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 2) (Tracked)
Volume 8

November 2024

Application Reference: 8.12
APFP Regulation: 5(2)(q)
Revision: 02

Unrestricted

Company	**RWE Renewables UK Dogger Bank South (West) Limited and RWE Renewables UK Dogger Bank South (East) Limited**	Asset:	**Development**
Project:	**Dogger Bank South Offshore Wind Farms**	Sub Project/Package:	**Consents**
Document Title or Description:	Outline Drainage Strategy (Revision 2) (Tracked)		
Document Number:	004993634-02	Contractor Reference Number:	N/A

Rev No.	Date	Status/Reason for Issue	Author	Checked by	Approved by
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

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.

Contents

Plates

Tables

Appendices

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

4. 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.

5. 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

6. 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.

7. 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).

8. 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.

9. 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.

10. Where necessary post construction (restoration) drains may also be installed in consultation with landowners, the Environment Agency, LLFA (ERYC) and IDB, as appropriate to 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.

1.3 Surface Water Management Plan

11. 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, should any temporary dewatering be required. This would be approved under DCO Requirement 19 upon appointment of a Principal Contractor(s).

12. 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)**.

13. 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.

14. The **Obstacle Crossing Register Volume 7, Appendix 5-2 (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

15. Requirement 17 of the **Draft DCO (Volume 3, 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.

1.5 Onshore Converter Station Outline Operational Drainage Strategy

1.5.1 Site Description and Location

16. **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 68 ha
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

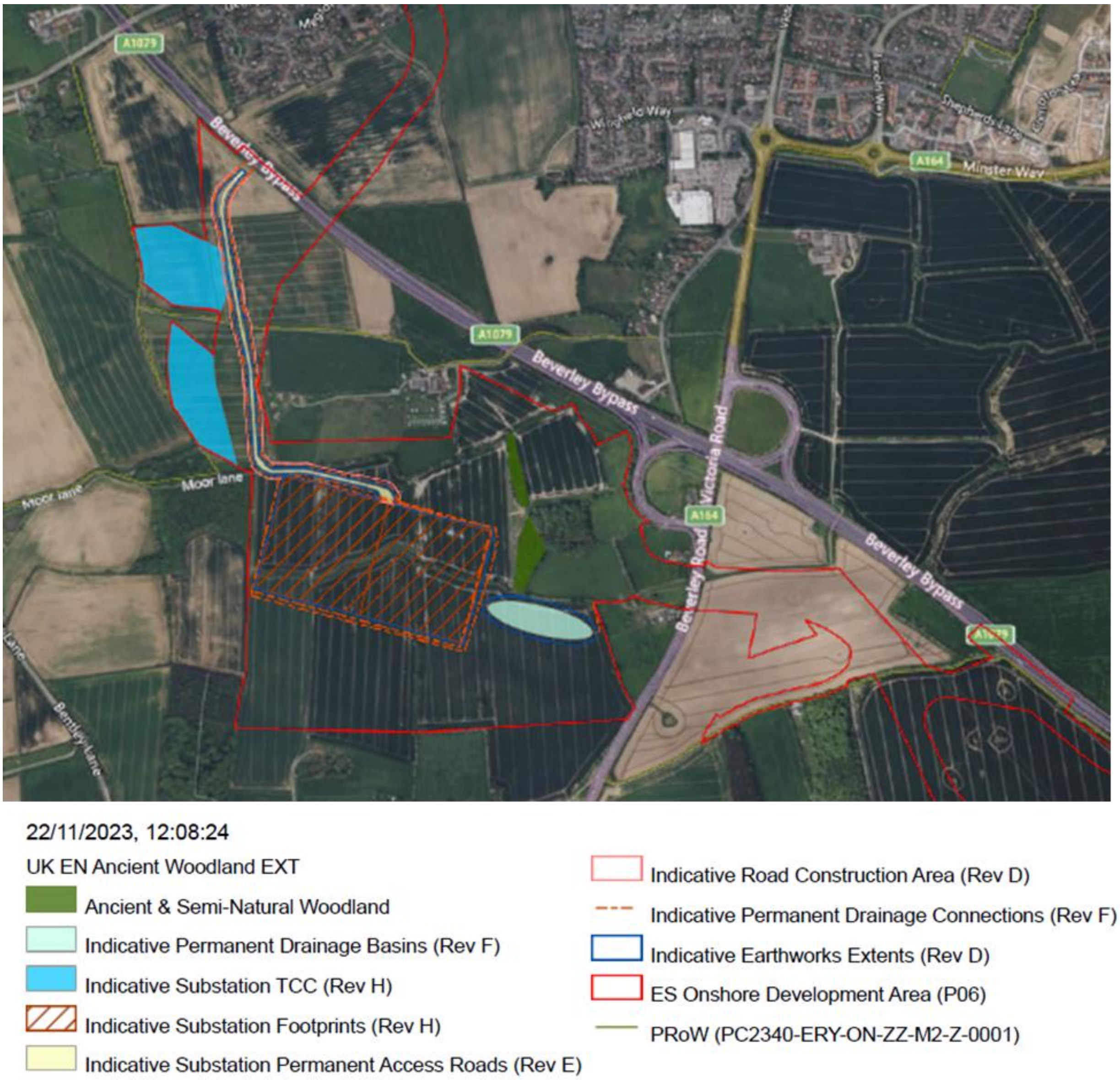
17. The Onshore Substation Zone, within which up to two Onshore Converter Station(s) will be constructed is located on agricultural land approximately 0.75km south west of the town of Beverley in EYRC. The site lies to the south of the A1079 Beverley Bypass, to the west of the A164 road, to the east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

18. 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.

19. 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 **10.13 Arboricultural Survey Report and Preliminary Arboricultural Impact Assessment (Revision 2)** [AS-036 and AS-037].

20. 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

21. 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.

22. 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.

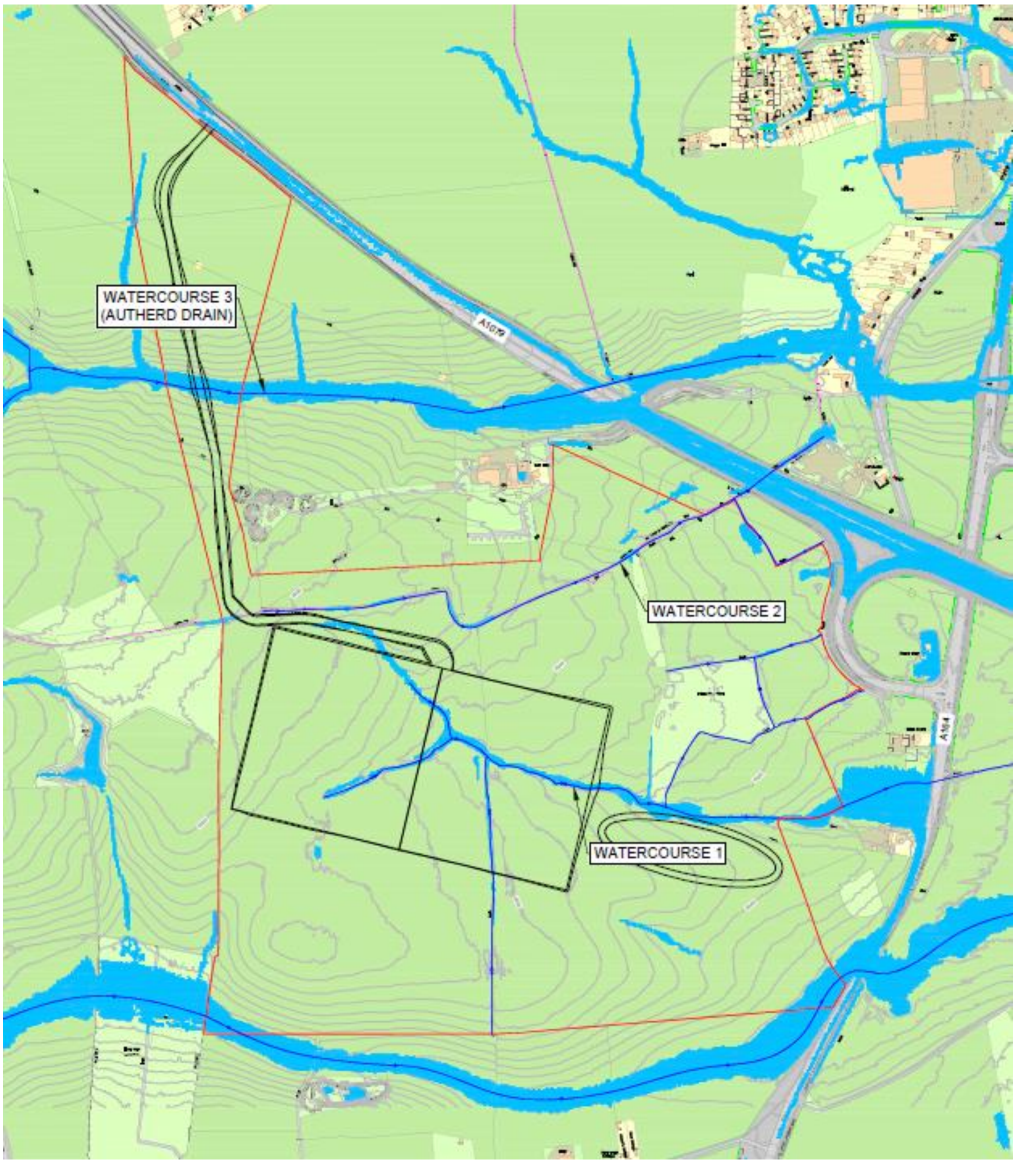
23. To the north of the site, perpendicular to the route of the proposed permanent access, the "Autherd Drain" (Watercourse 3 – see **Plate 1-2** below) crosses the site boundary, discharging to the east and passing below the A1079.

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

25. 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.

26. **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

27. It is proposed to construct an engineered platform (indicative substation footprint on **Plate 1-1**) of up to 488m x 264m to support the Onshore Converter Station(s) for the Projects. The platform is to be located centrally within the Onshore Substation Zone as described in section 1.5.1 of this report.

28. 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.

29. Drawing ED13554-GE-1122 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

30. 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.

31. 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

32. 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.

33. 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.

34. 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).

35. 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.

36. 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

37. 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. Therefore, the development will not increase any flood risk downstream.

1.5.4.3 Onshore Converter Station(s) Flood Risk Management

38. 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.

39. 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

40. 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.

41. 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.

42. 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

43. 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

44. 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.

45. 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).

46. See section 1.5.7 for more details.

1.5.5 Onshore Converter Station(s) SuDS Requirements

47. 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.

48. 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.

49. 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.

50. 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.

51. The detailed SuDS design approach will be landscape-led, as set out in the **Outline Landscape Management Plan (Revision 2)** [APP-236]. 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.

1.5.5.1 SuDS Treatment Train

52. 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

53. 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

54. 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.

55. 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.

56. Priority 2 – Site investigation and infiltration tests for the site have been undertaken. The desktop studies suggest that the underlaying strata on site will be unsuitable for the disposal of surface water to ground via infiltration. However, this will be reviewed once results of the site investigation are available.

57. 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. The suitability of each of these watercourses for discharge is to be further assessed on site prior to the detailed design stage, however they are expected to be suitable given they are shown as ordinary watercourses on Environment Agency flood maps and discharge from the site will be restricted to greenfield run-off rates.

58. 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.

59. 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.

60. 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

61. 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.

62. 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.

63. 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.

64. 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

65. 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.

66. The proposed SuDS (detention) basin is located just south of an area of ancient woodland. The position and shape of the basin will be reviewed at the detailed stage to ensure a 15m buffer from the ancient woodland edge. The buffer will exclude storage of materials, movement of plant machinery and any other construction related activities. As detailed in section 1.5.5 the SuDs design will be a landscape-led approach considering biodiversity and existing woodland, wherever possible.

67. 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 2 & 3. Filter trenches are subject to detailed design and may incorporate additional SuDS components as necessary – to be reviewed at detailed design stage.

68. 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 OWC.

69. 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.

70. 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

71. 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.

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

73. 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.*
- *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 18.7 l/s.

- *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: 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.*
- *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).*

74. 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 13,958m^3.

75. 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).

76. 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).

77. Based on the above, a SuDS (detention) basin with an overall construction depth of 1.5m and a plan area of approximately 18,316m^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.

1.5.8 Foul Water Drainage Outline Strategy

78. 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. Design sizing and requirements will be determined at the detailed design stage.

1.5.9 Onshore Converter Station(s) Drainage Future Maintenance

79. 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.

80. 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

81. 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.

82. 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.

83. Post construction drainage would be installed following the completions of the works providing restoration of drainage capacity in temporary works areas.

84. 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.

85. 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).

86. Sufficient space is available for a SuDS (detention) basin catering for run-off from the Onshore Converter Sstation 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.

87. 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).

88. 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.

89. 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

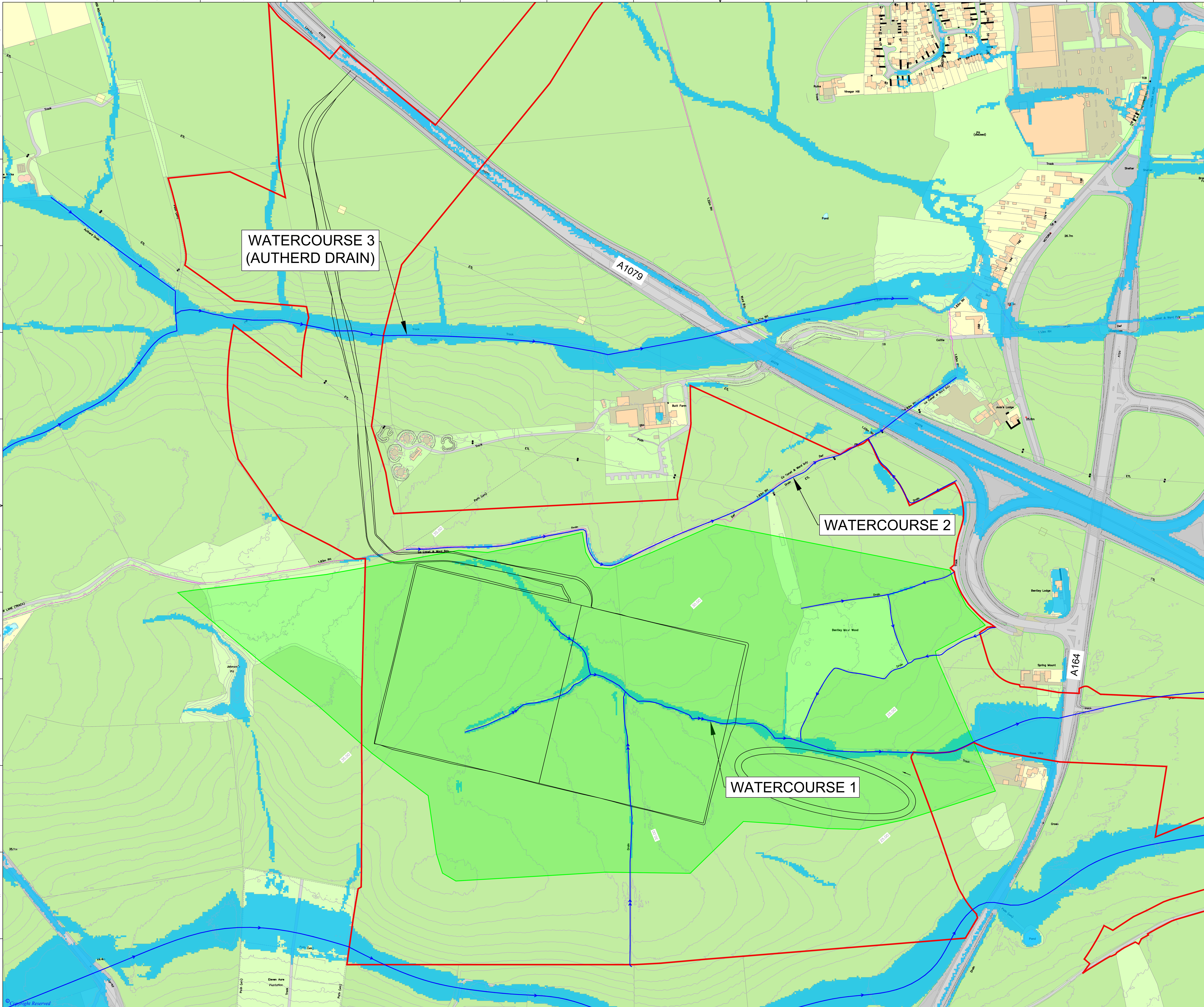
Department for Levelling Up, Housing & Communities (Dec, 2023), National Planning Policy Framework, https://www.gov.uk/government/publications/national-planning-policy-framework--2

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
03	16/05/2024	FINAL FOR ENVIRONMENTAL STATEMENT	PM	AH	AH

RWE

wardell armstrong

PROJECT TITLE
DOGGER BANK SOUTH OFFSHORE WIND FARM

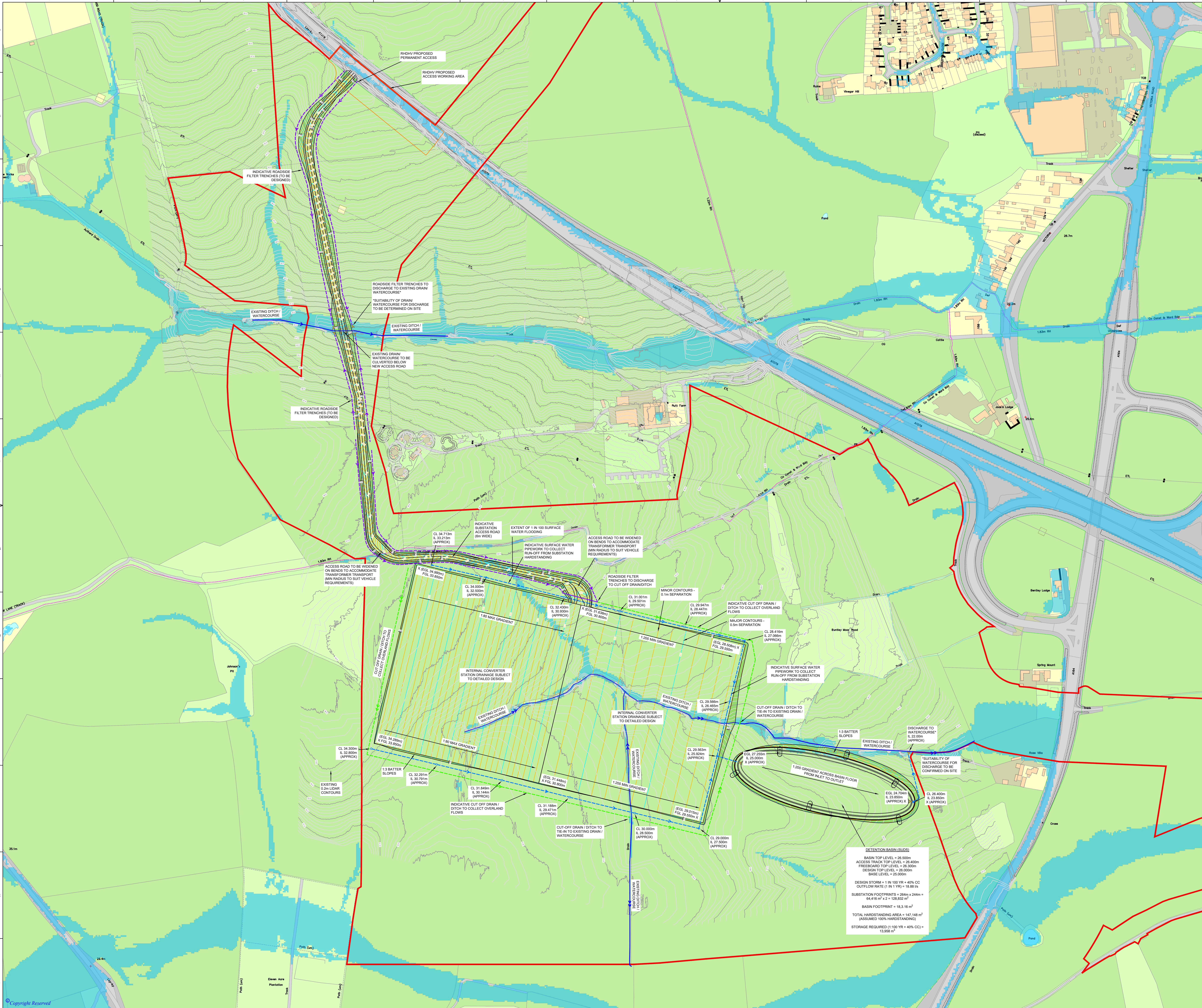
DRAWING TITLE
SUBSTATION ZONE TWO HVDC OPTION
INDICATIVE PRE-DEVELOPMENT
DRAINAGE

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	REVISION
ED13554-GE-1127	03
DBS DOCUMENT NUMBER	REVISION
DBS-WAR-V2-XX-M2-C-0057-C	03

RWE ECODOC NUMBER	SHEET No	REVISION
005205305-01	001 OF 001	01



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
- 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.

REV	DATE	REASON FOR ISSUE	BY	CHK	APP
05	16/05/2024	FINAL FOR ENVIRONMENTAL STATEMENT	PM	AH	AH

RWE

wardell armstrong

PROJECT TITLE

DOGGER BANK SOUTH OFFSHORE WIND FARM

DRAWING TITLE

SUBSTATION ZONE TWO HVDC OPTION INDICATIVE SUBSTATION PLATFORM AND SUDS ENGINEERING LAYOUT

DRAWING STATUS

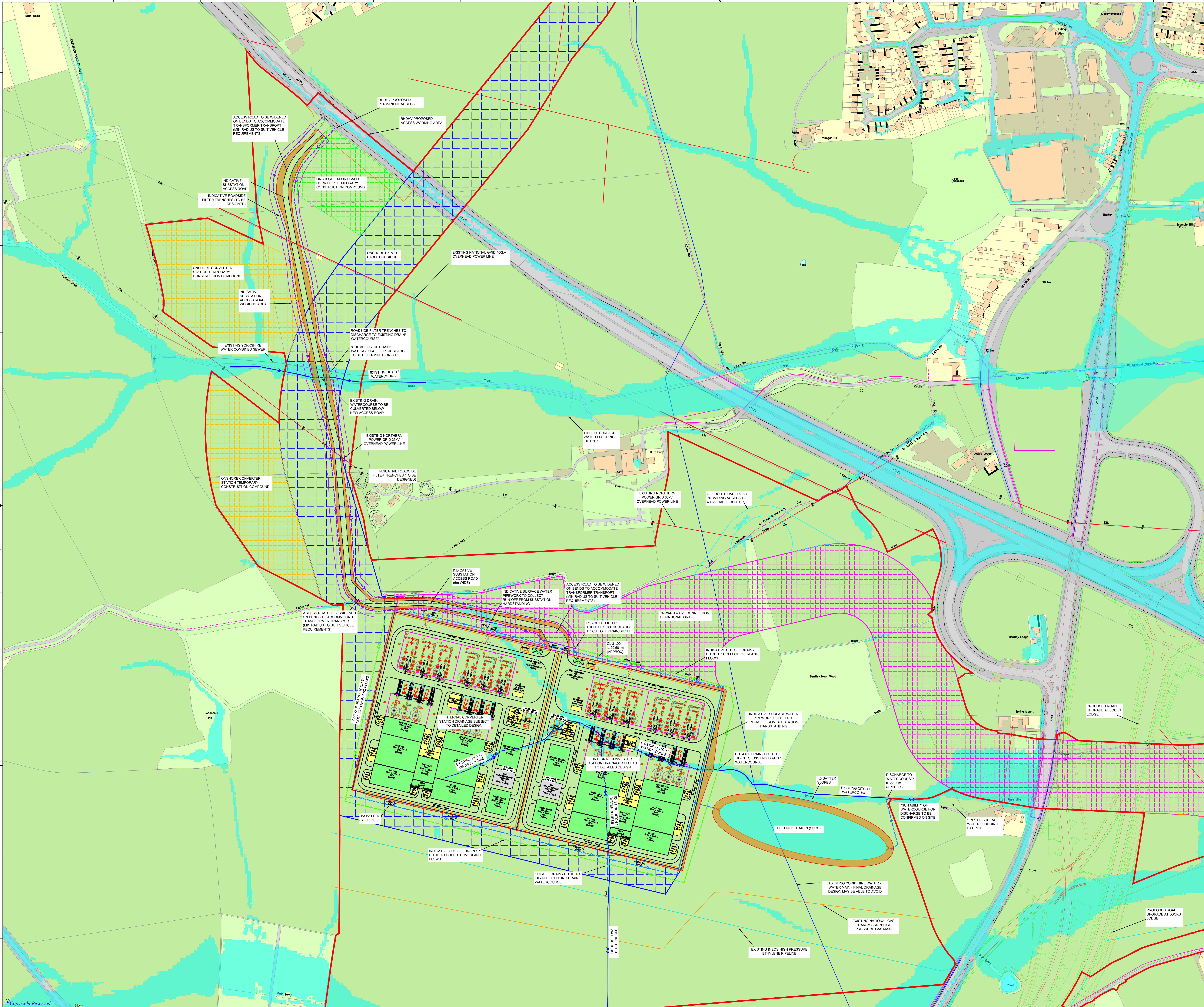
FINAL

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

WA DRAWING NUMBER	REVISION
ED13554-GE-1100	05
DBS DOCUMENT NUMBER	REVISION
DBS-WAR-V2-XX-M2-C-0023-E	005

RWE ECODOC NUMBER	SHEET No	REVISION
004491154-05	001 OF 001	05

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

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
02	09/05/2024	FINAL FOR ENVIRONMENTAL STATEMENT	ZF	PM	AH

RWE

wardell armstrong

PROJECT TITLE
DOGGER BANK SOUTH OFFSHORE WIND FARM

DRAWING TITLE
SUBSTATION ZONE CO-LOCATED HVDC OPTION INDICATIVE SUBSTATION GENERAL ARRANGEMENT

DRAWING STATUS
FINAL

SHEET SIZE	DESIGNED	DRAWN	CHECKED	APPROVED
A1	PM	CS	PM	AH
SHEET SCALE	DATE	DATE	DATE	DATE
NTS	29/09/2023	29/09/2023	29/09/2023	29/09/2023

WA DRAWING NUMBER	REVISION
ED13554-GE-1122	02
DBS DOCUMENT NUMBER	REVISION
DBS-WAR-V2-XX-M2-C-0061-B	02

RWE ECODOC NUMBER	SHEET No	REVISION
004939622-02	001 OF 001	02

APPENDIX B – 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 244m.

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)	64,416	64,416	
SUDS Basin Footprint (including perimeter access track) (m2)	18,316		
Total (m2)	**147,148**		
Pre-Development Run-Off Rates (calculated from HR Wallingford Greenfield Runoff Rate Estimation Online Tool) (l/s)			
1.4 l/s/ha (l/s)	20.60		
	IH124 Method		
1 Year Return (l/s)	**18.68**		
2 Year Return (Q_{BAR}) (l/s)	21.72		
30 Year Return (l/s)	38.01		
100 Year Return (l/s)	45.18		Changed 2 l/s/ha rate to 1.4 l/s/ha rate
200 Year Return (l/s)	51.48		
	FEH Method		
1 Year Return (l/s)	34.25		
2 Year Return (Q_{BAR}) (l/s)	39.83		
30 Year Return (l/s)	69.70		
100 Year Return (l/s)	82.84		
200 Year Return (l/s)	94.39		
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 SCC guidance.**		
Attenuation Storage Required (calculated from FEH13 Rainfall using Micro Drainage design software) (m3)			
All Hardstanding Areas (m3)	13,958.00		
Total storage required (m3)	**13958**		
Design Check - Attenuation Dimensions (m)			
Design Top area (m2)	15,370		
Freeboard Top area (m2)	16,049		
Perimeter access track top area (m2)	18,079		
Basin Top area (m2)	18,316		
Base area (m2)	13,174		
Design storage depth (m)	1.0		
Design freeboard (design depth + 0.3m) (m)	1.3		
Overall depth (design depth + 0.5m) (m)	1.5		
Side slopes (m)	1 in 4		

Design Check - Attenuation Storage Provided		
Detention Basins		
Basin Design	14,272	
Freeboard	4712.85	
Perimeter access track	1706.4	
Additional storage between track and basin top	1819.75	
Total (design)	**14,272**	
Total (inc. freeboard, access track etc)	22,511	
Design storage required < attenuation storage provided?	**YES = OK**	
Discharge Location	**Existing watercourse (TBC).**	**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	**16,022.1**	
1 in 1000 year + 40% climate change	**22,229.1**	
Storage Available		
Total (inc. freeboard, access track etc)	**22,511**	
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	13,958	
Total storage available (inc. freeboard, access track etc)	22,511	
Surplus (freeboard minus design)	**8,553**	
1 in 10 year + 40% climate change	**8501.1**	
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:	SS Zone 4 - 2x HVDC FEH

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:	53.81545° N
Longitude:	0.45314° W
Reference:	4217358124
Date:	Sep 25 2023 15:31

Runoff estimation approach

FEH Statistical

Site characteristics

Total site area (ha):	12.8832

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):	655	655
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):		39.83
1 in 1 year (l/s):		34.25
1 in 30 years (l/s):		69.7
1 in 100 year (l/s):		82.84
1 in 200 years (l/s):		94.39

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Christopher Sneddon
Site name:	Dogger Bank
Site location:	SS Zone 4 - 2x HVDC IH124

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:	53.81545° N
Longitude:	0.45314° W
Reference:	3277730978
Date:	Sep 25 2023 15:33

Runoff estimation approach

IH124

Site characteristics

Total site area (ha): 12.8832

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):	655	655
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):	21.72	21.72
1 in 1 year (l/s):	18.68	18.68
1 in 30 years (l/s):	38.01	38.01
1 in 100 year (l/s):	45.18	45.18
1 in 200 years (l/s):	51.48	51.48

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	0.163	0.163	14.3	2170.8	O K
30 min Summer	0.208	0.208	18.0	2792.1	O K
60 min Summer	0.256	0.256	18.5	3438.0	O K
120 min Summer	0.309	0.309	18.7	4170.9	O K
180 min Summer	0.341	0.341	18.7	4616.2	O K
240 min Summer	0.364	0.364	18.7	4938.0	O K
360 min Summer	0.397	0.397	18.7	5397.3	O K
480 min Summer	0.420	0.420	18.7	5727.4	O K
600 min Summer	0.439	0.439	18.7	5983.6	O K
720 min Summer	0.453	0.453	18.7	6191.2	O K
960 min Summer	0.476	0.476	18.7	6514.0	O K
1440 min Summer	0.503	0.503	18.7	6901.4	O K
2160 min Summer	0.522	0.522	18.7	7170.0	O K
2880 min Summer	0.529	0.529	18.7	7271.5	O K
4320 min Summer	0.537	0.537	18.7	7377.9	O K
5760 min Summer	0.542	0.542	18.7	7448.6	O K
7200 min Summer	0.546	0.546	18.7	7514.6	O K
8640 min Summer	0.549	0.549	18.7	7561.8	O K
10080 min Summer	0.552	0.552	18.7	7595.7	O K
15 min Winter	0.182	0.182	16.2	2431.0	O K
30 min Winter	0.233	0.233	18.3	3128.0	O K
60 min Winter	0.286	0.286	18.6	3853.1	O K
120 min Winter	0.345	0.345	18.7	4677.4	O K
180 min Winter	0.381	0.381	18.7	5179.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	78.937	0.0	858.1	19
30 min Summer	50.914	0.0	1182.4	34
60 min Summer	31.486	0.0	2221.3	64
120 min Summer	19.243	0.0	2677.3	124
180 min Summer	14.296	0.0	2886.6	184
240 min Summer	11.544	0.0	2988.2	244
360 min Summer	8.516	0.0	3035.2	364
480 min Summer	6.856	0.0	3000.5	482
600 min Summer	5.794	0.0	2956.0	602
720 min Summer	5.050	0.0	2907.7	722
960 min Summer	4.068	0.0	2807.9	962
1440 min Summer	2.991	0.0	2612.5	1442
2160 min Summer	2.195	0.0	5551.5	2160
2880 min Summer	1.766	0.0	5285.8	2796
4320 min Summer	1.308	0.0	4758.4	3460
5760 min Summer	1.064	0.0	9915.5	4264
7200 min Summer	0.913	0.0	10044.8	5048
8640 min Summer	0.809	0.0	9686.9	5888
10080 min Summer	0.734	0.0	9197.3	6760
15 min Winter	78.937	0.0	997.4	19
30 min Winter	50.914	0.0	1330.2	34
60 min Winter	31.486	0.0	2488.7	64
120 min Winter	19.243	0.0	2914.7	122
180 min Winter	14.296	0.0	3061.0	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	0.407	0.407	18.7	5543.2	O K
360 min Winter	0.444	0.444	18.7	6064.4	O K
480 min Winter	0.471	0.471	18.7	6441.0	O K
600 min Winter	0.492	0.492	18.7	6735.3	O K
720 min Winter	0.508	0.508	18.7	6975.0	O K
960 min Winter	0.535	0.535	18.7	7352.1	O K
1440 min Winter	0.567	0.567	18.7	7821.2	O K
2160 min Winter	0.592	0.592	18.7	8181.1	O K
2880 min Winter	0.605	0.605	18.7	8358.8	O K
4320 min Winter	0.612	0.612	18.7	8460.9	O K
5760 min Winter	0.612	0.612	18.7	8463.3	O K
7200 min Winter	0.614	0.614	18.7	8497.1	O K
8640 min Winter	0.615	0.615	18.7	8501.1	O K
10080 min Winter	0.613	0.613	18.7	8482.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
240 min Winter	11.544	0.0	3094.7	240
360 min Winter	8.516	0.0	3064.2	360
480 min Winter	6.856	0.0	3018.5	478
600 min Winter	5.794	0.0	2968.8	596
720 min Winter	5.050	0.0	2918.5	714
960 min Winter	4.068	0.0	2820.3	946
1440 min Winter	2.991	0.0	2638.2	1412
2160 min Winter	2.195	0.0	5589.2	2096
2880 min Winter	1.766	0.0	5329.5	2768
4320 min Winter	1.308	0.0	4852.9	4060
5760 min Winter	1.064	0.0	10642.0	4608
7200 min Winter	0.913	0.0	10356.4	5544
8640 min Winter	0.809	0.0	9916.9	6480
10080 min Winter	0.734	0.0	9480.3	7456

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) 14.715

Time (mins) From:	To:	Area (ha)
0	4	14.715

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	13174.0	1.000	15370.0	1.300	16049.0	1.400	18079.0	1.500	18316.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0193-1870-1000-1870
Design Head (m)	1.000
Design Flow (l/s)	18.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	193
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	18.7	Kick-Flo®	0.717	16.0
Flush-Flo™	0.336	18.7	Mean Flow over Head Range	-	15.8

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	6.7	0.800	16.8	2.000	26.0	4.000	36.3	7.000	47.6
0.200	17.9	1.000	18.7	2.200	27.2	4.500	38.5	7.500	49.2
0.300	18.7	1.200	20.4	2.400	28.4	5.000	40.5	8.000	50.8
0.400	18.6	1.400	21.9	2.600	29.5	5.500	42.4	8.500	52.3
0.500	18.3	1.600	23.4	3.000	31.6	6.000	44.2	9.000	53.8
0.600	17.7	1.800	24.7	3.500	34.1	6.500	45.9	9.500	55.2

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
15 min Summer	0.278	0.278	18.6	3742.7	O K
30 min Summer	0.363	0.363	18.7	4919.3	O K
60 min Summer	0.449	0.449	18.7	6134.1	O K
120 min Summer	0.514	0.514	18.7	7050.8	O K
180 min Summer	0.554	0.554	18.7	7624.1	O K
240 min Summer	0.583	0.583	18.7	8045.0	O K
360 min Summer	0.625	0.625	18.7	8652.2	O K
480 min Summer	0.656	0.656	18.7	9098.7	O K
600 min Summer	0.680	0.680	18.7	9453.3	O K
720 min Summer	0.700	0.700	18.7	9747.7	O K
960 min Summer	0.732	0.732	18.7	10220.7	O K
1440 min Summer	0.775	0.775	18.7	10852.5	O K
2160 min Summer	0.811	0.811	18.7	11393.1	O K
2880 min Summer	0.832	0.832	18.7	11703.7	O K
4320 min Summer	0.851	0.851	18.7	11986.7	O K
5760 min Summer	0.855	0.855	18.7	12060.1	O K
7200 min Summer	0.861	0.861	18.7	12139.6	O K
8640 min Summer	0.865	0.865	18.7	12205.0	O K
10080 min Summer	0.869	0.869	18.7	12256.8	O K
15 min Winter	0.310	0.310	18.7	4192.6	O K
30 min Winter	0.405	0.405	18.7	5511.3	O K
60 min Winter	0.501	0.501	18.7	6873.4	O K
120 min Winter	0.573	0.573	18.7	7903.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	136.059	0.0	1518.7	19
30 min Summer	89.543	0.0	1594.1	34
60 min Summer	55.972	0.0	3182.7	64
120 min Summer	32.333	0.0	3152.3	124
180 min Summer	23.419	0.0	3110.0	184
240 min Summer	18.617	0.0	3068.4	244
360 min Summer	13.461	0.0	2990.4	364
480 min Summer	10.701	0.0	2916.3	484
600 min Summer	8.962	0.0	2844.1	604
720 min Summer	7.756	0.0	2772.7	724
960 min Summer	6.183	0.0	2636.5	962
1440 min Summer	4.495	0.0	2460.7	1442
2160 min Summer	3.273	0.0	5255.7	2160
2880 min Summer	2.620	0.0	5049.2	2880
4320 min Summer	1.928	0.0	4783.9	4320
5760 min Summer	1.559	0.0	10460.2	5248
7200 min Summer	1.330	0.0	10048.9	5976
8640 min Summer	1.171	0.0	9681.2	6744
10080 min Summer	1.054	0.0	9387.5	7472
15 min Winter	136.059	0.0	1579.2	19
30 min Winter	89.543	0.0	1598.2	34
60 min Winter	55.972	0.0	3182.4	64
120 min Winter	32.333	0.0	3125.9	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	0.618	0.618	18.7	8550.1	O K
240 min Winter	0.651	0.651	18.7	9025.9	O K
360 min Winter	0.698	0.698	18.7	9715.8	O K
480 min Winter	0.732	0.732	18.7	10226.8	O K
600 min Winter	0.760	0.760	18.7	10632.8	O K
720 min Winter	0.782	0.782	18.7	10968.5	O K
960 min Winter	0.818	0.818	18.7	11504.5	O K
1440 min Winter	0.867	0.867	18.7	12228.1	O K
2160 min Winter	0.909	0.909	18.7	12872.0	O K
2880 min Winter	0.935	0.935	18.7	13263.4	O K
4320 min Winter	0.962	0.962	18.7	13682.9	O K
5760 min Winter	0.973	0.973	18.7	13848.6	O K
7200 min Winter	0.977	0.977	18.7	13900.6	O K
8640 min Winter	0.977	0.977	18.7	13910.8	O K
10080 min Winter	0.980	0.980	18.7	13958.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180 min Winter	23.419	0.0	3070.3	182
240 min Winter	18.617	0.0	3017.2	242
360 min Winter	13.461	0.0	2912.7	360
480 min Winter	10.701	0.0	2810.0	480
600 min Winter	8.962	0.0	2734.3	598
720 min Winter	7.756	0.0	2681.1	716
960 min Winter	6.183	0.0	2621.6	952
1440 min Winter	4.495	0.0	2583.1	1426
2160 min Winter	3.273	0.0	5350.0	2120
2880 min Winter	2.620	0.0	5281.0	2820
4320 min Winter	1.928	0.0	5093.3	4152
5760 min Winter	1.559	0.0	10729.2	5472
7200 min Winter	1.330	0.0	10461.8	6696
8640 min Winter	1.171	0.0	10279.5	7008
10080 min Winter	1.054	0.0	10051.9	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) 14.715

Time (mins) From:	To:	Area (ha)
0	4	14.715

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	13174.0	1.000	15370.0	1.300	16049.0	1.400	18079.0	1.500	18316.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0193-1870-1000-1870
Design Head (m)	1.000
Design Flow (l/s)	18.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	193
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	18.7	Kick-Flo®	0.717	16.0
Flush-Flo™	0.336	18.7	Mean Flow over Head Range	-	15.8

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	6.7	0.800	16.8	2.000	26.0	4.000	36.3	7.000	47.6
0.200	17.9	1.000	18.7	2.200	27.2	4.500	38.5	7.500	49.2
0.300	18.7	1.200	20.4	2.400	28.4	5.000	40.5	8.000	50.8
0.400	18.6	1.400	21.9	2.600	29.5	5.500	42.4	8.500	52.3
0.500	18.3	1.600	23.4	3.000	31.6	6.000	44.2	9.000	53.8
0.600	17.7	1.800	24.7	3.500	34.1	6.500	45.9	9.500	55.2

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	0.318	0.318	18.7	4292.7	O K
30 min Summer	0.416	0.416	18.7	5659.8	O K
60 min Summer	0.517	0.517	18.7	7092.9	O K
120 min Summer	0.589	0.589	18.7	8135.5	O K
180 min Summer	0.635	0.635	18.7	8794.9	O K
240 min Summer	0.668	0.668	18.7	9278.8	O K
360 min Summer	0.715	0.715	18.7	9970.1	O K
480 min Summer	0.750	0.750	18.7	10490.5	O K
600 min Summer	0.778	0.778	18.7	10903.2	O K
720 min Summer	0.801	0.801	18.7	11242.6	O K
960 min Summer	0.836	0.836	18.7	11768.1	O K
1440 min Summer	0.884	0.884	18.7	12487.4	O K
2160 min Summer	0.926	0.926	18.7	13124.7	O K
2880 min Summer	0.950	0.950	18.7	13497.2	O K
4320 min Summer	0.973	0.973	18.7	13837.7	O K
5760 min Summer	0.977	0.977	18.7	13903.7	O K
7200 min Summer	0.979	0.979	18.7	13938.8	O K
8640 min Summer	0.981	0.981	18.7	13964.8	O K
10080 min Summer	0.982	0.982	18.7	13977.8	O K
15 min Winter	0.355	0.355	18.7	4808.8	O K
30 min Winter	0.464	0.464	18.7	6340.7	O K
60 min Winter	0.576	0.576	18.7	7947.4	O K
120 min Winter	0.657	0.657	18.7	9119.1	O K
180 min Winter	0.708	0.708	18.7	9863.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	156.014	0.0	1583.9	19
30 min Summer	102.974	0.0	1597.3	34
60 min Summer	64.669	0.0	3176.7	64
120 min Summer	37.256	0.0	3112.8	124
180 min Summer	26.962	0.0	3051.6	184
240 min Summer	21.417	0.0	2992.5	244
360 min Summer	15.452	0.0	2875.3	364
480 min Summer	12.277	0.0	2774.4	484
600 min Summer	10.277	0.0	2707.3	604
720 min Summer	8.890	0.0	2663.1	724
960 min Summer	7.071	0.0	2621.2	964
1440 min Summer	5.132	0.0	2585.2	1442
2160 min Summer	3.732	0.0	5353.7	2164
2880 min Summer	2.984	0.0	5296.7	2880
4320 min Summer	2.186	0.0	5089.0	4320
5760 min Summer	1.761	0.0	10709.0	5480
7200 min Summer	1.495	0.0	10429.5	6128
8640 min Summer	1.311	0.0	10219.5	6840
10080 min Summer	1.175	0.0	9954.2	7664
15 min Winter	156.014	0.0	1599.4	19
30 min Winter	102.974	0.0	1590.6	34
60 min Winter	64.669	0.0	3147.4	64
120 min Winter	37.256	0.0	3053.7	124
180 min Winter	26.962	0.0	2958.1	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	0.745	0.745	18.7	10410.5	O K
360 min Winter	0.797	0.797	18.7	11189.8	O K
480 min Winter	0.837	0.837	18.7	11775.5	O K
600 min Winter	0.868	0.868	18.7	12241.7	O K
720 min Winter	0.893	0.893	18.7	12626.7	O K
960 min Winter	0.933	0.933	18.7	13227.4	O K
1440 min Winter	0.987	0.987	18.7	14060.4	O K
2160 min Winter	1.037	1.037	19.0	14822.7	O K
2880 min Winter	1.067	1.067	19.3	15291.9	O K
4320 min Winter	1.099	1.099	19.6	15788.7	O K
5760 min Winter	1.111	1.111	19.7	15979.6	O K
7200 min Winter	1.114	1.114	19.7	16022.1	O K
8640 min Winter	1.111	1.111	19.7	15975.8	O K
10080 min Winter	1.111	1.111	19.7	15970.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
240 min Winter	21.417	0.0	2870.5	242
360 min Winter	15.452	0.0	2779.0	360
480 min Winter	12.277	0.0	2745.7	480
600 min Winter	10.277	0.0	2748.4	598
720 min Winter	8.890	0.0	2763.6	716
960 min Winter	7.071	0.0	2772.0	952
1440 min Winter	5.132	0.0	2737.6	1426
2160 min Winter	3.732	0.0	5657.6	2120
2880 min Winter	2.984	0.0	5615.7	2824
4320 min Winter	2.186	0.0	5395.6	4188
5760 min Winter	1.761	0.0	11183.9	5480
7200 min Winter	1.495	0.0	11079.3	6768
8640 min Winter	1.311	0.0	10884.1	7864
10080 min Winter	1.175	0.0	10608.7	8064

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) 14.715

Time (mins) From:	To:	Area (ha)
0	4	14.715

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	13174.0	1.000	15370.0	1.300	16049.0	1.400	18079.0	1.500	18316.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0193-1870-1000-1870
Design Head (m)	1.000
Design Flow (l/s)	18.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	193
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	18.7	Kick-Flo®	0.717	16.0
Flush-Flo™	0.336	18.7	Mean Flow over Head Range	-	15.8

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	6.7	0.800	16.8	2.000	26.0	4.000	36.3	7.000	47.6
0.200	17.9	1.000	18.7	2.200	27.2	4.500	38.5	7.500	49.2
0.300	18.7	1.200	20.4	2.400	28.4	5.000	40.5	8.000	50.8
0.400	18.6	1.400	21.9	2.600	29.5	5.500	42.4	8.500	52.3
0.500	18.3	1.600	23.4	3.000	31.6	6.000	44.2	9.000	53.8
0.600	17.7	1.800	24.7	3.500	34.1	6.500	45.9	9.500	55.2

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	0.443	0.443	18.7	6052.7	O K
30 min Summer	0.585	0.585	18.7	8067.7	O K
60 min Summer	0.729	0.729	18.7	10178.1	O K
120 min Summer	0.839	0.839	18.7	11818.8	O K
180 min Summer	0.905	0.905	18.7	12815.6	O K
240 min Summer	0.952	0.952	18.7	13528.7	O K
360 min Summer	1.017	1.017	18.9	14521.4	O K
480 min Summer	1.063	1.063	19.2	15224.0	O K
600 min Summer	1.097	1.097	19.5	15765.7	O K
720 min Summer	1.125	1.125	19.8	16203.3	O K
960 min Summer	1.168	1.168	20.1	16879.2	O K
1440 min Summer	1.226	1.226	20.6	17794.4	Flood Risk
2160 min Summer	1.276	1.276	21.0	18585.1	Flood Risk
2880 min Summer	1.303	1.303	21.2	19025.3	Flood Risk
4320 min Summer	1.325	1.325	21.4	19376.8	Flood Risk
5760 min Summer	1.324	1.324	21.4	19365.5	Flood Risk
7200 min Summer	1.314	1.314	21.3	19198.9	Flood Risk
8640 min Summer	1.305	1.305	21.2	19045.3	Flood Risk
10080 min Summer	1.295	1.295	21.2	18896.8	Flood Risk
15 min Winter	0.495	0.495	18.7	6780.1	O K
30 min Winter	0.651	0.651	18.7	9037.9	O K
60 min Winter	0.812	0.812	18.7	11402.9	O K
120 min Winter	0.934	0.934	18.7	13242.3	O K
180 min Winter	1.007	1.007	18.8	14362.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	219.837	0.0	1600.8	19
30 min Summer	146.633	0.0	1551.0	34
60 min Summer	92.634	0.0	2957.7	64
120 min Summer	53.959	0.0	2836.8	124
180 min Summer	39.131	0.0	2881.2	184
240 min Summer	31.078	0.0	2943.6	244
360 min Summer	22.374	0.0	3017.0	364
480 min Summer	17.697	0.0	3057.0	484
600 min Summer	14.746	0.0	3078.7	604
720 min Summer	12.702	0.0	3088.7	724
960 min Summer	10.035	0.0	3086.3	964
1440 min Summer	7.206	0.0	3031.5	1442
2160 min Summer	5.178	0.0	6276.0	2164
2880 min Summer	4.099	0.0	6195.4	2880
4320 min Summer	2.954	0.0	5901.1	4320
5760 min Summer	2.347	0.0	12258.3	5760
7200 min Summer	1.968	0.0	12056.4	6704
8640 min Summer	1.707	0.0	11763.4	7344
10080 min Summer	1.515	0.0	11393.6	8064
15 min Winter	219.837	0.0	1589.2	19
30 min Winter	146.633	0.0	1513.8	34
60 min Winter	92.634	0.0	2861.2	64
120 min Winter	53.959	0.0	2939.5	124
180 min Winter	39.131	0.0	3041.6	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	1.059	1.059	19.2	15164.8	O K
360 min Winter	1.131	1.131	19.8	16284.2	O K
480 min Winter	1.181	1.181	20.2	17079.6	O K
600 min Winter	1.220	1.220	20.6	17695.2	Flood Risk
720 min Winter	1.251	1.251	20.8	18194.3	Flood Risk
960 min Winter	1.300	1.300	21.2	18970.6	Flood Risk
1440 min Winter	1.364	1.364	21.7	20036.2	Flood Risk
2160 min Winter	1.417	1.417	22.1	20985.7	Flood Risk
2880 min Winter	1.448	1.448	22.3	21548.6	Flood Risk
4320 min Winter	1.478	1.478	22.5	22087.1	Flood Risk
5760 min Winter	1.485	1.485	22.6	22229.1	Flood Risk
7200 min Winter	1.482	1.482	22.6	22175.2	Flood Risk
8640 min Winter	1.473	1.473	22.5	21996.1	Flood Risk
10080 min Winter	1.459	1.459	22.4	21745.2	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
240 min Winter	31.078	0.0	3106.7	242
360 min Winter	22.374	0.0	3182.9	362
480 min Winter	17.697	0.0	3223.9	480
600 min Winter	14.746	0.0	3245.5	598
720 min Winter	12.702	0.0	3255.0	716
960 min Winter	10.035	0.0	3250.1	954
1440 min Winter	7.206	0.0	3187.1	1428
2160 min Winter	5.178	0.0	6613.9	2136
2880 min Winter	4.099	0.0	6517.0	2824
4320 min Winter	2.954	0.0	6186.3	4196
5760 min Winter	2.347	0.0	12956.0	5536
7200 min Winter	1.968	0.0	12723.1	6848
8640 min Winter	1.707	0.0	12400.5	8120
10080 min Winter	1.515	0.0	12003.8	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) 14.715

Time From:	**(mins) To:**	**Area (ha)**
0	4	14.715

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	13174.0	1.000	15370.0	1.300	16049.0	1.400	18079.0	1.500	18316.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0193-1870-1000-1870
Design Head (m)	1.000
Design Flow (l/s)	18.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	193
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	18.7	Kick-Flo®	0.717	16.0
Flush-Flo™	0.336	18.7	Mean Flow over Head Range	-	15.8

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	6.7	0.800	16.8	2.000	26.0	4.000	36.3	7.000	47.6
0.200	17.9	1.000	18.7	2.200	27.2	4.500	38.5	7.500	49.2
0.300	18.7	1.200	20.4	2.400	28.4	5.000	40.5	8.000	50.8
0.400	18.6	1.400	21.9	2.600	29.5	5.500	42.4	8.500	52.3
0.500	18.3	1.600	23.4	3.000	31.6	6.000	44.2	9.000	53.8
0.600	17.7	1.800	24.7	3.500	34.1	6.500	45.9	9.500	55.2

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