0.2	0.2	61.0	O K
960 min Summer	0.835	0.835	0.0	0.2	0.2	64.0	O K
1440 min Summer	0.860	0.860	0.0	0.2	0.2	67.6	O K
2160 min Summer	0.877	0.877	0.0	0.2	0.2	69.9	O K
2880 min Summer	0.883	0.883	0.0	0.2	0.2	70.7	O K
4320 min Summer	0.882	0.882	0.0	0.2	0.2	70.6	O K
5760 min Summer	0.880	0.880	0.0	0.2	0.2	70.4	O K
7200 min Summer	0.880	0.880	0.0	0.2	0.2	70.3	O K
8640 min Summer	0.880	0.880	0.0	0.2	0.2	70.4	O K
10080 min Summer	0.882	0.882	0.0	0.2	0.2	70.6	O K
15 min Winter	0.509	0.509	0.0	0.1	0.1	24.1	O K
30 min Winter	0.577	0.577	0.0	0.1	0.1	31.0	O K
60 min Winter	0.641	0.641	0.0	0.1	0.1	38.2	O K
120 min Winter	0.706	0.706	0.0	0.1	0.1	46.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	78.937	0.0	10.1	19
30 min Summer	50.914	0.0	10.8	34
60 min Summer	31.486	0.0	21.7	64
120 min Summer	19.243	0.0	22.8	124
180 min Summer	14.296	0.0	23.4	184
240 min Summer	11.544	0.0	23.8	244
360 min Summer	8.516	0.0	24.2	364
480 min Summer	6.856	0.0	24.4	484
600 min Summer	5.794	0.0	24.6	602
720 min Summer	5.050	0.0	24.6	722
960 min Summer	4.068	0.0	24.6	962
1440 min Summer	2.991	0.0	24.3	1442
2160 min Summer	2.195	0.0	48.9	2160
2880 min Summer	1.766	0.0	48.5	2880
4320 min Summer	1.308	0.0	46.7	3676
5760 min Summer	1.064	0.0	93.0	4448
7200 min Summer	0.913	0.0	92.3	5256
8640 min Summer	0.809	0.0	90.8	6056
10080 min Summer	0.734	0.0	88.4	6952
15 min Winter	78.937	0.0	10.4	19
30 min Winter	50.914	0.0	11.1	34
60 min Winter	31.486	0.0	22.4	64
120 min Winter	19.243	0.0	23.5	122

Summary of Results for 10 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Σ Max Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	0.743	0.743	0.0	0.1	0.1	51.3	O K
240 min Winter	0.768	0.768	0.0	0.2	0.2	54.9	O K
360 min Winter	0.805	0.805	0.0	0.2	0.2	60.0	O K
480 min Winter	0.832	0.832	0.0	0.2	0.2	63.7	O K
600 min Winter	0.853	0.853	0.0	0.2	0.2	66.5	O K
720 min Winter	0.869	0.869	0.0	0.2	0.2	68.9	O K
960 min Winter	0.896	0.896	0.0	0.2	0.2	72.5	O K
1440 min Winter	0.928	0.928	0.0	0.2	0.2	76.9	O K
2160 min Winter	0.951	0.951	0.0	0.2	0.2	80.2	O K
2880 min Winter	0.962	0.962	0.0	0.2	0.2	81.7	O K
4320 min Winter	0.967	0.967	0.0	0.2	0.2	82.4	O K
5760 min Winter	0.964	0.964	0.0	0.2	0.2	81.9	O K
7200 min Winter	0.965	0.965	0.0	0.2	0.2	82.1	O K
8640 min Winter	0.966	0.966	0.0	0.2	0.2	82.2	O K
10080 min Winter	0.965	0.965	0.0	0.2	0.2	82.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180 min Winter	14.296	0.0	24.1	182
240 min Winter	11.544	0.0	24.5	242
360 min Winter	8.516	0.0	24.9	360
480 min Winter	6.856	0.0	25.1	478
600 min Winter	5.794	0.0	25.3	596
720 min Winter	5.050	0.0	25.3	714
960 min Winter	4.068	0.0	25.3	950
1440 min Winter	2.991	0.0	25.0	1414
2160 min Winter	2.195	0.0	50.5	2100
2880 min Winter	1.766	0.0	50.0	2772
4320 min Winter	1.308	0.0	48.1	4064
5760 min Winter	1.064	0.0	96.9	4728
7200 min Winter	0.913	0.0	96.0	5616
8640 min Winter	0.809	0.0	94.3	6560
10080 min Winter	0.734	0.0	92.0	7464

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	10	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 503065 437026 TA 03065 37026	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.146

Time From: (mins)	To:	Area (ha)
0	4	0.146

Model Details

Storage is Online Cover Level (m) 2.000

Infiltration Trench Structure

Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	3.1
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	149.0
Safety Factor	1.0	Slope (1:X)	200.0
Porosity	0.30	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000	Cap Infiltration Depth (m)	0.000

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0018-2000-1500-2000
Design Head (m)	1.500
Design Flow (l/s)	0.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	18
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	0.2	Kick-Flo®	0.161	0.1
Flush-Flo™	0.075	0.1	Mean Flow over Head Range	-	0.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.1	0.800	0.2	2.000	0.2	4.000	0.3	7.000	0.4
0.200	0.1	1.000	0.2	2.200	0.2	4.500	0.3	7.500	0.4
0.300	0.1	1.200	0.2	2.400	0.2	5.000	0.3	8.000	0.4
0.400	0.1	1.400	0.2	2.600	0.3	5.500	0.4	8.500	0.4
0.500	0.1	1.600	0.2	3.000	0.3	6.000	0.4	9.000	0.4
0.600	0.1	1.800	0.2	3.500	0.3	6.500	0.4	9.500	0.4

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

Half Drain Time : 6464 minutes.

Outflow is too low. Design is unsatisfactory.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.632	0.632	0.0	0.1	0.1	37.1	O K
30 min Summer	0.724	0.724	0.0	0.1	0.1	48.8	O K
60 min Summer	0.811	0.811	0.0	0.2	0.2	60.8	O K
120 min Summer	0.877	0.877	0.0	0.2	0.2	69.9	O K
180 min Summer	0.917	0.917	0.0	0.2	0.2	75.5	O K
240 min Summer	0.947	0.947	0.0	0.2	0.2	79.6	O K
360 min Summer	0.990	0.990	0.0	0.2	0.2	85.5	O K
480 min Summer	1.021	1.021	0.0	0.2	0.2	89.8	O K
600 min Summer	1.045	1.045	0.0	0.2	0.2	93.2	O K
720 min Summer	1.065	1.065	0.0	0.2	0.2	96.0	O K
960 min Summer	1.097	1.097	0.0	0.2	0.2	100.3	O K
1440 min Summer	1.138	1.138	0.0	0.2	0.2	106.0	O K
2160 min Summer	1.171	1.171	0.0	0.2	0.2	110.7	O K
2880 min Summer	1.189	1.189	0.0	0.2	0.2	113.1	O K
4320 min Summer	1.202	1.202	0.0	0.2	0.2	114.9	O K
5760 min Summer	1.204	1.204	0.0	0.2	0.2	115.2	O K
7200 min Summer	1.207	1.207	0.0	0.2	0.2	115.6	O K
8640 min Summer	1.210	1.210	0.0	0.2	0.2	116.0	O K
10080 min Summer	1.212	1.212	0.0	0.2	0.2	116.3	O K
15 min Winter	0.669	0.669	0.0	0.1	0.1	41.6	O K
30 min Winter	0.767	0.767	0.0	0.2	0.2	54.7	O K
60 min Winter	0.864	0.864	0.0	0.2	0.2	68.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	136.059	0.0	11.6	19
30 min Summer	89.543	0.0	12.3	34
60 min Summer	55.972	0.0	25.3	64
120 min Summer	32.333	0.0	26.1	124
180 min Summer	23.419	0.0	26.6	184
240 min Summer	18.617	0.0	26.9	244
360 min Summer	13.461	0.0	27.2	364
480 min Summer	10.701	0.0	27.4	484
600 min Summer	8.962	0.0	27.5	604
720 min Summer	7.756	0.0	27.6	724
960 min Summer	6.183	0.0	27.5	962
1440 min Summer	4.495	0.0	27.1	1442
2160 min Summer	3.273	0.0	55.2	2160
2880 min Summer	2.620	0.0	54.6	2880
4320 min Summer	1.928	0.0	52.4	4320
5760 min Summer	1.559	0.0	107.1	5016
7200 min Summer	1.330	0.0	105.7	5768
8640 min Summer	1.171	0.0	103.6	6576
10080 min Summer	1.054	0.0	100.8	7360
15 min Winter	136.059	0.0	11.9	19
30 min Winter	89.543	0.0	12.6	34
60 min Winter	55.972	0.0	26.0	64

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
120 min Winter	0.938	0.938	0.0	0.2	0.2	78.3	O K
180 min Winter	0.984	0.984	0.0	0.2	0.2	84.7	O K
240 min Winter	1.018	1.018	0.0	0.2	0.2	89.4	O K
360 min Winter	1.066	1.066	0.0	0.2	0.2	96.1	O K
480 min Winter	1.102	1.102	0.0	0.2	0.2	101.0	O K
600 min Winter	1.130	1.130	0.0	0.2	0.2	104.9	O K
720 min Winter	1.153	1.153	0.0	0.2	0.2	108.1	O K
960 min Winter	1.189	1.189	0.0	0.2	0.2	113.2	O K
1440 min Winter	1.238	1.238	0.0	0.2	0.2	120.0	O K
2160 min Winter	1.281	1.281	0.0	0.2	0.2	125.9	O K
2880 min Winter	1.306	1.306	0.0	0.2	0.2	129.4	O K
4320 min Winter	1.331	1.331	0.0	0.2	0.2	132.9	O K
5760 min Winter	1.340	1.340	0.0	0.2	0.2	134.0	O K
7200 min Winter	1.341	1.341	0.0	0.2	0.2	134.2	O K
8640 min Winter	1.343	1.343	0.0	0.2	0.2	134.4	O K
10080 min Winter	1.346	1.346	0.0	0.2	0.2	134.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
120 min Winter	32.333	0.0	26.9	124
180 min Winter	23.419	0.0	27.4	182
240 min Winter	18.617	0.0	27.7	242
360 min Winter	13.461	0.0	28.1	360
480 min Winter	10.701	0.0	28.3	478
600 min Winter	8.962	0.0	28.4	596
720 min Winter	7.756	0.0	28.5	716
960 min Winter	6.183	0.0	28.4	952
1440 min Winter	4.495	0.0	28.0	1426
2160 min Winter	3.273	0.0	57.2	2120
2880 min Winter	2.620	0.0	56.6	2800
4320 min Winter	1.928	0.0	54.3	4152
5760 min Winter	1.559	0.0	111.6	5472
7200 min Winter	1.330	0.0	110.1	6632
8640 min Winter	1.171	0.0	107.9	6920
10080 min Winter	1.054	0.0	105.0	7864

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 503065 437026 TA 03065 37026	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.146

Time From:	(mins) To:	Area (ha)
0	4	0.146

Model Details

Storage is Online Cover Level (m) 2.000

Infiltration Trench Structure

Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	3.1
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	149.0
Safety Factor	1.0	Slope (1:X)	200.0
Porosity	0.30	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000	Cap Infiltration Depth (m)	0.000

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0018-2000-1500-2000
Design Head (m)	1.500
Design Flow (l/s)	0.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	18
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.500	0.2	Kick-Flo®	0.161	0.1
Flush-Flo™	0.075	0.1	Mean Flow over Head Range	-	0.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	0.1	0.800	0.2	2.000	0.2	4.000	0.3	7.000	0.4
0.200	0.1	1.000	0.2	2.200	0.2	4.500	0.3	7.500	0.4
0.300	0.1	1.200	0.2	2.400	0.2	5.000	0.3	8.000	0.4
0.400	0.1	1.400	0.2	2.600	0.3	5.500	0.4	8.500	0.4
0.500	0.1	1.600	0.2	3.000	0.3	6.000	0.4	9.000	0.4
0.600	0.1	1.800	0.2	3.500	0.3	6.500	0.4	9.500	0.4

Summary of Results for 200 year Return Period (+40%)

Half Drain Time : 7188 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.677	0.677	0.0	0.1	0.1	42.6	O K
30 min Summer	0.778	0.778	0.0	0.2	0.2	56.1	O K
60 min Summer	0.880	0.880	0.0	0.2	0.2	70.3	O K
120 min Summer	0.954	0.954	0.0	0.2	0.2	80.6	O K
180 min Summer	1.001	1.001	0.0	0.2	0.2	87.1	O K
240 min Summer	1.035	1.035	0.0	0.2	0.2	91.8	O K
360 min Summer	1.084	1.084	0.0	0.2	0.2	98.5	O K
480 min Summer	1.120	1.120	0.0	0.2	0.2	103.5	O K
600 min Summer	1.148	1.148	0.0	0.2	0.2	107.5	O K
720 min Summer	1.171	1.171	0.0	0.2	0.2	110.7	O K
960 min Summer	1.207	1.207	0.0	0.2	0.2	115.6	O K
1440 min Summer	1.255	1.255	0.0	0.2	0.2	122.3	O K
2160 min Summer	1.297	1.297	0.0	0.2	0.2	128.1	O K
2880 min Summer	1.320	1.320	0.0	0.2	0.2	131.3	O K
4320 min Summer	1.339	1.339	0.0	0.2	0.2	133.9	O K
5760 min Summer	1.340	1.340	0.0	0.2	0.2	134.1	O K
7200 min Summer	1.341	1.341	0.0	0.2	0.2	134.2	O K
8640 min Summer	1.341	1.341	0.0	0.2	0.2	134.2	O K
10080 min Summer	1.341	1.341	0.0	0.2	0.2	134.2	O K
15 min Winter	0.716	0.716	0.0	0.1	0.1	47.7	O K
30 min Winter	0.826	0.826	0.0	0.2	0.2	62.9	O K
60 min Winter	0.941	0.941	0.0	0.2	0.2	78.8	O K
120 min Winter	1.025	1.025	0.0	0.2	0.2	90.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	156.014	0.0	12.0	19
30 min Summer	102.974	0.0	12.7	34
60 min Summer	64.669	0.0	26.2	64
120 min Summer	37.256	0.0	27.1	124
180 min Summer	26.962	0.0	27.6	184
240 min Summer	21.417	0.0	27.9	244
360 min Summer	15.452	0.0	28.3	364
480 min Summer	12.277	0.0	28.5	484
600 min Summer	10.277	0.0	28.6	604
720 min Summer	8.890	0.0	28.7	724
960 min Summer	7.071	0.0	28.6	962
1440 min Summer	5.132	0.0	28.2	1442
2160 min Summer	3.732	0.0	57.6	2160
2880 min Summer	2.984	0.0	56.9	2880
4320 min Summer	2.186	0.0	54.6	4320
5760 min Summer	1.761	0.0	112.1	5360
7200 min Summer	1.495	0.0	110.4	6048
8640 min Summer	1.311	0.0	108.0	6824
10080 min Summer	1.175	0.0	105.0	7560
15 min Winter	156.014	0.0	12.3	19
30 min Winter	102.974	0.0	13.1	34
60 min Winter	64.669	0.0	27.0	64
120 min Winter	37.256	0.0	27.9	124

Summary of Results for 200 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	1.078	1.078	0.0	0.2	0.2	97.7	O K
240 min Winter	1.116	1.116	0.0	0.2	0.2	103.1	O K
360 min Winter	1.171	1.171	0.0	0.2	0.2	110.7	O K
480 min Winter	1.212	1.212	0.0	0.2	0.2	116.3	O K
600 min Winter	1.245	1.245	0.0	0.2	0.2	120.9	O K
720 min Winter	1.272	1.272	0.0	0.2	0.2	124.6	O K
960 min Winter	1.313	1.313	0.0	0.2	0.2	130.4	O K
1440 min Winter	1.371	1.371	0.0	0.2	0.2	138.3	O K
2160 min Winter	1.422	1.422	0.0	0.2	0.2	145.5	O K
2880 min Winter	1.453	1.453	0.0	0.2	0.2	149.8	O K
4320 min Winter	1.485	1.485	0.0	0.2	0.2	154.2	O K
5760 min Winter	1.496	1.496	0.0	0.2	0.2	155.7	O K
7200 min Winter	1.497	1.497	0.0	0.2	0.2	155.8	O K
8640 min Winter	1.493	1.493	0.0	0.2	0.2	155.3	O K
10080 min Winter	1.494	1.494	0.0	0.2	0.2	155.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180 min Winter	26.962	0.0	28.5	182
240 min Winter	21.417	0.0	28.8	242
360 min Winter	15.452	0.0	29.3	360
480 min Winter	12.277	0.0	29.5	480
600 min Winter	10.277	0.0	29.6	598
720 min Winter	8.890	0.0	29.7	716
960 min Winter	7.071	0.0	29.6	952
1440 min Winter	5.132	0.0	29.1	1426
2160 min Winter	3.732	0.0	59.8	2120
2880 min Winter	2.984	0.0	59.0	2820
4320 min Winter	2.186	0.0	56.6	4188
5760 min Winter	1.761	0.0	116.9	5480
7200 min Winter	1.495	0.0	115.1	6768
8640 min Winter	1.311	0.0	112.6	7264
10080 min Winter	1.175	0.0	109.4	7968

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	200	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 503065 437026 TA 03065 37026	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.146

Time (mins) From:	To:	Area (ha)
0	4	0.146

Model Details

Storage is Online Cover Level (m) 2.000

Infiltration Trench Structure

Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	3.1
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	149.0
Safety Factor	1.0	Slope (1:X)	200.0
Porosity	0.30	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000	Cap Infiltration Depth (m)	0.000

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0018-2000-1500-2000
Design Head (m)	1.500
Design Flow (l/s)	0.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	18
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.500	0.2	Kick-Flo®	0.161	0.1
Flush-Flo™	0.075	0.1	Mean Flow over Head Range	-	0.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	0.1	0.800	0.2	2.000	0.2	4.000	0.3	7.000	0.4
0.200	0.1	1.000	0.2	2.200	0.2	4.500	0.3	7.500	0.4
0.300	0.1	1.200	0.2	2.400	0.2	5.000	0.3	8.000	0.4
0.400	0.1	1.400	0.2	2.600	0.3	5.500	0.4	8.500	0.4
0.500	0.1	1.600	0.2	3.000	0.3	6.000	0.4	9.000	0.4
0.600	0.1	1.800	0.2	3.500	0.3	6.500	0.4	9.500	0.4

Summary of Results for 1000 year Return Period (+40%)

Half Drain Time : 9098 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.806	0.806	0.0	0.2	0.2	60.0	O K
30 min Summer	0.950	0.950	0.0	0.2	0.2	80.0	O K
60 min Summer	1.101	1.101	0.0	0.2	0.2	100.9	O K
120 min Summer	1.218	1.218	0.0	0.2	0.2	117.1	O K
180 min Summer	1.289	1.289	0.0	0.2	0.2	126.9	O K
240 min Summer	1.339	1.339	0.0	0.2	0.2	134.0	O K
360 min Summer	1.410	1.410	0.0	0.2	0.2	143.7	O K
480 min Summer	1.459	1.459	0.0	0.2	0.2	150.6	O K
600 min Summer	1.498	1.498	0.0	0.2	0.2	155.9	O K
720 min Summer	1.528	1.528	0.0	0.2	0.2	160.2	O K
960 min Summer	1.576	1.576	0.0	0.2	0.2	166.8	O K
1440 min Summer	1.640	1.640	0.0	0.2	0.2	175.6	O K
2160 min Summer	1.695	1.695	0.0	0.2	0.2	183.2	O K
2880 min Summer	1.725	1.725	0.0	0.2	0.2	187.4	Flood Risk
4320 min Summer	1.748	1.748	0.0	0.2	0.2	190.6	Flood Risk
5760 min Summer	1.746	1.746	0.0	0.2	0.2	190.3	Flood Risk
7200 min Summer	1.733	1.733	0.0	0.2	0.2	188.5	Flood Risk
8640 min Summer	1.721	1.721	0.0	0.2	0.2	186.9	Flood Risk
10080 min Summer	1.710	1.710	0.0	0.2	0.2	185.4	Flood Risk
15 min Winter	0.858	0.858	0.0	0.2	0.2	67.3	O K
30 min Winter	1.019	1.019	0.0	0.2	0.2	89.6	O K
60 min Winter	1.188	1.188	0.0	0.2	0.2	113.1	O K
120 min Winter	1.320	1.320	0.0	0.2	0.2	131.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	219.837	0.0	12.9	19
30 min Summer	146.633	0.0	13.9	34
60 min Summer	92.634	0.0	28.9	64
120 min Summer	53.959	0.0	30.1	124
180 min Summer	39.131	0.0	30.8	184
240 min Summer	31.078	0.0	31.2	244
360 min Summer	22.374	0.0	31.7	364
480 min Summer	17.697	0.0	31.9	484
600 min Summer	14.746	0.0	32.1	604
720 min Summer	12.702	0.0	32.1	724
960 min Summer	10.035	0.0	32.0	964
1440 min Summer	7.206	0.0	31.3	1442
2160 min Summer	5.178	0.0	64.4	2164
2880 min Summer	4.099	0.0	63.4	2880
4320 min Summer	2.954	0.0	60.3	4320
5760 min Summer	2.347	0.0	125.1	5760
7200 min Summer	1.968	0.0	122.6	6704
8640 min Summer	1.707	0.0	119.4	7344
10080 min Summer	1.515	0.0	115.6	8064
15 min Winter	219.837	0.0	13.3	19
30 min Winter	146.633	0.0	14.3	34
60 min Winter	92.634	0.0	29.9	64
120 min Winter	53.959	0.0	31.2	124

Summary of Results for 1000 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	1.400	1.400	0.0	0.2	0.2	142.3	O K
240 min Winter	1.457	1.457	0.0	0.2	0.2	150.3	O K
360 min Winter	1.536	1.536	0.0	0.2	0.2	161.3	O K
480 min Winter	1.593	1.593	0.0	0.2	0.2	169.1	O K
600 min Winter	1.637	1.637	0.0	0.2	0.2	175.2	O K
720 min Winter	1.672	1.672	0.0	0.2	0.2	180.1	O K
960 min Winter	1.727	1.727	0.0	0.2	0.2	187.7	Flood Risk
1440 min Winter	1.802	1.802	0.0	0.2	0.2	198.1	Flood Risk
2160 min Winter	1.868	1.868	0.0	0.2	0.2	207.3	Flood Risk
2880 min Winter	1.908	1.908	0.0	0.2	0.2	212.7	Flood Risk
4320 min Winter	1.945	1.945	0.0	0.2	0.2	217.9	Flood Risk
5760 min Winter	1.954	1.954	0.0	0.2	0.2	219.2	Flood Risk
7200 min Winter	1.950	1.950	0.0	0.2	0.2	218.6	Flood Risk
8640 min Winter	1.937	1.937	0.0	0.2	0.2	216.8	Flood Risk
10080 min Winter	1.919	1.919	0.0	0.2	0.2	214.3	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180 min Winter	39.131	0.0	31.9	182
240 min Winter	31.078	0.0	32.4	242
360 min Winter	22.374	0.0	32.9	362
480 min Winter	17.697	0.0	33.1	480
600 min Winter	14.746	0.0	33.3	598
720 min Winter	12.702	0.0	33.3	716
960 min Winter	10.035	0.0	33.2	954
1440 min Winter	7.206	0.0	32.5	1428
2160 min Winter	5.178	0.0	67.0	2136
2880 min Winter	4.099	0.0	65.9	2824
4320 min Winter	2.954	0.0	62.7	4196
5760 min Winter	2.347	0.0	130.7	5536
7200 min Winter	1.968	0.0	128.0	6848
8640 min Winter	1.707	0.0	124.6	8120
10080 min Winter	1.515	0.0	120.5	9184

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	1000	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 503065 437026 TA 03065 37026	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.146

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.146

Model Details

Storage is Online Cover Level (m) 2.000

Infiltration Trench Structure

Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	3.1
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	149.0
Safety Factor	1.0	Slope (1:X)	200.0
Porosity	0.30	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000	Cap Infiltration Depth (m)	0.000

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0018-2000-1500-2000
Design Head (m)	1.500
Design Flow (l/s)	0.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	18
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.500	0.2	Kick-Flo®	0.161	0.1
Flush-Flo™	0.075	0.1	Mean Flow over Head Range	-	0.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	0.1	0.800	0.2	2.000	0.2	4.000	0.3	7.000	0.4
0.200	0.1	1.000	0.2	2.200	0.2	4.500	0.3	7.500	0.4
0.300	0.1	1.200	0.2	2.400	0.2	5.000	0.3	8.000	0.4
0.400	0.1	1.400	0.2	2.600	0.3	5.500	0.4	8.500	0.4
0.500	0.1	1.600	0.2	3.000	0.3	6.000	0.4	9.000	0.4
0.600	0.1	1.800	0.2	3.500	0.3	6.500	0.4	9.500	0.4

SUDS Design Summary - Dogger Bank - Zone 4 - Road Drainage - 06.02.25		
Notes:		
1. SUDS design proposal to attenuate surface water flows from access road hardstanding areas.		
2. Road hardstanding assumed to be 100% hardstanding for design.		
3. Drainage from access roads to discharge to adjacent filter trenches then to an existing watercourse at the pre-development run-off rate. To mimic existing drainage regime and achieve no net increase in flows to receiving watercourse.		
4. SUDS design undertaken in line with national and local guidance and as set out in The SUDS Manual (C753).		
5. Pre Development discharge rates estimated using FEH method - HR Wallingford Greenfield Runoff Rate Estimation Online Tool.		
6. SUDS sizing estimated using FEH13 Rainfall and Micro Drainage design software.		
Design Parameters / Assumptions	**HVDC (AIS)**	**Change Notes**
Hardstanding (all footprints assumed 100% impermeable)		
South Access Road (Discharge to Watercourse 2)	2,433	
Total (m2)	**2,433**	
Pre-Development Run-Off Rates (calculated from HR Wallingford Greenfield Runoff Rate Estimation Online Tool) (l/s)		Low discharge rates may cause a blockage risk. Suitable discharge rates to be agreed with the local authority at detailed design stage.
1.4 l/s/ha (l/s)	**0.34**	
	IH124 Method	
1 Year Return (l/s)	0.35	
2 Year Return (Q_{BAR}) (l/s)	0.41	
30 Year Return (l/s)	0.71	
100 Year Return (l/s)	0.84	
200 Year Return (l/s)	0.96	
	FEH Method	
1 Year Return (l/s)	0.63	
2 Year Return (Q_{BAR}) (l/s)	0.73	
30 Year Return (l/s)	1.28	
100 Year Return (l/s)	1.52	
200 Year Return (l/s)	1.74	
Attenuated Post Development Run-Off Rates	**Limited to pre-development (1.4 l/s/ha) run-off rate. Provides betterment over IH124 rate and FEH rate.**	Low discharge rates may cause a blockage risk. Suitable discharge rates to be agreed with the local authority at detailed design stage.
Design Storm Event	**1 in 100 year + 40% climate change as per ERYC guidance.**	
Attenuation Storage Required (calculated from FEH13 Rainfall using Micro Drainage design software) (m3)		Based on filter trenches either side of road, each taking half the hardstanding area (1217 m2) and limited to half the greenfield run-off rate (0.17 l/s)
All Hardstanding Areas (m3)	102.3	
Total storage required (m3)	**102.3**	
Filter Trench Dimensions (m)		
Length	138	
Width	4.50	
Gradient (1:X)	200	
Gravel Voids	0.3	
Design storage depth (m)	0.9	
Design freeboard (m)	0.4	
Overall depth (design depth + freeboard) (m)	1.3	
Design Check - Attenuation Storage Provided		
Filter Trenches		
Filter Trench Design	103	
Freeboard	75	
Total (design)	**103**	
Total (inc. freeboard)	178	
Design storage required < attenuation storage provided?	**YES = OK**	
Discharge Location	**Existing watercourse 2.**	**Design flows up to 1:100 year + 40% CC are attenuated within the filter trench design depth (1.5m).** **Additional 500mm freeboard provided provided over and above design capacity (total 2.0m depth).** **Filter trenches to be stepped to suit road gradients to utilise capacity along entire length.**
Sensitivity Check - Attenuation Storage Provided		
Storage Requirements		
1 in 200 year + 40% climate change	**119.9**	
1 in 1000 year + 40% climate change	**172.5**	
Storage Available		
Total (inc. freeboard, access track etc)	**178**	
Sensitivity check storage required < attenuation storage provided?	**YES = OK**	
Sensitivity Check - Half Drain Down Time		
Half Drain Down Time = < 24 hours?	**NO**	
Surplus Storage Available (Over and Above Design Storm)		
Total storage required (m3) - 1 in 100 year + 40% climate change	102.3	
Total storage available (inc. freeboard, access track etc)	178	
Surplus (freeboard minus design)	**76**	
1 in 10 year + 40% climate change	**63**	
Subsequent storm surplus storage can cater for	**Up to 1 in 10 year**	
Sensitivity check storage required < attenuation storage provided?	**YES = OK**	

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Christopher Sneddon
Site name:	Dogger Bank
Site location:	South Access Road WC2

Site Details

Latitude:	53.81527° N
Longitude:	0.45088° W
Reference:	2783921195
Date:	Feb 05 2025 17:30

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Runoff estimation approach

FEH Statistical

Site characteristics

Total site area (ha):	0.2433

Methodology

Q_{MED} estimation method:	Calculate from BFI and SAAR
BFI and SPR method:	Specify BFI manually
HOST class:	N/A
BFI / BFIHOST:	0.44
Q_{MED} (l/s):	
Q_{BAR} / Q_{MED} factor:	1.06

Hydrological characteristics

	Default	Edited
SAAR (mm):	649	649
Hydrological region:	3	3
Growth curve factor 1 year:	0.86	0.86
Growth curve factor 30 years:	1.75	1.75
Growth curve factor 100 years:	2.08	2.08
Growth curve factor 200 years:	2.37	2.37

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):		0.73
1 in 1 year (l/s):		0.63
1 in 30 years (l/s):		1.28
1 in 100 year (l/s):		1.52
1 in 200 years (l/s):		1.74

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Christopher Sneddon
Site name:	Dogger Bank
Site location:	South Access Road WC2

Site Details

Latitude:	53.81527° N
Longitude:	0.45088° W
Reference:	1577373719
Date:	Feb 05 2025 17:30

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Runoff estimation approach: IH124

Site characteristics

Total site area (ha): 0.2433

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	2	2
HOST class:	N/A	N/A
SPR/SPRHOST:	0.3	0.3

Hydrological characteristics

	Default	Edited
SAAR (mm):	649	649
Hydrological region:	3	3
Growth curve factor 1 year:	0.86	0.86
Growth curve factor 30 years:	1.75	1.75
Growth curve factor 100 years:	2.08	2.08
Growth curve factor 200 years:	2.37	2.37

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	0.41	0.41
1 in 1 year (l/s):	0.35	0.35
1 in 30 years (l/s):	0.71	0.71
1 in 100 year (l/s):	0.84	0.84
1 in 200 years (l/s):	0.96	0.96

Summary of Results for 10 year Return Period (+40%)

Half Drain Time : 3181 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m^3)	Status
15 min Summer	0.364	0.364	0.0	0.1	0.1	17.9	O K
30 min Summer	0.413	0.413	0.0	0.1	0.1	23.0	O K
60 min Summer	0.458	0.458	0.0	0.2	0.2	28.3	O K
120 min Summer	0.504	0.504	0.0	0.2	0.2	34.2	O K
180 min Summer	0.529	0.529	0.0	0.2	0.2	37.8	O K
240 min Summer	0.546	0.546	0.0	0.2	0.2	40.3	O K
360 min Summer	0.569	0.569	0.0	0.2	0.2	43.8	O K
480 min Summer	0.585	0.585	0.0	0.2	0.2	46.2	O K
600 min Summer	0.596	0.596	0.0	0.2	0.2	48.0	O K
720 min Summer	0.605	0.605	0.0	0.2	0.2	49.4	O K
960 min Summer	0.617	0.617	0.0	0.2	0.2	51.4	O K
1440 min Summer	0.629	0.629	0.0	0.2	0.2	53.4	O K
2160 min Summer	0.631	0.631	0.0	0.2	0.2	53.8	O K
2880 min Summer	0.628	0.628	0.0	0.2	0.2	53.2	O K
4320 min Summer	0.620	0.620	0.0	0.2	0.2	51.9	O K
5760 min Summer	0.614	0.614	0.0	0.2	0.2	51.0	O K
7200 min Summer	0.612	0.612	0.0	0.2	0.2	50.5	O K
8640 min Summer	0.610	0.610	0.0	0.2	0.2	50.2	O K
10080 min Summer	0.609	0.609	0.0	0.2	0.2	50.1	O K
15 min Winter	0.386	0.386	0.0	0.1	0.1	20.1	O K
30 min Winter	0.437	0.437	0.0	0.1	0.1	25.8	O K
60 min Winter	0.485	0.485	0.0	0.2	0.2	31.8	O K
120 min Winter	0.534	0.534	0.0	0.2	0.2	38.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m^3)	Discharge Volume (m^3)	Time-Peak (mins)
15 min Summer	78.937	0.0	10.9	19
30 min Summer	50.914	0.0	11.7	34
60 min Summer	31.486	0.0	23.0	64
120 min Summer	19.243	0.0	24.5	124
180 min Summer	14.296	0.0	25.2	184
240 min Summer	11.544	0.0	25.7	244
360 min Summer	8.516	0.0	26.2	364
480 min Summer	6.856	0.0	26.5	482
600 min Summer	5.794	0.0	26.7	602
720 min Summer	5.050	0.0	26.8	722
960 min Summer	4.068	0.0	26.9	962
1440 min Summer	2.991	0.0	26.7	1442
2160 min Summer	2.195	0.0	52.5	2160
2880 min Summer	1.766	0.0	52.3	2512
4320 min Summer	1.308	0.0	50.8	3288
5760 min Summer	1.064	0.0	93.5	4088
7200 min Summer	0.913	0.0	94.9	4904
8640 min Summer	0.809	0.0	93.8	5792
10080 min Summer	0.734	0.0	91.4	6648
15 min Winter	78.937	0.0	11.3	19
30 min Winter	50.914	0.0	12.0	34
60 min Winter	31.486	0.0	23.9	64
120 min Winter	19.243	0.0	25.3	122

Summary of Results for 10 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control Σ (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	0.561	0.561	0.0	0.2	0.2	42.5	O K
240 min Winter	0.580	0.580	0.0	0.2	0.2	45.3	O K
360 min Winter	0.605	0.605	0.0	0.2	0.2	49.4	O K
480 min Winter	0.622	0.622	0.0	0.2	0.2	52.2	O K
600 min Winter	0.634	0.634	0.0	0.2	0.2	54.3	O K
720 min Winter	0.644	0.644	0.0	0.2	0.2	56.0	O K
960 min Winter	0.659	0.659	0.0	0.2	0.2	58.6	O K
1440 min Winter	0.674	0.674	0.0	0.2	0.2	61.3	O K
2160 min Winter	0.681	0.681	0.0	0.2	0.2	62.6	O K
2880 min Winter	0.681	0.681	0.0	0.2	0.2	62.6	O K
4320 min Winter	0.673	0.673	0.0	0.2	0.2	61.1	O K
5760 min Winter	0.665	0.665	0.0	0.2	0.2	59.8	O K
7200 min Winter	0.659	0.659	0.0	0.2	0.2	58.6	O K
8640 min Winter	0.654	0.654	0.0	0.2	0.2	57.7	O K
10080 min Winter	0.650	0.650	0.0	0.2	0.2	57.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180 min Winter	14.296	0.0	26.0	182
240 min Winter	11.544	0.0	26.5	240
360 min Winter	8.516	0.0	27.0	358
480 min Winter	6.856	0.0	27.3	476
600 min Winter	5.794	0.0	27.5	596
720 min Winter	5.050	0.0	27.6	712
960 min Winter	4.068	0.0	27.6	944
1440 min Winter	2.991	0.0	27.3	1402
2160 min Winter	2.195	0.0	54.2	2076
2880 min Winter	1.766	0.0	53.8	2736
4320 min Winter	1.308	0.0	52.1	3460
5760 min Winter	1.064	0.0	100.0	4384
7200 min Winter	0.913	0.0	100.2	5336
8640 min Winter	0.809	0.0	98.8	6232
10080 min Winter	0.734	0.0	96.3	7168

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	10	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 503065 437026 TA 03065 37026	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.122

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.122

Model Details

Storage is Online Cover Level (m) 1.300

Infiltration Trench Structure

Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	4.5
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	138.0
Safety Factor	1.0	Slope (1:X)	200.0
Porosity	0.30	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000	Cap Infiltration Depth (m)	0.000

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0020-2000-0900-2000
Design Head (m)	0.900
Design Flow (l/s)	0.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	20
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	0.900	0.2	Kick-Flo®	0.180	0.1
Flush-Flo™	0.088	0.1	Mean Flow over Head Range	-	0.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	0.1	0.800	0.2	2.000	0.3	4.000	0.4	7.000	0.5
0.200	0.1	1.000	0.2	2.200	0.3	4.500	0.4	7.500	0.5
0.300	0.1	1.200	0.2	2.400	0.3	5.000	0.4	8.000	0.5
0.400	0.1	1.400	0.2	2.600	0.3	5.500	0.4	8.500	0.5
0.500	0.2	1.600	0.3	3.000	0.3	6.000	0.5	9.000	0.5
0.600	0.2	1.800	0.3	3.500	0.4	6.500	0.5	9.500	0.6

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

Half Drain Time : 4652 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.479	0.479	0.0	0.2	0.2	31.0	O K
30 min Summer	0.549	0.549	0.0	0.2	0.2	40.7	O K
60 min Summer	0.613	0.613	0.0	0.2	0.2	50.7	O K
120 min Summer	0.656	0.656	0.0	0.2	0.2	58.1	O K
180 min Summer	0.681	0.681	0.0	0.2	0.2	62.7	O K
240 min Summer	0.699	0.699	0.0	0.2	0.2	66.0	O K
360 min Summer	0.724	0.724	0.0	0.2	0.2	70.7	O K
480 min Summer	0.742	0.742	0.0	0.2	0.2	74.0	O K
600 min Summer	0.756	0.756	0.0	0.2	0.2	76.5	O K
720 min Summer	0.767	0.767	0.0	0.2	0.2	78.6	O K
960 min Summer	0.784	0.784	0.0	0.2	0.2	81.7	O K
1440 min Summer	0.803	0.803	0.0	0.2	0.2	85.4	O K
2160 min Summer	0.816	0.816	0.0	0.2	0.2	87.7	O K
2880 min Summer	0.819	0.819	0.0	0.2	0.2	88.3	O K
4320 min Summer	0.814	0.814	0.0	0.2	0.2	87.4	O K
5760 min Summer	0.809	0.809	0.0	0.2	0.2	86.5	O K
7200 min Summer	0.805	0.805	0.0	0.2	0.2	85.6	O K
8640 min Summer	0.801	0.801	0.0	0.2	0.2	84.9	O K
10080 min Summer	0.798	0.798	0.0	0.2	0.2	84.5	O K
15 min Winter	0.507	0.507	0.0	0.2	0.2	34.7	O K
30 min Winter	0.581	0.581	0.0	0.2	0.2	45.6	O K
60 min Winter	0.649	0.649	0.0	0.2	0.2	56.8	O K
120 min Winter	0.695	0.695	0.0	0.2	0.2	65.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	136.059	0.0	12.6	19
30 min Summer	89.543	0.0	13.5	34
60 min Summer	55.972	0.0	27.3	64
120 min Summer	32.333	0.0	28.3	124
180 min Summer	23.419	0.0	28.8	184
240 min Summer	18.617	0.0	29.1	244
360 min Summer	13.461	0.0	29.5	364
480 min Summer	10.701	0.0	29.7	484
600 min Summer	8.962	0.0	29.8	602
720 min Summer	7.756	0.0	29.8	722
960 min Summer	6.183	0.0	29.8	962
1440 min Summer	4.495	0.0	29.3	1442
2160 min Summer	3.273	0.0	59.0	2160
2880 min Summer	2.620	0.0	58.4	2880
4320 min Summer	1.928	0.0	56.3	3756
5760 min Summer	1.559	0.0	112.1	4504
7200 min Summer	1.330	0.0	111.1	5264
8640 min Summer	1.171	0.0	109.0	6128
10080 min Summer	1.054	0.0	105.9	6960
15 min Winter	136.059	0.0	13.0	19
30 min Winter	89.543	0.0	13.8	34
60 min Winter	55.972	0.0	28.2	64
120 min Winter	32.333	0.0	29.1	122

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control Σ (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	0.723	0.723	0.0	0.2	0.2	70.4	O K
240 min Winter	0.743	0.743	0.0	0.2	0.2	74.2	O K
360 min Winter	0.772	0.772	0.0	0.2	0.2	79.5	O K
480 min Winter	0.792	0.792	0.0	0.2	0.2	83.4	O K
600 min Winter	0.808	0.808	0.0	0.2	0.2	86.3	O K
720 min Winter	0.821	0.821	0.0	0.2	0.2	88.8	O K
960 min Winter	0.841	0.841	0.0	0.2	0.2	92.5	O K
1440 min Winter	0.866	0.866	0.0	0.2	0.2	97.1	O K
2160 min Winter	0.885	0.885	0.0	0.2	0.2	100.6	O K
2880 min Winter	0.893	0.893	0.0	0.2	0.2	102.0	O K
4320 min Winter	0.894	0.894	0.0	0.2	0.2	102.3	O K
5760 min Winter	0.887	0.887	0.0	0.2	0.2	101.0	O K
7200 min Winter	0.884	0.884	0.0	0.2	0.2	100.3	O K
8640 min Winter	0.879	0.879	0.0	0.2	0.2	99.4	O K
10080 min Winter	0.873	0.873	0.0	0.2	0.2	98.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180 min Winter	23.419	0.0	29.6	182
240 min Winter	18.617	0.0	30.0	242
360 min Winter	13.461	0.0	30.3	360
480 min Winter	10.701	0.0	30.5	478
600 min Winter	8.962	0.0	30.6	596
720 min Winter	7.756	0.0	30.7	714
960 min Winter	6.183	0.0	30.6	950
1440 min Winter	4.495	0.0	30.1	1414
2160 min Winter	3.273	0.0	60.8	2100
2880 min Winter	2.620	0.0	60.2	2792
4320 min Winter	1.928	0.0	57.9	4104
5760 min Winter	1.559	0.0	116.5	4840
7200 min Winter	1.330	0.0	115.2	5616
8640 min Winter	1.171	0.0	113.0	6568
10080 min Winter	1.054	0.0	110.2	7472

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 503065 437026 TA 03065 37026	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.122

Time From:	(mins) To:	Area (ha)
0	4	0.122

Model Details

Storage is Online Cover Level (m) 1.300

Infiltration Trench Structure

Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	4.5
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	138.0
Safety Factor	1.0	Slope (1:X)	200.0
Porosity	0.30	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000	Cap Infiltration Depth (m)	0.000

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0020-2000-0900-2000
Design Head (m)	0.900
Design Flow (l/s)	0.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	20
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	0.900	0.2	Kick-Flo®	0.180	0.1
Flush-Flo™	0.088	0.1	Mean Flow over Head Range	-	0.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	0.1	0.800	0.2	2.000	0.3	4.000	0.4	7.000	0.5
0.200	0.1	1.000	0.2	2.200	0.3	4.500	0.4	7.500	0.5
0.300	0.1	1.200	0.2	2.400	0.3	5.000	0.4	8.000	0.5
0.400	0.1	1.400	0.2	2.600	0.3	5.500	0.4	8.500	0.5
0.500	0.2	1.600	0.3	3.000	0.3	6.000	0.5	9.000	0.5
0.600	0.2	1.800	0.3	3.500	0.4	6.500	0.5	9.500	0.6

Summary of Results for 200 year Return Period (+40%)

Half Drain Time : 5243 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.513	0.513	0.0	0.2	0.2	35.5	O K
30 min Summer	0.589	0.589	0.0	0.2	0.2	46.8	O K
60 min Summer	0.659	0.659	0.0	0.2	0.2	58.6	O K
120 min Summer	0.705	0.705	0.0	0.2	0.2	67.1	O K
180 min Summer	0.733	0.733	0.0	0.2	0.2	72.4	O K
240 min Summer	0.754	0.754	0.0	0.2	0.2	76.2	O K
360 min Summer	0.783	0.783	0.0	0.2	0.2	81.5	O K
480 min Summer	0.803	0.803	0.0	0.2	0.2	85.4	O K
600 min Summer	0.820	0.820	0.0	0.2	0.2	88.4	O K
720 min Summer	0.833	0.833	0.0	0.2	0.2	90.9	O K
960 min Summer	0.852	0.852	0.0	0.2	0.2	94.5	O K
1440 min Summer	0.876	0.876	0.0	0.2	0.2	99.0	O K
2160 min Summer	0.894	0.894	0.0	0.2	0.2	102.2	O K
2880 min Summer	0.900	0.900	0.0	0.2	0.2	103.4	O K
4320 min Summer	0.897	0.897	0.0	0.2	0.2	102.8	O K
5760 min Summer	0.891	0.891	0.0	0.2	0.2	101.7	O K
7200 min Summer	0.885	0.885	0.0	0.2	0.2	100.6	O K
8640 min Summer	0.879	0.879	0.0	0.2	0.2	99.4	O K
10080 min Summer	0.873	0.873	0.0	0.2	0.2	98.4	O K
15 min Winter	0.543	0.543	0.0	0.2	0.2	39.8	O K
30 min Winter	0.624	0.624	0.0	0.2	0.2	52.5	O K
60 min Winter	0.698	0.698	0.0	0.2	0.2	65.7	O K
120 min Winter	0.749	0.749	0.0	0.2	0.2	75.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	156.014	0.0	13.0	19
30 min Summer	102.974	0.0	13.9	34
60 min Summer	64.669	0.0	28.4	64
120 min Summer	37.256	0.0	29.3	124
180 min Summer	26.962	0.0	29.8	184
240 min Summer	21.417	0.0	30.2	244
360 min Summer	15.452	0.0	30.5	364
480 min Summer	12.277	0.0	30.7	484
600 min Summer	10.277	0.0	30.8	604
720 min Summer	8.890	0.0	30.9	722
960 min Summer	7.071	0.0	30.8	962
1440 min Summer	5.132	0.0	30.3	1442
2160 min Summer	3.732	0.0	61.2	2160
2880 min Summer	2.984	0.0	60.6	2880
4320 min Summer	2.186	0.0	58.3	4016
5760 min Summer	1.761	0.0	117.1	4672
7200 min Summer	1.495	0.0	115.7	5408
8640 min Summer	1.311	0.0	113.4	6224
10080 min Summer	1.175	0.0	110.3	7064
15 min Winter	156.014	0.0	13.4	19
30 min Winter	102.974	0.0	14.3	34
60 min Winter	64.669	0.0	29.2	64
120 min Winter	37.256	0.0	30.2	124

Summary of Results for 200 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	0.781	0.781	0.0	0.2	0.2	81.2	O K
240 min Winter	0.804	0.804	0.0	0.2	0.2	85.6	O K
360 min Winter	0.837	0.837	0.0	0.2	0.2	91.7	O K
480 min Winter	0.861	0.861	0.0	0.2	0.2	96.2	O K
600 min Winter	0.880	0.880	0.0	0.2	0.2	99.7	O K
720 min Winter	0.895	0.895	0.0	0.2	0.2	102.5	O K
960 min Winter	0.918	0.918	0.0	0.2	0.2	106.8	O K
1440 min Winter	0.948	0.948	0.0	0.2	0.2	112.4	O K
2160 min Winter	0.972	0.972	0.0	0.2	0.2	116.8	O K
2880 min Winter	0.984	0.984	0.0	0.2	0.2	119.0	O K
4320 min Winter	0.989	0.989	0.0	0.2	0.2	119.9	O K
5760 min Winter	0.982	0.982	0.0	0.2	0.2	118.7	O K
7200 min Winter	0.975	0.975	0.0	0.2	0.2	117.4	O K
8640 min Winter	0.969	0.969	0.0	0.2	0.2	116.3	O K
10080 min Winter	0.962	0.962	0.0	0.2	0.2	115.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180 min Winter	26.962	0.0	30.7	182
240 min Winter	21.417	0.0	31.0	242
360 min Winter	15.452	0.0	31.4	360
480 min Winter	12.277	0.0	31.6	478
600 min Winter	10.277	0.0	31.7	596
720 min Winter	8.890	0.0	31.8	714
960 min Winter	7.071	0.0	31.7	952
1440 min Winter	5.132	0.0	31.2	1416
2160 min Winter	3.732	0.0	63.3	2116
2880 min Winter	2.984	0.0	62.5	2796
4320 min Winter	2.186	0.0	60.0	4108
5760 min Winter	1.761	0.0	121.7	5352
7200 min Winter	1.495	0.0	120.0	5760
8640 min Winter	1.311	0.0	117.5	6656
10080 min Winter	1.175	0.0	114.4	7568

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	200	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 503065 437026 TA 03065 37026	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.122

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.122

Model Details

Storage is Online Cover Level (m) 1.300

Infiltration Trench Structure

Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	4.5
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	138.0
Safety Factor	1.0	Slope (1:X)	200.0
Porosity	0.30	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000	Cap Infiltration Depth (m)	0.000

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0020-2000-0900-2000
Design Head (m)	0.900
Design Flow (l/s)	0.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	20
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	0.900	0.2	Kick-Flo®	0.180	0.1
Flush-Flo™	0.088	0.1	Mean Flow over Head Range	-	0.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	0.1	0.800	0.2	2.000	0.3	4.000	0.4	7.000	0.5
0.200	0.1	1.000	0.2	2.200	0.3	4.500	0.4	7.500	0.5
0.300	0.1	1.200	0.2	2.400	0.3	5.000	0.4	8.000	0.5
0.400	0.1	1.400	0.2	2.600	0.3	5.500	0.4	8.500	0.5
0.500	0.2	1.600	0.3	3.000	0.3	6.000	0.5	9.000	0.5
0.600	0.2	1.800	0.3	3.500	0.4	6.500	0.5	9.500	0.6

Summary of Results for 1000 year Return Period (+40%)

Half Drain Time : 6851 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.609	0.609	0.0	0.2	0.2	50.1	O K
30 min Summer	0.704	0.704	0.0	0.2	0.2	66.8	O K
60 min Summer	0.797	0.797	0.0	0.2	0.2	84.2	O K
120 min Summer	0.869	0.869	0.0	0.2	0.2	97.6	O K
180 min Summer	0.912	0.912	0.0	0.2	0.2	105.7	O K
240 min Summer	0.943	0.943	0.0	0.2	0.2	111.4	O K
360 min Summer	0.985	0.985	0.0	0.2	0.2	119.3	O K
480 min Summer	1.014	1.014	0.0	0.2	0.2	124.7	Flood Risk
600 min Summer	1.037	1.037	0.0	0.2	0.2	128.9	Flood Risk
720 min Summer	1.054	1.054	0.0	0.2	0.2	132.2	Flood Risk
960 min Summer	1.081	1.081	0.0	0.2	0.2	137.1	Flood Risk
1440 min Summer	1.115	1.115	0.0	0.2	0.2	143.4	Flood Risk
2160 min Summer	1.140	1.140	0.0	0.2	0.2	148.1	Flood Risk
2880 min Summer	1.150	1.150	0.0	0.2	0.2	150.0	Flood Risk
4320 min Summer	1.148	1.148	0.0	0.2	0.2	149.5	Flood Risk
5760 min Summer	1.133	1.133	0.0	0.2	0.2	146.8	Flood Risk
7200 min Summer	1.120	1.120	0.0	0.2	0.2	144.3	Flood Risk
8640 min Summer	1.107	1.107	0.0	0.2	0.2	141.9	Flood Risk
10080 min Summer	1.094	1.094	0.0	0.2	0.2	139.5	Flood Risk
15 min Winter	0.645	0.645	0.0	0.2	0.2	56.2	O K
30 min Winter	0.747	0.747	0.0	0.2	0.2	74.8	O K
60 min Winter	0.851	0.851	0.0	0.2	0.2	94.3	O K
120 min Winter	0.932	0.932	0.0	0.2	0.2	109.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	219.837	0.0	14.1	19
30 min Summer	146.633	0.0	15.1	34
60 min Summer	92.634	0.0	31.1	64
120 min Summer	53.959	0.0	32.3	124
180 min Summer	39.131	0.0	32.9	184
240 min Summer	31.078	0.0	33.3	244
360 min Summer	22.374	0.0	33.7	364
480 min Summer	17.697	0.0	33.9	484
600 min Summer	14.746	0.0	34.0	604
720 min Summer	12.702	0.0	34.0	724
960 min Summer	10.035	0.0	33.9	962
1440 min Summer	7.206	0.0	33.3	1442
2160 min Summer	5.178	0.0	67.7	2160
2880 min Summer	4.099	0.0	66.7	2880
4320 min Summer	2.954	0.0	63.8	4320
5760 min Summer	2.347	0.0	129.8	5240
7200 min Summer	1.968	0.0	127.4	5904
8640 min Summer	1.707	0.0	124.3	6656
10080 min Summer	1.515	0.0	120.5	7368
15 min Winter	219.837	0.0	14.5	19
30 min Winter	146.633	0.0	15.5	34
60 min Winter	92.634	0.0	32.1	64
120 min Winter	53.959	0.0	33.3	124

Summary of Results for 1000 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	0.981	0.981	0.0	0.2	0.2	118.5	O K
240 min Winter	1.016	1.016	0.0	0.2	0.2	125.0	Flood Risk
360 min Winter	1.064	1.064	0.0	0.2	0.2	133.9	Flood Risk
480 min Winter	1.097	1.097	0.0	0.2	0.2	140.2	Flood Risk
600 min Winter	1.123	1.123	0.0	0.2	0.2	145.0	Flood Risk
720 min Winter	1.144	1.144	0.0	0.2	0.2	148.8	Flood Risk
960 min Winter	1.175	1.175	0.0	0.2	0.2	154.6	Flood Risk
1440 min Winter	1.215	1.215	0.0	0.2	0.2	162.1	Flood Risk
2160 min Winter	1.248	1.248	0.0	0.2	0.2	168.2	Flood Risk
2880 min Winter	1.264	1.264	0.0	0.2	0.2	171.2	Flood Risk
4320 min Winter	1.271	1.271	0.0	0.2	0.2	172.5	Flood Risk
5760 min Winter	1.262	1.262	0.0	0.2	0.2	170.8	Flood Risk
7200 min Winter	1.246	1.246	0.0	0.2	0.2	167.9	Flood Risk
8640 min Winter	1.230	1.230	0.0	0.2	0.2	164.8	Flood Risk
10080 min Winter	1.216	1.216	0.0	0.2	0.2	162.3	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180 min Winter	39.131	0.0	33.9	182
240 min Winter	31.078	0.0	34.4	242
360 min Winter	22.374	0.0	34.8	360
480 min Winter	17.697	0.0	35.1	480
600 min Winter	14.746	0.0	35.2	598
720 min Winter	12.702	0.0	35.2	716
960 min Winter	10.035	0.0	35.1	952
1440 min Winter	7.206	0.0	34.4	1426
2160 min Winter	5.178	0.0	70.2	2120
2880 min Winter	4.099	0.0	69.2	2820
4320 min Winter	2.954	0.0	66.0	4152
5760 min Winter	2.347	0.0	135.2	5472
7200 min Winter	1.968	0.0	132.6	6696
8640 min Winter	1.707	0.0	129.2	7000
10080 min Winter	1.515	0.0	125.1	7864

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	1000	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 503065 437026 TA 03065 37026	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.122

Time (mins) From:	**To:**	**Area (ha)**
0	4	0.122

Model Details

Storage is Online Cover Level (m) 1.300

Infiltration Trench Structure

Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	4.5
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	138.0
Safety Factor	1.0	Slope (1:X)	200.0
Porosity	0.30	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000	Cap Infiltration Depth (m)	0.000

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0020-2000-0900-2000
Design Head (m)	0.900
Design Flow (l/s)	0.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	20
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	0.900	0.2	Kick-Flo®	0.180	0.1
Flush-Flo™	0.088	0.1	Mean Flow over Head Range	-	0.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	0.1	0.800	0.2	2.000	0.3	4.000	0.4	7.000	0.5
0.200	0.1	1.000	0.2	2.200	0.3	4.500	0.4	7.500	0.5
0.300	0.1	1.200	0.2	2.400	0.3	5.000	0.4	8.000	0.5
0.400	0.1	1.400	0.2	2.600	0.3	5.500	0.4	8.500	0.5
0.500	0.2	1.600	0.3	3.000	0.3	6.000	0.5	9.000	0.5
0.600	0.2	1.800	0.3	3.500	0.4	6.500	0.5	9.500	0.6

SUDS Design Summary - Dogger Bank - Zone 4 - Road Drainage - 06.02.25

Notes:

1. SUDS design proposal to attenuate surface water flows from access road hardstanding areas.
2. Road hardstanding assumed to be 100% hardstanding for design.
3. Drainage from access roads to discharge to adjacent filter trenches then to an existing watercourse at the pre-development run-off rate. To mimic existing drainage regime and achieve no net increase in flows to receiving watercourse.
4. SUDS design undertaken in line with national and local guidance and as set out in The SUDS Manual (C753).
5. Pre Development discharge rates estimated using FEH method - HR Wallingford Greenfield Runoff Rate Estimation Online Tool.
6. SUDS sizing estimated using FEH13 Rainfall and Micro Drainage design software.

Design Parameters / Assumptions	HVDC (AIS)	Change Notes
Hardstanding (all footprints assumed 100% impermeable)		
South Access Road (Discharge to Watercourse 1)	4,709	
Total (m2)	**4,709**	
Pre-Development Run-Off Rates (calculated from HR Wallingford Greenfield Runoff Rate Estimation Online Tool) (l/s)		
1.4 l/s/ha (l/s)	**0.66**	
	IH124 Method	
1 Year Return (l/s)	0.68	
2 Year Return (Q_{BAR}) (l/s)	0.79	
30 Year Return (l/s)	1.37	Low discharge rates may cause a blockage risk. Suitable discharge rates to be agreed with the local authority at detailed design stage.
100 Year Return (l/s)	1.63	
200 Year Return (l/s)	1.86	
	FEH Method	
1 Year Return (l/s)	1.22	
2 Year Return (Q_{BAR}) (l/s)	1.42	
30 Year Return (l/s)	2.48	
100 Year Return (l/s)	2.95	
200 Year Return (l/s)	3.36	
Attenuated Post Development Run-Off Rates	**Limited to pre-development (1.4 l/s/ha) run-off rate. Provides betterment over IH124 rate and FEH rate.**	Low discharge rates may cause a blockage risk. Suitable discharge rates to be agreed with the local authority at detailed design stage.
Design Storm Event	**1 in 100 year + 40% climate change as per ERYC guidance.**	
Attenuation Storage Required (calculated from FEH13 Rainfall using Micro Drainage design software) (m3)		
All Hardstanding Areas (m3)	218.2	Based on filter trenches either side of road, each taking half the hardstanding area (2354 m2) and limited to half the greenfield run-off rate (0.33 l/s)
Total storage required (m3)	**218.2**	
Filter Trench Dimensions (m)		
Length	288	
Width	3.30	
Gradient (1:X)	200	
Gravel Voids	0.3	
Design storage depth (m)	1.5	
Design freeboard (m)	0.5	
Overall depth (design depth + freeboard) (m)	2.0	
Design Check - Attenuation Storage Provided		
Filter Trenches		
Filter Trench Design	223	
Freeboard	173	
Total (design)	**223**	
Total (inc. freeboard)	396	
Design storage required < attenuation storage provided?	**YES = OK**	
Discharge Location	**Existing watercourse 3.**	**Design flows up to 1:100 year + 40% CC are attenuated within the filter trench design depth (1.5m).** **Additional 500mm freeboard provided provided over and above design capacity (total 2.0m depth).** **Filter trenches to be stepped to suit road gradients to utilise capacity along entire length.**
Sensitivity Check - Attenuation Storage Provided		
Storage Requirements		
1 in 200 year + 40% climate change	**253**	
1 in 1000 year + 40% climate change	**356.2**	
Storage Available		
Total (inc. freeboard, access track etc)	**396**	
Sensitivity check storage required < attenuation storage provided?	**YES = OK**	
Sensitivity Check - Half Drain Down Time		
Half Drain Down Time = < 24 hours?	**NO**	
Surplus Storage Available (Over and Above Design Storm)		
Total storage required (m3) - 1 in 100 year + 40% climate change	218.2	
Total storage available (inc. freeboard, access track etc)	396	
Surplus (freeboard minus design)	**177.8**	
1 in 10 year + 40% climate change	**132.6**	
Subsequent storm surplus storage can cater for	**Up to 1 in 10 year**	
Sensitivity check storage required < attenuation storage provided?	**YES = OK**	

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Christopher Sneddon
Site name:	Dogger Bank
Site location:	South Access Road WC1

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	53.81527° N
Longitude:	0.45088° W
Reference:	2194371889
Date:	Feb 05 2025 17:47

Runoff estimation approach

FEH Statistical

Site characteristics

Total site area (ha):	0.4709

Methodology

Q_{MED} estimation method:	Calculate from BFI and SAAR
BFI and SPR method:	Specify BFI manually
HOST class:	N/A
BFI / BFIHOST:	0.44
Q_{MED} (l/s):	
Q_{BAR} / Q_{MED} factor:	1.06

Hydrological characteristics

	Default	Edited
SAAR (mm):	649	649
Hydrological region:	3	3
Growth curve factor 1 year:	0.86	0.86
Growth curve factor 30 years:	1.75	1.75
Growth curve factor 100 years:	2.08	2.08
Growth curve factor 200 years:	2.37	2.37

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):		1.42
1 in 1 year (l/s):		1.22
1 in 30 years (l/s):		2.48
1 in 100 year (l/s):		2.95
1 in 200 years (l/s):		3.36

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Christopher Sneddon
Site name:	Dogger Bank
Site location:	South Access Road WC1

Site Details

Latitude:	53.81527° N
Longitude:	0.45088° W
Reference:	1176068345
Date:	Feb 05 2025 17:48

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Runoff estimation approach: IH124

Site characteristics

Total site area (ha): 0.4709

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	2	2
HOST class:	N/A	N/A
SPR/SPRHOST:	0.3	0.3

Hydrological characteristics

	Default	Edited
SAAR (mm):	649	649
Hydrological region:	3	3
Growth curve factor 1 year:	0.86	0.86
Growth curve factor 30 years:	1.75	1.75
Growth curve factor 100 years:	2.08	2.08
Growth curve factor 200 years:	2.37	2.37

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	0.79	0.79
1 in 1 year (l/s):	0.68	0.68
1 in 30 years (l/s):	1.37	1.37
1 in 100 year (l/s):	1.63	1.63
1 in 200 years (l/s):	1.86	1.86

Summary of Results for 10 year Return Period (+40%)

Half Drain Time : 4460 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.591	0.591	0.0	0.2	0.2	34.6	O K
30 min Summer	0.671	0.671	0.0	0.2	0.2	44.5	O K
60 min Summer	0.744	0.744	0.0	0.2	0.2	54.8	O K
120 min Summer	0.819	0.819	0.0	0.2	0.2	66.4	O K
180 min Summer	0.862	0.862	0.0	0.2	0.2	73.5	O K
240 min Summer	0.891	0.891	0.0	0.2	0.2	78.6	O K
360 min Summer	0.931	0.931	0.0	0.2	0.2	85.8	O K
480 min Summer	0.958	0.958	0.0	0.2	0.2	90.9	O K
600 min Summer	0.979	0.979	0.0	0.2	0.2	94.9	O K
720 min Summer	0.995	0.995	0.0	0.2	0.2	98.1	O K
960 min Summer	1.020	1.020	0.0	0.3	0.3	103.0	O K
1440 min Summer	1.048	1.048	0.0	0.3	0.3	108.8	O K
2160 min Summer	1.066	1.066	0.0	0.3	0.3	112.5	O K
2880 min Summer	1.072	1.072	0.0	0.3	0.3	113.7	O K
4320 min Summer	1.071	1.071	0.0	0.3	0.3	113.5	O K
5760 min Summer	1.069	1.069	0.0	0.3	0.3	113.2	O K
7200 min Summer	1.069	1.069	0.0	0.3	0.3	113.0	O K
8640 min Summer	1.069	1.069	0.0	0.3	0.3	113.1	O K
10080 min Summer	1.070	1.070	0.0	0.3	0.3	113.4	O K
15 min Winter	0.626	0.626	0.0	0.2	0.2	38.8	O K
30 min Winter	0.710	0.710	0.0	0.2	0.2	49.9	O K
60 min Winter	0.788	0.788	0.0	0.2	0.2	61.5	O K
120 min Winter	0.868	0.868	0.0	0.2	0.2	74.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	78.937	0.0	16.3	19
30 min Summer	50.914	0.0	17.4	34
60 min Summer	31.486	0.0	34.9	64
120 min Summer	19.243	0.0	36.8	124
180 min Summer	14.296	0.0	37.8	184
240 min Summer	11.544	0.0	38.4	244
360 min Summer	8.516	0.0	39.1	364
480 min Summer	6.856	0.0	39.5	484
600 min Summer	5.794	0.0	39.7	602
720 min Summer	5.050	0.0	39.8	722
960 min Summer	4.068	0.0	39.8	962
1440 min Summer	2.991	0.0	39.3	1442
2160 min Summer	2.195	0.0	79.1	2160
2880 min Summer	1.766	0.0	78.3	2880
4320 min Summer	1.308	0.0	75.3	3676
5760 min Summer	1.064	0.0	150.1	4440
7200 min Summer	0.913	0.0	149.1	5256
8640 min Summer	0.809	0.0	146.6	6056
10080 min Summer	0.734	0.0	142.7	6952
15 min Winter	78.937	0.0	16.8	19
30 min Winter	50.914	0.0	17.9	34
60 min Winter	31.486	0.0	36.1	64
120 min Winter	19.243	0.0	38.0	122

Summary of Results for 10 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control Σ (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	0.913	0.913	0.0	0.2	0.2	82.6	O K
240 min Winter	0.944	0.944	0.0	0.2	0.2	88.3	O K
360 min Winter	0.988	0.988	0.0	0.2	0.2	96.5	O K
480 min Winter	1.017	1.017	0.0	0.3	0.3	102.5	O K
600 min Winter	1.040	1.040	0.0	0.3	0.3	107.1	O K
720 min Winter	1.058	1.058	0.0	0.3	0.3	110.8	O K
960 min Winter	1.086	1.086	0.0	0.3	0.3	116.7	O K
1440 min Winter	1.118	1.118	0.0	0.3	0.3	123.8	O K
2160 min Winter	1.142	1.142	0.0	0.3	0.3	129.1	O K
2880 min Winter	1.153	1.153	0.0	0.3	0.3	131.5	O K
4320 min Winter	1.157	1.157	0.0	0.3	0.3	132.6	O K
5760 min Winter	1.154	1.154	0.0	0.3	0.3	131.8	O K
7200 min Winter	1.155	1.155	0.0	0.3	0.3	132.1	O K
8640 min Winter	1.156	1.156	0.0	0.3	0.3	132.2	O K
10080 min Winter	1.155	1.155	0.0	0.3	0.3	132.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180 min Winter	14.296	0.0	38.9	182
240 min Winter	11.544	0.0	39.5	242
360 min Winter	8.516	0.0	40.2	360
480 min Winter	6.856	0.0	40.6	478
600 min Winter	5.794	0.0	40.8	596
720 min Winter	5.050	0.0	40.9	714
960 min Winter	4.068	0.0	40.9	950
1440 min Winter	2.991	0.0	40.3	1414
2160 min Winter	2.195	0.0	81.5	2100
2880 min Winter	1.766	0.0	80.6	2772
4320 min Winter	1.308	0.0	77.4	4064
5760 min Winter	1.064	0.0	156.3	4728
7200 min Winter	0.913	0.0	154.7	5616
8640 min Winter	0.809	0.0	151.9	6568
10080 min Winter	0.734	0.0	148.2	7464

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	10	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 503065 437026 TA 03065 37026	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.235

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.235

Model Details

Storage is Online Cover Level (m) 2.000

Infiltration Trench Structure

Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	3.3
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	288.0
Safety Factor	1.0	Slope (1:X)	200.0
Porosity	0.30	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000	Cap Infiltration Depth (m)	0.000

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0022-3000-1500-3000
Design Head (m)	1.500
Design Flow (l/s)	0.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	22
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.500	0.3	Kick-Flo®	0.200	0.1
Flush-Flo™	0.098	0.1	Mean Flow over Head Range	-	0.2

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	0.1	0.800	0.2	2.000	0.3	4.000	0.5	7.000	0.6
0.200	0.1	1.000	0.3	2.200	0.4	4.500	0.5	7.500	0.6
0.300	0.2	1.200	0.3	2.400	0.4	5.000	0.5	8.000	0.6
0.400	0.2	1.400	0.3	2.600	0.4	5.500	0.5	8.500	0.6
0.500	0.2	1.600	0.3	3.000	0.4	6.000	0.5	9.000	0.7
0.600	0.2	1.800	0.3	3.500	0.4	6.500	0.6	9.500	0.7

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

Half Drain Time : 6613 minutes.

Outflow is too low. Design is unsatisfactory.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m^3)	Status
15 min Summer	0.777	0.777	0.0	0.2	0.2	59.7	O K
30 min Summer	0.891	0.891	0.0	0.2	0.2	78.5	O K
60 min Summer	0.994	0.994	0.0	0.2	0.2	97.9	O K
120 min Summer	1.066	1.066	0.0	0.3	0.3	112.5	O K
180 min Summer	1.108	1.108	0.0	0.3	0.3	121.5	O K
240 min Summer	1.138	1.138	0.0	0.3	0.3	128.2	O K
360 min Summer	1.179	1.179	0.0	0.3	0.3	137.7	O K
480 min Summer	1.209	1.209	0.0	0.3	0.3	144.6	O K
600 min Summer	1.231	1.231	0.0	0.3	0.3	150.1	O K
720 min Summer	1.249	1.249	0.0	0.3	0.3	154.5	O K
960 min Summer	1.277	1.277	0.0	0.3	0.3	161.6	O K
1440 min Summer	1.313	1.313	0.0	0.3	0.3	170.8	O K
2160 min Summer	1.342	1.342	0.0	0.3	0.3	178.4	O K
2880 min Summer	1.358	1.358	0.0	0.3	0.3	182.5	O K
4320 min Summer	1.369	1.369	0.0	0.3	0.3	185.6	O K
5760 min Summer	1.371	1.371	0.0	0.3	0.3	186.0	O K
7200 min Summer	1.373	1.373	0.0	0.3	0.3	186.7	O K
8640 min Summer	1.376	1.376	0.0	0.3	0.3	187.3	O K
10080 min Summer	1.377	1.377	0.0	0.3	0.3	187.7	O K
15 min Winter	0.822	0.822	0.0	0.2	0.2	66.9	O K
30 min Winter	0.943	0.943	0.0	0.2	0.2	88.0	O K
60 min Winter	1.053	1.053	0.0	0.3	0.3	109.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m^3)	Discharge Volume (m^3)	Time-Peak (mins)
15 min Summer	136.059	0.0	18.7	19
30 min Summer	89.543	0.0	19.9	34
60 min Summer	55.972	0.0	40.8	64
120 min Summer	32.333	0.0	42.2	124
180 min Summer	23.419	0.0	42.9	184
240 min Summer	18.617	0.0	43.4	244
360 min Summer	13.461	0.0	43.9	364
480 min Summer	10.701	0.0	44.1	484
600 min Summer	8.962	0.0	44.2	604
720 min Summer	7.756	0.0	44.2	724
960 min Summer	6.183	0.0	44.0	962
1440 min Summer	4.495	0.0	43.2	1442
2160 min Summer	3.273	0.0	88.1	2160
2880 min Summer	2.620	0.0	86.9	2880
4320 min Summer	1.928	0.0	83.3	4320
5760 min Summer	1.559	0.0	171.1	5128
7200 min Summer	1.330	0.0	168.5	5840
8640 min Summer	1.171	0.0	164.9	6656
10080 min Summer	1.054	0.0	160.4	7456
15 min Winter	136.059	0.0	19.2	19
30 min Winter	89.543	0.0	20.5	34
60 min Winter	55.972	0.0	42.0	64

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
120 min Winter	1.129	1.129	0.0	0.3	0.3	126.1	O K
180 min Winter	1.174	1.174	0.0	0.3	0.3	136.4	O K
240 min Winter	1.206	1.206	0.0	0.3	0.3	143.9	O K
360 min Winter	1.250	1.250	0.0	0.3	0.3	154.7	O K
480 min Winter	1.282	1.282	0.0	0.3	0.3	162.6	O K
600 min Winter	1.306	1.306	0.0	0.3	0.3	168.9	O K
720 min Winter	1.326	1.326	0.0	0.3	0.3	174.1	O K
960 min Winter	1.357	1.357	0.0	0.3	0.3	182.3	O K
1440 min Winter	1.397	1.397	0.0	0.3	0.3	193.3	O K
2160 min Winter	1.432	1.432	0.0	0.3	0.3	203.0	O K
2880 min Winter	1.452	1.452	0.0	0.3	0.3	208.7	O K
4320 min Winter	1.473	1.473	0.0	0.3	0.3	214.7	O K
5760 min Winter	1.481	1.481	0.0	0.3	0.3	216.8	O K
7200 min Winter	1.483	1.483	0.0	0.3	0.3	217.4	O K
8640 min Winter	1.483	1.483	0.0	0.3	0.3	217.5	O K
10080 min Winter	1.485	1.485	0.0	0.3	0.3	218.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
120 min Winter	32.333	0.0	43.4	124
180 min Winter	23.419	0.0	44.1	182
240 min Winter	18.617	0.0	44.6	242
360 min Winter	13.461	0.0	45.1	360
480 min Winter	10.701	0.0	45.3	478
600 min Winter	8.962	0.0	45.4	596
720 min Winter	7.756	0.0	45.4	716
960 min Winter	6.183	0.0	45.2	952
1440 min Winter	4.495	0.0	44.4	1426
2160 min Winter	3.273	0.0	90.7	2120
2880 min Winter	2.620	0.0	89.5	2820
4320 min Winter	1.928	0.0	85.7	4152
5760 min Winter	1.559	0.0	177.1	5472
7200 min Winter	1.330	0.0	174.4	6696
8640 min Winter	1.171	0.0	170.6	7008
10080 min Winter	1.054	0.0	166.0	7872

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 503065 437026 TA 03065 37026	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.235

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.235

Model Details

Storage is Online Cover Level (m) 2.000

Infiltration Trench Structure

Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	3.3
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	288.0
Safety Factor	1.0	Slope (1:X)	200.0
Porosity	0.30	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000	Cap Infiltration Depth (m)	0.000

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0022-3000-1500-3000
Design Head (m)	1.500
Design Flow (l/s)	0.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	22
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.500	0.3	Kick-Flo®	0.200	0.1
Flush-Flo™	0.098	0.1	Mean Flow over Head Range	-	0.2

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	0.1	0.800	0.2	2.000	0.3	4.000	0.5	7.000	0.6
0.200	0.1	1.000	0.3	2.200	0.4	4.500	0.5	7.500	0.6
0.300	0.2	1.200	0.3	2.400	0.4	5.000	0.5	8.000	0.6
0.400	0.2	1.400	0.3	2.600	0.4	5.500	0.5	8.500	0.6
0.500	0.2	1.600	0.3	3.000	0.4	6.000	0.5	9.000	0.7
0.600	0.2	1.800	0.3	3.500	0.4	6.500	0.6	9.500	0.7

Summary of Results for 200 year Return Period (+40%)

Half Drain Time : 7448 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.832	0.832	0.0	0.2	0.2	68.5	O K
30 min Summer	0.955	0.955	0.0	0.2	0.2	90.3	O K
60 min Summer	1.069	1.069	0.0	0.3	0.3	113.2	O K
120 min Summer	1.145	1.145	0.0	0.3	0.3	129.8	O K
180 min Summer	1.190	1.190	0.0	0.3	0.3	140.2	O K
240 min Summer	1.222	1.222	0.0	0.3	0.3	147.8	O K
360 min Summer	1.266	1.266	0.0	0.3	0.3	158.6	O K
480 min Summer	1.297	1.297	0.0	0.3	0.3	166.7	O K
600 min Summer	1.322	1.322	0.0	0.3	0.3	173.0	O K
720 min Summer	1.342	1.342	0.0	0.3	0.3	178.2	O K
960 min Summer	1.372	1.372	0.0	0.3	0.3	186.3	O K
1440 min Summer	1.411	1.411	0.0	0.3	0.3	197.1	O K
2160 min Summer	1.445	1.445	0.0	0.3	0.3	206.6	O K
2880 min Summer	1.464	1.464	0.0	0.3	0.3	212.0	O K
4320 min Summer	1.480	1.480	0.0	0.3	0.3	216.6	O K
5760 min Summer	1.481	1.481	0.0	0.3	0.3	217.0	O K
7200 min Summer	1.482	1.482	0.0	0.3	0.3	217.1	O K
8640 min Summer	1.482	1.482	0.0	0.3	0.3	217.2	O K
10080 min Summer	1.481	1.481	0.0	0.3	0.3	217.1	O K
15 min Winter	0.881	0.881	0.0	0.2	0.2	76.8	O K
30 min Winter	1.011	1.011	0.0	0.3	0.3	101.2	O K
60 min Winter	1.132	1.132	0.0	0.3	0.3	126.9	O K
120 min Winter	1.212	1.212	0.0	0.3	0.3	145.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	156.014	0.0	19.3	19
30 min Summer	102.974	0.0	20.6	34
60 min Summer	64.669	0.0	42.4	64
120 min Summer	37.256	0.0	43.7	124
180 min Summer	26.962	0.0	44.4	184
240 min Summer	21.417	0.0	44.9	244
360 min Summer	15.452	0.0	45.3	364
480 min Summer	12.277	0.0	45.6	484
600 min Summer	10.277	0.0	45.7	604
720 min Summer	8.890	0.0	45.7	724
960 min Summer	7.071	0.0	45.4	962
1440 min Summer	5.132	0.0	44.6	1442
2160 min Summer	3.732	0.0	91.2	2160
2880 min Summer	2.984	0.0	89.9	2880
4320 min Summer	2.186	0.0	86.1	4320
5760 min Summer	1.761	0.0	177.7	5480
7200 min Summer	1.495	0.0	174.7	6128
8640 min Summer	1.311	0.0	170.6	6840
10080 min Summer	1.175	0.0	165.8	7664
15 min Winter	156.014	0.0	19.8	19
30 min Winter	102.974	0.0	21.1	34
60 min Winter	64.669	0.0	43.6	64
120 min Winter	37.256	0.0	44.9	124

Summary of Results for 200 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	1.260	1.260	0.0	0.3	0.3	157.3	O K
240 min Winter	1.294	1.294	0.0	0.3	0.3	165.9	O K
360 min Winter	1.341	1.341	0.0	0.3	0.3	178.1	O K
480 min Winter	1.376	1.376	0.0	0.3	0.3	187.3	O K
600 min Winter	1.402	1.402	0.0	0.3	0.3	194.6	O K
720 min Winter	1.424	1.424	0.0	0.3	0.3	200.6	O K
960 min Winter	1.457	1.457	0.0	0.3	0.3	210.0	O K
1440 min Winter	1.502	1.502	0.0	0.3	0.3	222.9	O K
2160 min Winter	1.543	1.543	0.0	0.3	0.3	234.7	O K
2880 min Winter	1.568	1.568	0.0	0.3	0.3	241.9	O K
4320 min Winter	1.595	1.595	0.0	0.3	0.3	249.4	O K
5760 min Winter	1.605	1.605	0.0	0.3	0.3	252.4	O K
7200 min Winter	1.607	1.607	0.0	0.3	0.3	253.0	O K
8640 min Winter	1.605	1.605	0.0	0.3	0.3	252.3	O K
10080 min Winter	1.604	1.604	0.0	0.3	0.3	251.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180 min Winter	26.962	0.0	45.7	182
240 min Winter	21.417	0.0	46.1	242
360 min Winter	15.452	0.0	46.6	360
480 min Winter	12.277	0.0	46.8	480
600 min Winter	10.277	0.0	46.9	598
720 min Winter	8.890	0.0	46.9	716
960 min Winter	7.071	0.0	46.6	952
1440 min Winter	5.132	0.0	45.7	1426
2160 min Winter	3.732	0.0	93.8	2120
2880 min Winter	2.984	0.0	92.5	2824
4320 min Winter	2.186	0.0	88.6	4192
5760 min Winter	1.761	0.0	183.8	5528
7200 min Winter	1.495	0.0	180.6	6776
8640 min Winter	1.311	0.0	176.5	7952
10080 min Winter	1.175	0.0	171.6	8072

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	200	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 503065 437026 TA 03065 37026	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.235

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.235

Model Details

Storage is Online Cover Level (m) 2.000

Infiltration Trench Structure

Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	3.3
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	288.0
Safety Factor	1.0	Slope (1:X)	200.0
Porosity	0.30	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000	Cap Infiltration Depth (m)	0.000

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0022-3000-1500-3000
Design Head (m)	1.500
Design Flow (l/s)	0.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	22
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	0.3	Kick-Flo®	0.200	0.1
Flush-Flo™	0.098	0.1	Mean Flow over Head Range	-	0.2

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.1	0.800	0.2	2.000	0.3	4.000	0.5	7.000	0.6
0.200	0.1	1.000	0.3	2.200	0.4	4.500	0.5	7.500	0.6
0.300	0.2	1.200	0.3	2.400	0.4	5.000	0.5	8.000	0.6
0.400	0.2	1.400	0.3	2.600	0.4	5.500	0.5	8.500	0.6
0.500	0.2	1.600	0.3	3.000	0.4	6.000	0.5	9.000	0.7
0.600	0.2	1.800	0.3	3.500	0.4	6.500	0.6	9.500	0.7

Summary of Results for 1000 year Return Period (+40%)

Half Drain Time : 9648 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.988	0.988	0.0	0.2	0.2	96.6	O K
30 min Summer	1.141	1.141	0.0	0.3	0.3	128.8	O K
60 min Summer	1.281	1.281	0.0	0.3	0.3	162.4	O K
120 min Summer	1.380	1.380	0.0	0.3	0.3	188.5	O K
180 min Summer	1.437	1.437	0.0	0.3	0.3	204.4	O K
240 min Summer	1.476	1.476	0.0	0.3	0.3	215.7	O K
360 min Summer	1.532	1.532	0.0	0.3	0.3	231.4	O K
480 min Summer	1.571	1.571	0.0	0.3	0.3	242.6	O K
600 min Summer	1.601	1.601	0.0	0.3	0.3	251.1	O K
720 min Summer	1.625	1.625	0.0	0.3	0.3	258.1	O K
960 min Summer	1.663	1.663	0.0	0.3	0.3	268.8	O K
1440 min Summer	1.714	1.714	0.0	0.3	0.3	283.3	Flood Risk
2160 min Summer	1.758	1.758	0.0	0.3	0.3	296.0	Flood Risk
2880 min Summer	1.783	1.783	0.0	0.3	0.3	303.1	Flood Risk
4320 min Summer	1.804	1.804	0.0	0.3	0.3	309.1	Flood Risk
5760 min Summer	1.805	1.805	0.0	0.3	0.3	309.4	Flood Risk
7200 min Summer	1.796	1.796	0.0	0.3	0.3	306.9	Flood Risk
8640 min Summer	1.786	1.786	0.0	0.3	0.3	304.1	Flood Risk
10080 min Summer	1.778	1.778	0.0	0.3	0.3	301.5	Flood Risk
15 min Winter	1.046	1.046	0.0	0.3	0.3	108.3	O K
30 min Winter	1.207	1.207	0.0	0.3	0.3	144.3	O K
60 min Winter	1.356	1.356	0.0	0.3	0.3	182.0	O K
120 min Winter	1.461	1.461	0.0	0.3	0.3	211.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	219.837	0.0	20.9	19
30 min Summer	146.633	0.0	22.3	34
60 min Summer	92.634	0.0	46.3	64
120 min Summer	53.959	0.0	47.8	124
180 min Summer	39.131	0.0	48.6	184
240 min Summer	31.078	0.0	49.0	244
360 min Summer	22.374	0.0	49.5	364
480 min Summer	17.697	0.0	49.7	484
600 min Summer	14.746	0.0	49.7	604
720 min Summer	12.702	0.0	49.7	724
960 min Summer	10.035	0.0	49.4	964
1440 min Summer	7.206	0.0	48.4	1442
2160 min Summer	5.178	0.0	99.3	2164
2880 min Summer	4.099	0.0	97.7	2884
4320 min Summer	2.954	0.0	93.2	4320
5760 min Summer	2.347	0.0	193.8	5760
7200 min Summer	1.968	0.0	189.8	6992
8640 min Summer	1.707	0.0	184.9	7520
10080 min Summer	1.515	0.0	179.3	8272
15 min Winter	219.837	0.0	21.5	19
30 min Winter	146.633	0.0	22.9	34
60 min Winter	92.634	0.0	47.6	64
120 min Winter	53.959	0.0	49.1	124

Summary of Results for 1000 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	1.524	1.524	0.0	0.3	0.3	229.1	O K
240 min Winter	1.568	1.568	0.0	0.3	0.3	241.9	O K
360 min Winter	1.631	1.631	0.0	0.3	0.3	259.7	O K
480 min Winter	1.675	1.675	0.0	0.3	0.3	272.4	O K
600 min Winter	1.710	1.710	0.0	0.3	0.3	282.2	Flood Risk
720 min Winter	1.738	1.738	0.0	0.3	0.3	290.1	Flood Risk
960 min Winter	1.781	1.781	0.0	0.3	0.3	302.5	Flood Risk
1440 min Winter	1.841	1.841	0.0	0.3	0.3	319.5	Flood Risk
2160 min Winter	1.894	1.894	0.0	0.3	0.3	334.8	Flood Risk
2880 min Winter	1.927	1.927	0.0	0.3	0.3	344.1	Flood Risk
4320 min Winter	1.959	1.959	0.0	0.3	0.3	353.2	Flood Risk
5760 min Winter	1.969	1.969	0.0	0.3	0.3	356.2	Flood Risk
7200 min Winter	1.969	1.969	0.0	0.3	0.3	356.0	Flood Risk
8640 min Winter	1.961	1.961	0.0	0.3	0.3	353.8	Flood Risk
10080 min Winter	1.949	1.949	0.0	0.3	0.3	350.4	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180 min Winter	39.131	0.0	49.9	182
240 min Winter	31.078	0.0	50.4	242
360 min Winter	22.374	0.0	50.9	362
480 min Winter	17.697	0.0	51.1	480
600 min Winter	14.746	0.0	51.2	598
720 min Winter	12.702	0.0	51.1	716
960 min Winter	10.035	0.0	50.8	954
1440 min Winter	7.206	0.0	49.8	1428
2160 min Winter	5.178	0.0	102.4	2136
2880 min Winter	4.099	0.0	100.8	2828
4320 min Winter	2.954	0.0	96.1	4232
5760 min Winter	2.347	0.0	200.6	5584
7200 min Winter	1.968	0.0	196.5	6912
8640 min Winter	1.707	0.0	191.5	8208
10080 min Winter	1.515	0.0	185.7	9384

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	1000	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 503065 437026 TA 03065 37026	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.235

Time (mins) From:	To:	Area (ha)
0	4	0.235

APPENDIX D – INFILTRATION TESTING RESULTS

Model Details

Storage is Online Cover Level (m) 2.000

Infiltration Trench Structure

Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	3.3
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	288.0
Safety Factor	1.0	Slope (1:X)	200.0
Porosity	0.30	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000	Cap Infiltration Depth (m)	0.000

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0022-3000-1500-3000
Design Head (m)	1.500
Design Flow (l/s)	0.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	22
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.500	0.3	Kick-Flo®	0.200	0.1
Flush-Flo™	0.098	0.1	Mean Flow over Head Range	-	0.2

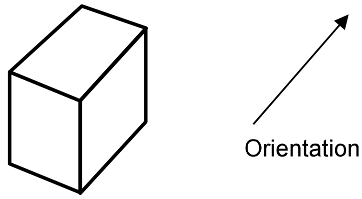
The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	0.1	0.800	0.2	2.000	0.3	4.000	0.5	7.000	0.6
0.200	0.1	1.000	0.3	2.200	0.4	4.500	0.5	7.500	0.6
0.300	0.2	1.200	0.3	2.400	0.4	5.000	0.5	8.000	0.6
0.400	0.2	1.400	0.3	2.600	0.4	5.500	0.5	8.500	0.6
0.500	0.2	1.600	0.3	3.000	0.4	6.000	0.5	9.000	0.7
0.600	0.2	1.800	0.3	3.500	0.4	6.500	0.6	9.500	0.7

SOAKAWAY TEST - DATA SHEET

CENTRAL ALLIANCE
GROUND ENGINEERING TECHNICAL SERVICES

Job Name	Dogger Bank South	Job Number	2372226	
Trial Pit Numbers:	TP3510	Test Numbers	1	Date 04.10.23



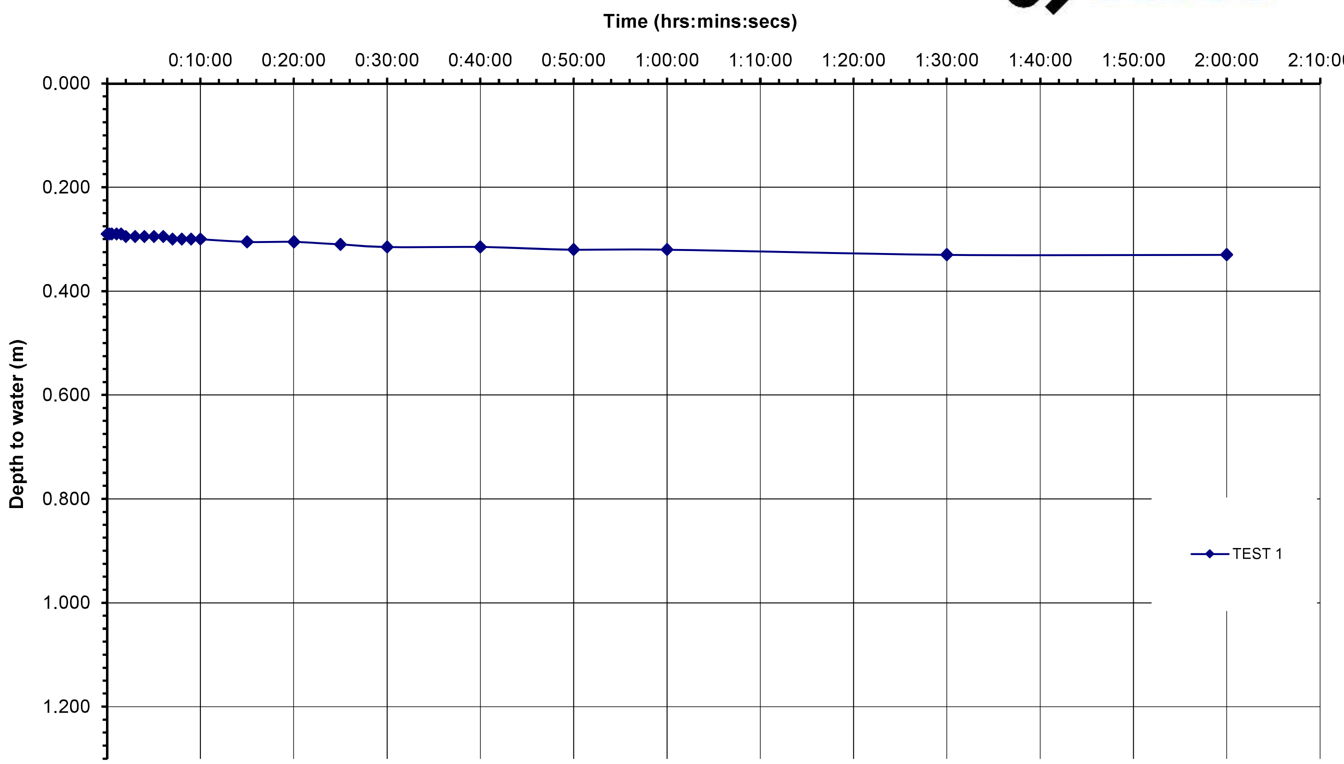
Orientation

Test 1		**Test 2**		**Test 3**			
Trial Pit Dimensions		Trial Pit Dimensions		Trial Pit Dimensions		Trial Pit Dimensions	
Length:	4.00 m	Length:		Length:		Length:	
Width:	1.20 m	Width:		Width:		Width:	
Depth:	1.50 m	Depth:		Depth:		Depth:	
4116l							
Effective Depth:	1.21 m	Effective Depth:		Effective Depth:		Effective Depth:	0.00 m

Test Data **Test Data** **Test Data** **Test Data**

Time (hh:mm:ss)	Depth (mbgl)	Time (hh:mm:ss)	Depth (mbgl)	Time (hh:mm:ss)	Depth (mbgl)	Time (hh:mm:ss)	Depth (mbgl)
0:00:00	0.290	0:00:00		0:00:00		0:00:00	
0:00:15	0.290	0:00:15		0:00:15		0:00:15	
0:00:30	0.290	0:00:30		0:00:30		0:00:30	
0:01:00	0.290	0:01:00		0:01:00		0:01:00	
0:01:30	0.290	0:01:30		0:01:30		0:01:30	
0:02:00	0.295	0:02:00		0:02:00		0:02:00	
0:03:00	0.295	0:03:00		0:03:00		0:03:00	
0:04:00	0.295	0:04:00		0:04:00		0:04:00	
0:05:00	0.295	0:05:00		0:05:00		0:05:00	
0:06:00	0.295	0:06:00		0:06:00		0:06:00	
0:07:00	0.300	0:07:00		0:07:00		0:07:00	
0:08:00	0.300	0:08:00		0:08:00		0:08:00	
0:09:00	0.300	0:09:00		0:09:00		0:09:00	
0:10:00	0.300	0:10:00		0:10:00		0:10:00	
0:15:00	0.305	0:15:00		0:15:00		0:15:00	
0:20:00	0.305	0:20:00		0:20:00		0:20:00	
0:25:00	0.310	0:25:00		0:25:00		0:25:00	
0:30:00	0.315	0:30:00		0:30:00		0:30:00	
0:40:00	0.315	0:40:00		0:40:00		0:40:00	
0:50:00	0.320	0:50:00		0:50:00		0:50:00	
1:00:00	0.320	1:00:00		1:00:00		1:00:00	
1:30:00	0.330	1:30:00		1:30:00		1:30:00	
2:00:00	0.330	2:00:00		2:00:00		2:00:00	
3:00:00		3:00:00		3:00:00		3:00:00	
4:00:00		4:00:00		4:00:00		4:00:00	
5:00:00		5:00:00		5:00:00		5:00:00	
6:00:00		6:00:00		6:00:00		6:00:00	
7:00:00		7:00:00		7:00:00		7:00:00	
8:00:00		8:00:00		8:00:00		8:00:00	

Soakaway Test



SOAKAWAY TEST - CALCULATION SHEET
Position:
Nomenclature:

Symbol:	Function:	Units:
f	Soil Infiltration Rate	m/s
V_{p75-25}	Effective storage volume of water in the trial pit between 75% and 25% effective depth	m^3
a_{s50}	Internal surface area of the trial pit up to 50% effective depth and including the base area	m^2
t_{p75-25}	Time for the water level to fall from 75% to 25% effective depth	seconds
d_{eff}	Effective depth	m
$d_{eff75-25}$	Depth between 75% and 25% of the effective depth	m
a_{base}	Trial pit base area	m^2

Test	**Test 1**
d_{eff} =	1.21 m
0.75 d_{eff} =	0.91 m
0.25 d_{eff} =	0.30 m
$d_{eff75-25}$ =	0.61 m
a_{base} =	4.80 m
V_{p75-25} =	2.90 m
a_{s50} =	11.09 m

To calculate $t_{p75-25,}$ use the Depth v Time graphs and draw on a linear line of best fit.

Then work out the time it takes for the water level to drop by $d_{eff75-25}$

Enter the time (in minutes) below:

t_{p75-25} =	
t_{p75-25} =	
f =	

Total fall:	0.04 m
((d_{eff} - Total fall) / d_{eff}) x 100%	96.7%

RWE Renewables UK Dogger Bank South (West) Limited

RWE Renewables UK Dogger Bank South (East) Limited

Windmill Hill Business Park
Whitehill Way
Swindon
Wiltshire, SN5 6PB