# East Anglia ONE North Offshore Windfarm

# Outline Operational Drainage Management Plan

Applicant: East Anglia ONE North Limited
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**Applicable to**
**East Anglia ONE North**

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# Executive Summary

1. The primary Sustainable Drainage System (SuDS) scheme that the Applicant is proposing for the onshore substations and National Grid substation site is an infiltration only design, if proved practicable. The secondary SuDS scheme that the Applicant is proposing is a hybrid infiltration and attenuation design. The Applicant additionally proposes an attenuation only design for completeness.

2. The consideration of all three of these schemes is in line with the SuDS drainage hierarchy in Chapter 3 of the CIRIA SuDS Manual (2015), and in line with Suffolk County Council's (SCC) (as Lead Local Flood Authority (LLFA)) SuDS drainage hierarchy.

3. East Suffolk Council also has two key policies (Policy SCLP9.5: Flood Risk; and Policy SCLP9.6: Sustainable Drainage Systems.11) which relate to flood risk and drainage. These have both been reviewed in the context of the Project and the Project is compliant.

4. In the context of this Project, SuDS refers to infiltration or attenuation with a positive discharge to the Friston Watercourse.

5. The Applicant has committed to not increasing flooding to the Projects' infrastructure or to the village of Friston and is surpassing the design standards required as per the CIRIA SuDS Manual (2015). Within this Outline Operational Drainage Management Plan (OODMP) the Applicant proposes a number of options to deliver the SuDS scheme, depending on the final design parameters and the confirmed existing ground conditions.

6. This plan also provides an overview of the management measures required for surface water and foul water drainage arising from the operation of the onshore substations and National Grid infrastructure.

7. The final surface water drainage design will follow the below stages:

    a) Confirm the infiltration rate for the site through percolation testing. This will dictate if an infiltration only scheme is viable;

    b) Confirm the pre-development greenfield $Q_{BAR}$ runoff rate calculated through detailed hydraulic modelling. This will become the maximum design discharge rate to the Friston Watercourse for events up to and including a 1 in 100 year (plus 40% to account for climate change) event, and will not be exceeded post-development should discharge to the Friston Watercourse be required (see ***Appendix 2*** for indicative connection to the Friston Watercourse);

c) Confirm the optimal SuDS basin(s) size, capacity and location using the above data. This will reflect either the infiltration rate, or both the infiltration rate and the discharge rate to the Friston Watercourse should a hybrid infiltration and attenuation scheme be adopted. During this SuDS design stage, additional factors will be taken into account such as revisions to the substation infrastructure footprint and its detailed design; landscaping requirements; and the optimum use of land.

# Glossary of Acronyms

| | |
|---|---|
| BS | British Standards |
| BGS | British Geological Survey |
| BMT | British Maritime Technology |
| CCS | Construction Consolidation Site |
| CDA | Critical Drainage Areas |
| CIRIA | Construction Industry Research and Information Association |
| DCO | Development Consent Order |
| DMRB | Design Manual for Roads and Bridges |
| EIA | Environmental Impact Assessment |
| ESC | East Suffolk Council |
| FRA | Flood Risk Assessment |
| JBA | Jeremy Benn Associates |
| LLFA | Lead Local Flood Authority |
| LFRMS | Local Flood Risk Management Strategy |
| NPPF | National Planning Policy Framework |
| NPPG | National Planning Practice Guidance |
| PPG | Pollution Prevention Guidance |
| PFRA | Preliminary Flood Risk Assessment |
| $Q_{BAR}$ | Mean Annual Flood |
| SCC | Suffolk County Council |
| SFRA | Strategic Flood Risk Assessment |
| SuDS | Sustainable Drainage Systems |
| WDC | Waveney District Council |
| WFD | Water Framework Directive |

# Glossary of Terminology

| | |
|---|---|
| Applicant | East Anglia ONE North Limited |
| Construction consolidation sites | Compounds associated with the onshore works which may include elements such as hard standings, lay down and storage areas for construction materials and equipment, areas for vehicular parking, welfare facilities, wheel washing facilities, workshop facilities and temporary fencing or other means of enclosure. |
| Development area | The area comprising the onshore development area and the offshore development area (described as the 'Order limits' within the Development Consent Order). |
| East Anglia ONE North project | The proposed project consisting of up to 67 wind turbines, up to four offshore electrical platforms, up to one construction, operation and maintenance platform, inter-array cables, platform link cables, up to one operational meteorological mast, up to two offshore export cables, fibre optic cables, landfall infrastructure, onshore cables and ducts, onshore substation, and National Grid infrastructure. |
| National Grid infrastructure | A National Grid substation, cable sealing end compounds, cable sealing end (with circuit breaker) compound, underground cabling and National Grid overhead line realignment works to facilitate connection to the national electricity grid, all of which will be consented as part of the proposed East Anglia ONE North project Development Consent Order but will be National Grid owned assets. |
| National Grid overhead line realignment works | Works required to upgrade the existing electricity pylons and overhead lines (including cable sealing end compounds and cable sealing end (with circuit breaker) compound) to transport electricity from the National Grid substation to the national electricity grid. |
| National Grid substation | The substation (including all of the electrical equipment within it) necessary to connect the electricity generated by the proposed East Anglia ONE North project to the national electricity grid which will be owned by National Grid but is being consented as part of the proposed East Anglia ONE North project Development Consent Order. |
| National Grid substation location | The proposed location of the National Grid substation. |
| Onshore development area | The area in which the landfall, onshore cable corridor, onshore substation, landscaping and ecological mitigation areas, temporary construction facilities (such as access roads and construction consolidation sites), and the National Grid infrastructure will be located. |
| Onshore substation | The East Anglia ONE North substation and all of the electrical equipment within the onshore substation and connecting to the National Grid infrastructure. |
| Onshore substation location | The proposed location of the onshore substation for the proposed East Anglia ONE North project. |
| Sustanable Drainage System | A collection of water management practices that aim to align modern drainage systems with natural water processes |
| $Q_{BAR}$ | Mean annual flood, the value of the average annual flood event recorded in a river. |

# 1 Introduction

## 1.1 Overview

8. This OODMP addresses operational surface water and foul water drainage management matters, and supports the Development Consent Order (DCO) application (the Applications) for the East Anglia TWO project and the East Anglia ONE North project (the Projects) submitted by East Anglia ONE North Limited (the Applicant).

9. Works to be undertaken include (amongst other things) the construction of an onshore substation, one for the East Anglia TWO Project (the Project); an onshore substation for the East Anglia ONE North Project; National Grid infrastructure; associated landscaping; and surface water management infrastructure.

10. Requirement 41 of the ***draft DCO*** (document updated at Deadline 8, document reference 3.1) requires an ODMP in respect of the above works to be submitted to, and approved by, the relevant planning authority, in consultation with SCC and the Environment Agency and which must be in line with this OODMP.

11. The primary SuDS solution being proposed by the Applicant is an infiltration only scheme. However, this is reliant upon percolation testing proving this to be a viable solution for the onshore substation and National Grid substation locations. As the viability of an infiltration only scheme is yet to be determined, the Applicant is additionally proposing a hybrid infiltration and attenuation scheme and an attenuation only scheme for completeness.

12. The information presented in this document is based on the updated maximum substation footprints The following Project updates have been submitted to the Examination and are applicable to this plan:

- An updated Outline Landscape Mitigation Plan within the ***Outline Landscape and Ecological Management Strategy*** (updated version submitted at Deadline 8, document reference 8.7);
- The ***Project Update Note*** (REP2-007) submitted at Deadline 2 regarding the approximate 10% reduction in the footprint of the substations;
- The ***Works Plans (Onshore)*** (REP7-005) to reflect the substation footprint reduction; and The ***Project Update Note for Deadline 3*** (REP3-052) which presents the new location of the National Grid substation sustainable drainage system (SuDS) basin.

## 1.2 Purpose

13. This OODMP presents an overview of the information to be presented within the final ODMP, including:

- Operational surface water management: Information on the SuDS measures to be adopted for potential infiltration, attenuation, treatment and conveying of surface water from the onshore substations and National Grid infrastructure; and
- Operational foul water management: information on wastewater arising from the onshore substations and National Grid infrastructure.

14. Parameters such as the storage volumes, runoff rates and proposed discharge rates quoted in this OODMP relate to the current design envelope of the Projects and will be subject to review during the detailed design of the Projects.

## 1.3 Basis of Design

15. The primary SuDS solution being proposed by the Applicant is an infiltration only scheme. However, this is reliant upon percolation testing proving this to be a viable solution for the onshore substation and National Grid substation locations. As the viability of an infiltration only scheme is yet to be determined, the Applicant is additionally proposing a hybrid infiltration and attenuation scheme and an attenuation only scheme for completeness.

16. The final surface water drainage design will follow the below stages:

a) Confirm the infiltration rate for the site through percolation testing and ground water levels. This will dictate if an infiltration only scheme is viable;

b) Confirm the pre-development greenfield $Q_{BAR}$ runoff rate calculated through detailed hydraulic modelling. This will become the maximum design discharge rate to the Friston Watercourse for events up to and including a 1 in 100 year (plus 40% to account for climate change) event, and will not be exceeded post-development should discharge to the Friston Watercourse be required (see ***Appendix 2*** for indicative connection to the Friston Watercourse);

c) Confirm the optimal SuDS basin(s) size, capacity and location using the above data. This will reflect either the infiltration rate, or both the infiltration rate and the discharge rate to the Friston Watercourse should a hybrid infiltration and attenuation scheme be adopted. During this SuDS design stage, additional factors will be taken into account such as revisions to the substation infrastructure footprint and its detailed design; landscaping requirements; and the optimum use of land.

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# 2 Relevant Legislation, Policy and Guidance

17. This section sets out the relevant legislation and guidance that have informed the development of this OODMP.

## 2.1 Legislation

### 2.1.1 Flood and Water Management Act (2010)

18. Under the Flood and Water Management Act (2010), Lead Local Flood Authorities (LLFAs) are responsible for managing the risk of flooding from surface water, groundwater and ordinary watercourses. Suffolk County Council (SCC) is the LLFA covering the onshore development area and they are required to deliver a strategy for local flood risk management in their area, to investigate flooding and to maintain a register of flood risk assets.

### 2.1.2 The Electricity Safety, Quality Continuity Regulations 2002

19. Regulation 3(4) places obligations on generators and distributors of electricity to, as far as reasonably practicable, prevent enclosed spaces from being contaminated with fluids (including water) which may cause danger. Environments that would be caught by this regulation include customers' premises (e.g. basements or stairwells), and generators' and distributors' own premises (e.g. substations or cable basements).

## 2.2 Planning Policy

### 2.2.1 National Policy Statements

20. Overarching National Policy Statement EN-1 section 5.7 'Flood Risk' has been followed.

### 2.2.2 National Planning Policy Framework

21. The following National Planning Policies have been followed:

- National Planning Policy Framework (NPPF); and
- National Planning Practice Guidance (NPPG) for Flood Risk and Coastal Change.

### 2.2.3 East Suffolk Council Policy

22. The East Suffolk Council (ESC) Suffolk Coastal Local Plan (which was adopted in September 2020) includes two key policies in relation to flood risk and drainage as follows:

   a. Policy SCLP9.5: Flood Risk; and

b. Policy SCLP9.6: Sustainable Drainage Systems.11.

23. Both of the above policies were reviewed in the context of the Project. The onshore substation and National Grid infrastructure locations are within Flood Zone 1, which the Environment Agency classifies as land being at low risk of flooding, having a less than 1 in 1,000 annual probability of river or sea flooding. However, as the site is greater than 1 hectare, and partly within an area that could be affected by surface water conveyance routes, a Flood Risk Assessment (FRA) is still required. The production of the FRA was in accordance with Policy SCLP9.5, whereby there is a requirement to carry out a FRA, specifically meeting the requirements of the Flood Risk National Planning Policy Guidance (and any successor).

### 2.2.4 Preliminary Flood Risk Assessments

24. A Preliminary Flood Risk Assessment (PFRA) for Suffolk was produced by SCC in June 2011. It was subsequently updated in December 2017.

25. The PFRA provides a high-level overview of the potential risk of flooding from local sources and identifies areas at flood risk which may require more detailed studies. PFRAs are used to identify areas that are at risk of significant flooding. The PFRA is used to inform the Local Flood Risk Management Strategy (LFRMS).

### 2.2.5 Strategic Flood Risk Assessments

26. Waveney District Council (WDC) and Suffolk Coastal District Council (SCDC) (now merged to form ESC) jointly commissioned a Level 1 Strategic Flood Risk Assessment (SFRA) in 2008. This was subsequently updated in 2018 (WDC and SCDC 2018).

27. A review of information contained within the Level 1 SFRA has been carried out to inform the understanding of flood risk issues within the onshore development area. This can be found in ***Appendix 20.3 Flood Risk Assessment*** (APP-496).

28. A Level 2 SFRA was prepared on behalf of WDC and SCDC and published in June 2018. The purpose of the Level 2 assessment is to analyse the level of flood risk associated with allocated development sites within their study area, in accordance with the NPPF and the NPPG.

29. Five allocated development sites were identified for assessment in the Level 2 SFRA. These sites were allocated during the ongoing formulation of the WDC Local Plan and are all located in the Lowestoft area. As none of the five allocated development sites are within the onshore development area, the Level 2 SFRA was not considered further by the Applicant (***section 20.3.5*** of ***Appendix 20.3 Flood Risk Assessment*** (APP-496)).

### 2.2.6 Suffolk Flood Risk Management Strategy

30. SCC's Flood Risk Management Strategy (FRMS) was published in 2016 and it outlines the aims and objectives of SCC as the LLFA and provides their policies based on these aims.

31. Critical Drainage Areas (CDAs) are those that fall within Flood Zone 1 that experience critical drainage problems as notified by the Environment Agency[1].

32. The Town and Country Planning (Development Management Procedure) (England) Order 2015 provides that in granting permission for development, other than minor development, which is to be carried out on land in area within Flood Zone 1 which has critical drainage problems and which has been notified to the local planning authority by the Environment Agency, the local planning authority must consult the Environment Agency.

33. Consideration of CDAs is therefore necessary to inform key flood risk priorities. The FRMS indicates that local authorities should identify CDAs within their SFRA. The Level 1 SFRA (WDC and SCDC 2018) indicated that SCDC and WDC has no defined CDAs.

#### 2.2.6.1 Appendix A – Sustainable Drainage Systems (SuDS)

34. SCC's FRMS Appendix A – Sustainable Drainage Systems (SuDS) A Local Design Guide, was published in May 2018. It sets out the guidelines for planning applications for all major developments, including the need for a site-specific drainage strategy.

35. It is noted that the Projects are Nationally Significant Infrastructure Projects and require DCOs rather than planning permission.

36. SCC's FRMS Appendix A – Sustainable Drainage Systems (SuDS) A Local Design Guide summarises the local guidelines for Suffolk and sets out in Section 5 the Suffolk Design Principles, specifically noting that SuDS should:

- Not increase flood risk off site (in all events up to the 1 in 100 year return period);
- Provide adequate standards of flood protection on site - in most cases no flooding inside buildings in events up to a 1 in 100 year return period and no flooding in other areas (apart from designated flood paths / storage areas) in events up to 1 in 30 year return period;
- Take account of the construction, operation and maintenance requirements of both surface and subsurface components, allowing for any

[1] https://www.gov.uk/guidance/flood-risk-assessment-in-flood-zone-1-and-critical-drainage-areas

personnel, vehicle or machinery access required to undertake this work; and
- Make allowances for climate change for all return periods.

37. The Suffolk Design Principles also set out requirements related to discharge rates, volume control and climate change allowances.

38. The Suffolk Design Principles advise that the drainage system for a site be designed for a 20% increase in rainfall as a result of climate change and that during the design a sensitivity check should be carried out for a 40% increase in rainfall to assess wider flood risk. However, SCC has requested that the Applicant design a SuDS which accounts for a 40% increase in rainfall as a result of climate change, therefore 40% has been applied throughout this OODMP. Further discussion on how elements of the Suffolk Design Principles will be incorporated into the final Projects drainage designs are discussed further in ***section 4***.

## 2.3 Guidance

### 2.3.1 British Standards

39. The following British Standards have informed the outline SuDS design for the onshore substations and National Grid infrastructure:

- Drain and sewer systems outside buildings (British Standard EN 752:2017);
- Separator systems for light liquids (British Standard EN 858 1:2002) and
- Gravity drainage systems inside building (British Standard EN 12056 3:2000).

### 2.3.2 Construction Industry Research and Information Association

40. The following guidance from the Construction Industry Research and Information Association (CIRIA) has informed the outline SuDS design for the onshore substations and National Grid infrastructure:

- CIRIA C753 SuDS Manual (Dec 2015); and
- CIRIA C762 Environmental Good Practice on Site (4th Edition 2016).

### 2.3.3 Design Manual for Roads and Bridges

41. The following guidance from the Design Manual for Roads & Bridges (DMRB) has informed the outline SuDS design for the onshore substations and National Grid infrastructure:

- DMRB: Vol 4 Section 2 Part 7 HA 107/04 Design of Outfall and Culvert Details; and

- DMRB: Vol 4 Section 2 Part 1 HA 106/04 Drainage of Runoff from Natural Catchments.

### 2.3.4 Environment Agency Guidance

42. The following Environment Agency guidance notes and documents[2] have informed the outline SuDS design for the onshore substations and National Grid infrastructure:

- Pollution Prevention Guidance (PPG) 1 General Guide to the Prevention of Water Pollution;
- PPG3 Use and Design of Oil Separators in Surface Water Systems;
- PPG4 Disposal of Sewage where no Mains Drainage is Available; and
- PPG5 Works in, or liable to affect Watercourses.

[2] These publications were all withdrawn in 2015, however still provide useful information to ensure best practice is achieved.

# 3 Existing Conditions

## 3.1 Overview

43. This section presents an overview of the existing conditions in and around the onshore substations and National Grid infrastructure. In establishing the baseline, existing infiltration rates and greenfield runoff rates can be identified which will allow the final onshore substations and National Grid infrastructure designs to be optimised in order to avoid exceedance of the existing runoff rate.

## 3.2 Methodology for Establishing Existing Conditions

44. This OODMP has been informed by documentation existing at the time of production. During the detailed design the final ODMP will be informed by any new documentation and will include details of how the existing conditions are established.

45. The data sources used to inform the water resources and flood risk baseline as per ***Chapter 20 Water Resources and Flood Risk*** (APP-068) and ***Appendix 20.3 Flood Risk Assessment*** (APP-496) are outlined in ***Table 3.1***.

**Table 3.1 Data Sources**

| Data | Year | Coverage | Confidence |
|---|---|---|---|
| Environment Agency's Flood Map for Planning | 2018 | Nationwide | High |
| Environment Agency's Risk of Flooding from Surface Water | 2018 | Nationwide | Medium |
| Environment Agency's Risk of Flooding from Rivers and Sea | 2018 | Nationwide | High |
| Environment Agency's Catchment Data Explorer for Water Framework Directive (WFD) River Basin Districts Management Catchments, Operational Catchments and WFD water bodies | 2017 | Nationwide | High |
| Environment Agency fisheries survey data | 2017 | Local | High |
| Environment Agency Product 4 Detailed Flood Risk Assessment Map for Knodishall and Thorpeness | 2017 | Local | High |
| Environment Agency groundwater and surface water abstractions data | 2018 | Local | High |
| Environment Agency priority species data | 2018 | Local | High |
| Suffolk County Council River and Sea Flood Risk and Incident Map | 2018 | Local | High |
| Suffolk County Council Surface Water Flood Risk and Incident Map | 2018 | Local | High |

| Data | Year | Coverage | Confidence |
|---|---|---|---|
| BMT (2020) Friston Surface Water Study – Technical Report[3] | 2020 | Local | High |

46. The Applicant has also adopted the Environment Agency's surface water flood risk definitions for reference in this report. These are summarised in ***Table 3.2***.

**Table 3.2 Summary of Environment Agency Flood Risk Definitions**

| Probability of Surface Water Flooding | Return Periods |
|---|---|
| Very low | Land with less than 1 in 1,000 annual probability of surface water flooding (<0.1%). |
| Low | Land with between 1 in 1,000 and 1 in 100 annual probability of surface water flooding (0.1% - 1%). |
| Medium | Land with between 1 in 100 and 1 in 30 annual probability of surface water flooding (1% - 3.3%). |
| High | Land with greater than 1 in 30 annual probability of surface water flooding (>3.3%). |

## 3.3 Existing Land Use

47. The onshore substations and National Grid infrastructure would be located on agricultural land of Grade 2 (very good) and Grade 3 (good to moderate) quality. This is shown in ***Figure 21.3*** (APP-270) and included in this document as ***Figure 1*** (***Appendix 1***). Further details on existing land use is presented in ***Chapter 21 Land Use*** (APP-069).

## 3.4 Hydrological Catchment(s)

48. The Level 1 SFRA (WDC and SCDC 2018) focussed on fluvial flood risk in a number of key catchments. The onshore substations and National Grid infrastructure are primarily located in the Friston Watercourse catchment, a tributary of the River Alde. The Level 1 SFRA does not cover this watercourse specifically and therefore information on the flood risk from the Friston Watercourse has been based on historic anecdotal information provided by the local community. The Friston Watercourse is designated as Main River by the Environment Agency south of Church Road.

49. A small area of the National Grid infrastructure, associated with modifications to the existing overhead lines, are partially located within the Hundred River

[3] A report commissioned by SCC to determine surface flood water risk to the village of Friston following flooding events in 2019

catchment. The Level 1 SFRA notes that the Hundred River is a coastal draining river which flows through the low-lying Beachfarm Marshland before entering the sea. However, the flood extent within the Level 1 SFRA also confirms that the National Grid infrastructure is located within Flood Zone 1 along with the onshore substations (***Figure 20.2*** (APP-266) included in this document as ***Figure 2*** (***Appendix 1***)). Therefore, the onshore substations and National Grid infrastructure are at low risk of flooding from fluvial sources.

50. The final ODMP will include a topographic survey which validates the existing conditions.

## 3.5 Existing Ground Conditions

51. The onshore substations and National Grid infrastructure are underlain by a Principal Aquifer in the Chalk bedrock (***Figure 18.4*** (APP-255), included in this document as ***Figure 3*** (***Appendix 1***)). The onshore substations and National Grid infrastructure are also underlain by Secondary (A, B and undifferentiated) aquifers in the superficial crag deposits, as reported in section 20.4.3.5 of ***Appendix 20.3 Flood Risk Assessment*** (APP-496).

52. The Level 1 SFRA (WDC and SCDC 2018) indicated that groundwater flooding is most likely to occur in low-lying areas which are underlain by permeable rock (aquifers), particularly after periods of sustained rainfall.

53. The Level 1 SFRA notes that the British Geological Survey (BGS) Susceptibility to Groundwater Flooding map shows the vast majority of the SFRA study area has a designation of “Limited potential for groundwater flooding to occur”, except in some concentrated areas surrounding the watercourses where the designation given is “Potential for groundwater flooding to occur at surface”.

54. There are five unlicensed (private) abstractions known to the Environment Agency close to (but outside) the onshore development area and a further three observation boreholes in the area (which may also be used for abstraction) (***Figure 18.4*** (APP-255)), included in this document as ***Figure 3*** (***Appendix 1***)). All but one of the unlicensed abstraction points appear to be related to non-industrial abstractions, therefore any abstraction is likely to have minimal impact on local groundwater resources and therefore minimal effect on the risk of flooding from groundwater sources.

55. Given the above, the onshore substations and National Grid infrastructure are considered to be at low risk of flooding from groundwater sources.

56. The final ODMP will be produced to include details of ground investigations which validates the existing conditions.

## 3.6 Background to Historic Flooding

57. The onshore substations and National Grid infrastructure are located within Flood Zone 1, at low risk from fluvial or tidal sources. There has been no history of flooding from these sources identified as part of the FRA for the onshore substations and National Grid infrastructure (***Appendix 20.3 Flood Risk Assessment*** (APP-496)); however, this does not mean that flooding has not occurred in the past.

58. As the onshore substation and National Grid infrastructure are located within Flood Zone 1, which the Environment Agency classifies as land being at low risk of flooding, a sequential test is not required, as per the UK Government guidance on the sequential test for Applicant (UK Government, 2012, updated 2017). Furthermore, any other potential sources of flood risk will be managed through the adoption of mitigation measures to ensure there is no risk to the Project, or resulting from the Project following development.

59. The National Grid substation, National Grid Construction Consolidation Site (CCS), cable sealing end compounds and permanent substation operational access road are located in an area with varying risk of surface water flooding. The northern and western boundary around the National Grid substation, including the cable sealing end compounds, and part of the footprint of the National Grid substation, includes areas at both high risk of surface water flooding (i.e. greater than 1 in 30 annual probability of surface water flooding) and medium risk of surface water flooding (i.e. between 1 in 100 and 1 in 30 annual probability of surface water flooding). This flood risk is associated with the drainage of surface water from the north in proximity to Little Moor Farm.

60. The onshore substations and onshore substations CCS are located in areas primarily at very low risk of surface water flooding (i.e. land with less than 1 in 1,000 annual probability of surface water flooding).

61. As part of the onshore substations and National Grid infrastructure a permanent substation operational access road will be built, to serve the onshore substations and National Grid infrastructure. In addition, permanent access tracks to the cable sealing end compounds will be built to the north of the National Grid substation. Parts of the substation operational access road are likely to cross areas at both high risk of surface water flooding (i.e. greater than 1 in 30 annual probability of surface water flooding) and medium risk of surface water flooding (i.e. between 1 in 100 and 1 in 30 annual probability of surface water flooding) (***Figure 20.3.3*** of ***Appendix 20.3 Flood Risk Assessment*** (APP-496), included in this document as ***Figure 4*** (***Appendix 1***)).

62. Flood incident records as recorded by the LLFA (received by the Applicant in July 2018) are reported as having a low priority and are generally located along

the B1121 Saxmundham Road (section 20.4.3.6 of ***Appendix 20.3 Flood Risk Assessment*** (APP-496)).

63. Subsequent information received from the LLFA (19th November 2019) has indicated that more recent surface water flooding events (occurring in October 2019) has affected the area around Friston.

64. There is a known (variable) risk associated with surface water flooding in proximity to the onshore substation and National Grid infrastructure.

## 3.6.1 Historic Rainfall and Flooding Events

### 3.6.1.1 Onshore Substations and National Grid Substation

65. The Product 4 data package (Annex 1 of ***Appendix 20.3 Flood Risk Assessment***) obtained from the Environment Agency does not indicate any records of flooding in the location of the onshore substations or the National Grid infrastructure. The Environment Agency indicate, in their Product 4 data package, that although there are no records of flooding, this does not mean that it has not been subject to flooding, only that no flooding has been reported to them in this location.

66. Information contained within the Level 1 SFRA (WDC and SCDC, 2018) does not show historic flooding to have affected the onshore substation or the National Grid infrastructure location.

67. Within the Level 1 SFRA flood incidents related to foul or surface sewers, groundwater, highways drainage, surface water and other sources were identified. A review of the Level 1 SFRA indicates reports of highway drainage issues in the vicinity of Friston; however, this is outside the area identified for the onshore substation and National Grid infrastructure.

### 3.6.1.2 Friston

68. SCC appointed BMT in 2019 to undertake an assessment of surface water flood risk in Friston, Suffolk following flooding events (BMT, 2020). BMT produced a hydraulic model[4] with the purpose of assessing both the current and potential future flood risk from surface water including the impact of climate change.

69. The Friston Surface Water Study Technical Report produced by BMT (2020) notes that the village of Friston has a well-documented history of surface water

[4] The Applicant notes that the outputs from the proposed hydraulic model may differ from the Friston Surface Water Study Technical Report (BMT, 2020) as it will be based on site investigation information which will be focused on the substation area and contributing catchments and used to inform the development of the detailed design. The Friston Surface Water Study Technical Report (BMT, 2020) focuses on the local surface water flood risk to the village of Friston.

flooding through anecdotal evidence as well as reported incidents, the most recent significant event occurring in October 2019. On 6th October 2019, a storm event triggered large amounts of surface water runoff from both the upstream catchment through Friston, as well as from surrounding fields which drain toward the village centre and the Friston River which flows North-South, in and out of culvert along Low Road, Friston.

70. The observed event was well documented, with significant flow observed running along Grove Road, Aldeburgh Road, Saxmundham Road and Low Road.

71. The model was informed by rainfall data which was supplied from the Thorpeness rainfall gauge which is 5km from Friston.

#### 3.6.1.3 Return Period of October 2019 Event

72. The modelling carried out by BMT, on behalf of SCC, was assessed against a number of theoretical return period rainfall events and for a variety of different storm durations. The modelling report by BMT (BMT, 2020) does not appear to have carried out a detailed rainfall analysis or provided a conclusion on the return period for the October 2019 rainfall event.

73. SCC indicated via email (25th September 2020) that the return period for this rainfall event was equivalent to approximately a 1 in 40-year event. Rainfall information or data related to this event, where available, will be reviewed further during the detailed drainage design to understand potential implications for the onshore substation and National Grid infrastructure.

74. No other flooding events with accompanying rainfall data have been identified to understand the significance of key return period events in the area.

#### 3.6.1.4 Applicant's Analysis of Results Data in the Friston Surface Water Study Technical Report

75. The Applicant reviewed the Friston Surface Water Study Technical Report (BMT, 2020) upon publication.

76. Following ISH 11, the Applicant analysed the modelling results, which were carried out in the Tuflow specialist modelling software, by assessing the maximum water depths and velocities at 17 key node points, as shown in ***Plate 1***.

**Plate 1 Node Location Points Used to Collate the Data in *Table 3 3* and *Table 3 4***


77. The outputs of the assessment of these 17 nodes can be seen in ***Table 3.3*** and ***Table 3.4***. ***Table 3.3*** presents information on maximum water depths and ***Table 3.4*** shows data on the maximum velocities, both during a 6 hour storm duration.

**Table 3.3 Maximum Water Depths (m) for Baseline Rainfall Events (6 Hour Storm Duration)**

| Node ID | 5yr | 20yr | 30yr | 100yr | 100yr (central climate change allowance) | 100yr (upper climate change allowance) | 1,000yr |
|---|---|---|---|---|---|---|---|
| **1** | 0.007 | 0.010 | 0.011 | 0.016 | 0.020 | 0.023 | 0.029 |
| **2** | 0.022 | 0.031 | 0.034 | 0.044 | 0.050 | 0.057 | 0.070 |
| **3** | 0.107 | 0.115 | 0.118 | 0.128 | 0.136 | 0.144 | 0.156 |
| **4** | 0.172 | 0.180 | 0.183 | 0.192 | 0.199 | 0.205 | 0.217 |
| **5** | 0.021 | 0.028 | 0.030 | 0.039 | 0.045 | 0.051 | 0.060 |
| **6** | 0.003 | 0.005 | 0.006 | 0.010 | 0.013 | 0.016 | 0.022 |
| **7** | 0.020 | 0.027 | 0.030 | 0.037 | 0.043 | 0.048 | 0.056 |
| **8** | 0.023 | 0.030 | 0.033 | 0.042 | 0.048 | 0.055 | 0.065 |
| **9** | 0.011 | 0.017 | 0.019 | 0.025 | 0.030 | 0.034 | 0.041 |
| **10** | 0.000 | 0.002 | 0.003 | 0.006 | 0.010 | 0.014 | 0.021 |
| **11** | 0.004 | 0.008 | 0.010 | 0.015 | 0.019 | 0.023 | 0.030 |

| Node ID | 5yr | 20yr | 30yr | 100yr | 100yr (central climate change allowance) | 100yr (upper climate change allowance) | 1,000yr |
|---|---|---|---|---|---|---|---|
| **12** | 0.015 | 0.023 | 0.026 | 0.033 | 0.038 | 0.043 | 0.050 |
| **13** | 0.014 | 0.026 | 0.029 | 0.037 | 0.042 | 0.047 | 0.086 |
| **14** | 0.010 | 0.024 | 0.027 | 0.037 | 0.045 | 0.051 | 0.083 |
| **15** | 0.140 | 0.149 | 0.151 | 0.159 | 0.165 | 0.170 | 0.200 |
| **16** | 0.017 | 0.020 | 0.021 | 0.024 | 0.025 | 0.027 | 0.081 |
| **17** | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.017 |

**Table 3.4 Maximum Velocities (m/s) for Baseline Rainfall Events**

| Node ID | 5yr | 20yr | 30yr | 100yr | 100yr (central climate change allowance) | 100yr (upper climate change allowance) | 1,000yr |
|---|---|---|---|---|---|---|---|
| **1** | 0.122 | 0.152 | 0.160 | 0.191 | 0.215 | 0.234 | 0.265 |
| **2** | 0.030 | 0.054 | 0.064 | 0.101 | 0.129 | 0.157 | 0.211 |
| **3** | 0.037 | 0.035 | 0.036 | 0.035 | 0.036 | 0.041 | 0.066 |
| **4** | 0.017 | 0.018 | 0.018 | 0.028 | 0.038 | 0.051 | 0.076 |
| **5** | 0.112 | 0.149 | 0.161 | 0.201 | 0.232 | 0.260 | 0.302 |
| **6** | 0.078 | 0.126 | 0.141 | 0.191 | 0.227 | 0.264 | 0.334 |
| **7** | 0.136 | 0.182 | 0.195 | 0.237 | 0.267 | 0.293 | 0.330 |
| **8** | 0.034 | 0.060 | 0.068 | 0.101 | 0.121 | 0.137 | 0.163 |
| **9** | 0.192 | 0.245 | 0.265 | 0.312 | 0.347 | 0.376 | 0.417 |
| **10** | 0.023 | 0.056 | 0.069 | 0.099 | 0.119 | 0.139 | 0.170 |
| **11** | 0.091 | 0.138 | 0.150 | 0.194 | 0.224 | 0.252 | 0.292 |
| **12** | 0.089 | 0.104 | 0.109 | 0.132 | 0.153 | 0.172 | 0.204 |
| **13** | 0.031 | 0.029 | 0.034 | 0.034 | 0.043 | 0.063 | 0.238 |
| **14** | 0.022 | 0.086 | 0.100 | 0.150 | 0.182 | 0.208 | 0.342 |

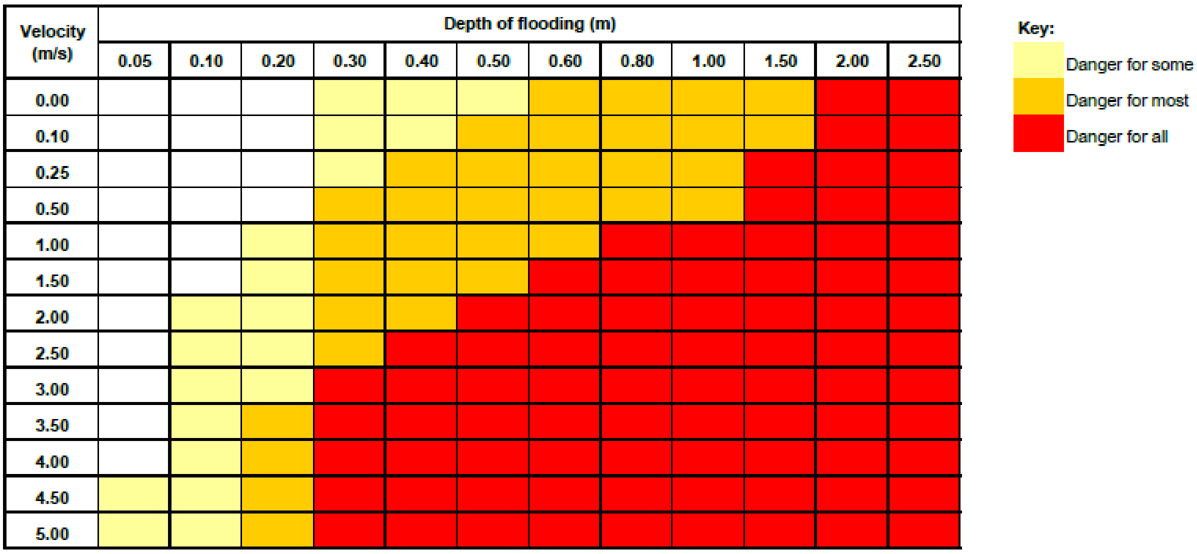
| Node ID | 5yr | 20yr | 30yr | 100yr | 100yr (central climate change allowance) | 100yr (upper climate change allowance) | 1,000yr |
|---|---|---|---|---|---|---|---|
| **15** | 0.027 | 0.027 | 0.027 | 0.027 | 0.031 | 0.040 | 0.084 |
| **16** | 0.055 | 0.056 | 0.057 | 0.057 | 0.056 | 0.056 | 0.379 |
| **17** | 0.021 | 0.023 | 0.023 | 0.024 | 0.026 | 0.026 | 0.447 |

78. The results shown in ***Table 3.3*** and ***Table 3.4*** have confirmed the Applicant's analysis in ***Section 3***; that although there is a surface water conveyance route through the National Grid substation location (see Figure 4 of ***Appendix 1***), there is no flood hazard risk.

79. To demonstrate this, the Applicant refers to Flood Risk Assessment Guidance for New Development Phase 2 Framework and Guidance for Assessing and Managing Flood Risk for New Development – Full Documentation and Tools R&D Technical Report FD2320/TR2 – Flood Risk to People, published by DEFRA and the Environment Agency as part of their Flood and Coastal Defence R&D Programme (October 2005). Within this report a Velocity, Depth and Flood Hazard Matrix is presented which takes into account the depth and velocity of surface water conveyance routes to derive a flood hazard rating (see ***Plate 2***).

80. The outputs of the Flood Risk to People report indicate that flood depths below 0.25 m and velocities below 0.5 m/s are considered *'very low hazard'*.

**Plate 2 Velocity, Depth and Flood Hazard Matrix (DEFRA, 2006)**



| Flood Hazard Rating (HR) | Colour Code | Hazard to People Classification |
|---|---|---|
| Less than 0.75 | | Very low hazard - Caution |
| 0.75 to 1.25 | | Danger for some – includes children, the elderly and the infirm |
| 1.25 to 2.0 | | Danger for most – includes the general public |
| More than 2.0 | | Danger for all – includes the emergency services |

81. When looking at ***Plate 2*** and taking into account the maximum depths and velocities shown in ***Table 3.3*** and ***Table 3.4***, it can be concluded that the flood risk at the onshore substation and National Grid substation locations is <0.75 which is classed as a '*very low hazard'*, as per the DEFRA / Environment Agency (2006) Velocity, Depth and Flood Hazard Matrix.

82. ***Table 3.5*** uses the below formula provided by DEFRA / Environment Agency (2006):

Depth x (Velocity + Velocity Coefficient) + Debris Factor = Flood Hazard Rating

- The Velocity Coefficient is a fixed value of 0.5
- The Debris Factor is 0 for all land uses with a flood depth of 0m - 0.25m

83. ***Table 3.5*** summarises the hazard rating for all 17 node points for key return period events. 5 year and 20 year return periods have not been included as they are smaller events than those utilised for surface water flood risk mapping. The two scenarios for 1 in 100 year with climate change allowance are not included as the Applicant is looking to ascertain the current baseline flood risk.

**Table 3.5 Summary of Maximum Depths (m) and Velocities (m/s) in relation to the Flood Hazard Matrix (DEFRA / Environment Agency, 2006)**

| Node ID | 30yr depth (m) | 30yr velocity (m/s) | 30yr hazard | 100yr depth (m) | 100yr velocity (m/s) | 100yr hazard | 1,000yr depth (m) | 1,000yr velocity (m/s) | 1,000yr hazard |
|---|---|---|---|---|---|---|---|---|---|
| **1** | 0.011 | 0.160 | 0.007 | 0.016 | 0.191 | 0.011 | 0.029 | 0.265 | 0.022 |
| **2** | 0.034 | 0.064 | 0.019 | 0.044 | 0.101 | 0.026 | 0.070 | 0.211 | 0.050 |
| **3** | 0.118 | 0.036 | 0.063 | 0.128 | 0.035 | 0.068 | 0.156 | 0.066 | 0.088 |
| **4** | 0.183 | 0.018 | 0.095 | 0.192 | 0.028 | 0.101 | 0.217 | 0.076 | 0.125 |
| **5** | 0.030 | 0.161 | 0.020 | 0.039 | 0.201 | 0.027 | 0.060 | 0.302 | 0.048 |
| **6** | 0.006 | 0.141 | 0.004 | 0.010 | 0.191 | 0.007 | 0.022 | 0.334 | 0.018 |
| **7** | 0.030 | 0.195 | 0.021 | 0.037 | 0.237 | 0.027 | 0.056 | 0.330 | 0.046 |
| **8** | 0.033 | 0.068 | 0.019 | 0.042 | 0.101 | 0.025 | 0.065 | 0.163 | 0.043 |

| Node ID | 30yr depth (m) | 30yr velocity (m/s) | 30yr hazard | 100yr depth (m) | 100yr velocity (m/s) | 100yr hazard | 1,000yr depth (m) | 1,000yr velocity (m/s) | 1,000yr hazard |
|---|---|---|---|---|---|---|---|---|---|
| **9** | 0.019 | 0.265 | 0.015 | 0.025 | 0.312 | 0.020 | 0.041 | 0.417 | 0.038 |
| **10** | 0.003 | 0.069 | 0.002 | 0.006 | 0.099 | 0.004 | 0.021 | 0.170 | 0.014 |
| **11** | 0.010 | 0.150 | 0.007 | 0.015 | 0.194 | 0.010 | 0.030 | 0.292 | 0.024 |
| **12** | 0.026 | 0.109 | 0.016 | 0.033 | 0.132 | 0.021 | 0.050 | 0.204 | 0.035 |
| **13** | 0.029 | 0.034 | 0.015 | 0.037 | 0.034 | 0.020 | 0.086 | 0.238 | 0.063 |
| **14** | 0.027 | 0.100 | 0.016 | 0.037 | 0.150 | 0.024 | 0.083 | 0.342 | 0.070 |
| **15** | 0.151 | 0.027 | 0.080 | 0.159 | 0.027 | 0.084 | 0.200 | 0.084 | 0.117 |
| **16** | 0.021 | 0.057 | 0.012 | 0.024 | 0.057 | 0.013 | 0.081 | 0.379 | 0.071 |
| **17** | 0.000 | 0.023 | 0.000 | 0.000 | 0.024 | 0.000 | 0.017 | 0.447 | 0.016 |
| **Av.** | 0.043 | 0.099 | 0.024 | 0.050 | 0.124 | 0.029 | 0.076 | 0.254 | 0.052 |

84. ***Table 3.5*** shows that the average (av.) 30 year, 100 year and 1,000 year hazards are 0.024, 0.029 and 0.052, respectively. All of these average values are towards the lower end of the threshold for the hazard rating that is deemed to be *'very low hazard'* (i.e. any values less than 0.75). The greatest hazard rating value within the site is 0.125, which is still well below the threshold value. Therefore, even during a 1 in 1,000 year event, there is no flood hazard risk to the onshore substation and National Grid substation locations.

85. The Applicant notes that the data from the Friston Surface Water Study Technical Report (BMT, 2020) confirms the current understanding of the potential flood risk to the site and does not change any of the material outputs within this OODMP. The above assessment supports the previous conclusions made by the Applicant around the baseline conditions and it can be concluded that there is no flood hazard risk.

## 3.7 Existing Hydrological and Hydrogeological Context

86. Regionally, the principal groundwater body underlying the onshore development area is the Waveney and East Suffolk Chalk and Crag. WFD classification data (Environment Agency, 2016) demonstrate that groundwater is under pressure from abstractions of groundwater and connected surface waters for arable agricultural uses, and from diffuse source pollution from livestock farming. Saline intrusion is not considered to be an issue, as adverse effects on

groundwater-dependent terrestrial ecosystems and surface water bodies are not reported.

### 3.7.1 Existing Friston Catchment

87. The Friston Surface Water Study Technical Report (BMT,2020) notes that the upper reaches of the Friston catchment consist of mainly arable land, with a number of large fields constituting most of the land cover. It also notes that the Friston River drains a catchment area of approximately 11km$^2$ to the southeast of Saxmundham via an open channel which is culverted in parts before flowing in open channel to its confluence with the tidal River Alde.

88. The upstream catchment collects surface water flow before draining into a box culvert which runs along the majority of Low Road (Figure 1-3 of BMT (2020)). Roughly two thirds of the way along Low Road, the watercourse re-emerges into an open channel which is subject to extensive vegetation growth. Downstream of Friston village, adjacent to a pig farm is a flood storage area and downstream of this the channel widens and becomes much flatter with shallower gradients leading to the confluence with the River Alde.

### 3.7.2 Existing Ground Conditions

89. The existing ground conditions at the onshore substations and National Grid infrastructure location are described in ***section 3.5*** and are located within an area shown as having a “limited potential for groundwater flooding to occur” (WDC and SCDC 2018). This is supported by section 2.2.2 of the BMT (2020) report which notes that soil types present in the upper catchment are very permeable, with many perforated pipes used to drain the soils, all of which contribute flow to the field drainage ditches and feed the lower catchment. The superficial geology is glacial till and eroded fluvial deposits. The Friston Surface Water Study Technical Report (BMT, 2020) also notes that the upper catchment is predominately made up of clay soils. In the village the soils become sandier.

90. To confirm the validity of the above description of the existing ground conditions, as provided in the Friston Surface Water Study Technical Report (BMT, 2020), the final ODMP will include details of the scope, extent and findings of the soil surveys which are required to validate the existing conditions.

### 3.7.3 Background to Catchment Hydraulic Modelling

91. Within the Friston Surface Water Study Technical Report (BMT, 2020) it was noted that previously 1D-2D hydraulic modelling of the Friston Catchment was carried out by Jeremy Benn Associates Consulting, on behalf of the Environment Agency, for a wider flood risk mapping study and the results summarised in the report Essex, Norfolk and Suffolk Survey and Model Build: Friston River, (JBA Consulting, November 2016). However, it is noted that the JBA model does not extend further north than Church Road, and therefore does

not reflect the entire hydrological catchment or include the proposed area for the onshore substations and National Grid infrastructure.

92. Subsequently BMT developed a 2D model to investigate surface water runoff in the Friston catchment and the flooding to Friston in October 2019. The results of this modelling have been reviewed and considered within this OODMP and will be considered further to inform the drainage design for the onshore substations and National Grid infrastructure. The results of the modelling carried out by BMT (2020) supported the existing understanding of flood risk to the onshore substations and National Grid infrastructure.

93. The final ODMP will be produced to include details of the scope and extent of the catchment hydraulic model required to validate the existing conditions, informed by a series of surveys including, but not limited to, those described in ***section 3.5*** of this document.

### 3.7.4 Presence of Existing Gauges in the Catchment (Rainfall and Flow)

94. Rain gauges are located at Thorpeness which is located 5km east from the Friston catchment and Woodbridge which is located approximately 6km northeast of Friston.

95. For the Friston Surface Water Study (BMT, 2020), BMT noted that antecedent rainfall was not included within the Thorpeness data pack, which is a key requirement to calculate the initial soil moisture of the catchment leading up to rainfall events. To determine this for the rainfall event of 6th October 2019, the previous 12 months of rainfall data leading up to the event was obtained for use in the Friston Surface Water Study Technical Report (BMT, 2020) from the Woodbridge rain gauge.

96. Due to the nature of the flood risk in the catchment there are no flow or level gauges that would be beneficial to understanding the surface water flood risk in the upper Friston catchment.

## 3.8 Existing Infiltration Potential

97. The final ODMP will be produced to include details of the scope, extent and findings of soil surveys undertaken to determine the existing infiltration potential of the soils within the catchment.

98. ***Section 4.2*** provides further background on the process of infiltration and how infiltration rates will be calculated. ***Section 6*** estimates infiltration values within the Order limits. However, as detailed percolation testing has not yet been undertaken, these calculations are based on indicative, conservative figures.

## 3.9 Existing Runoff Rate to Friston Watercourse

99. The existing pre-development greenfield runoff rates from the onshore substations and National Grid infrastructure location, used to inform the concept design of the ***Outline Landscape and Ecological Management Strategy*** (updated document submitted at Deadline 8, document reference 8.7), are summarised in ***Table 3.6*** below.

100. Runoff rates in ***Table 3.6*** below are expressed using a method based on the Flood Estimation Handbook (1999) 2013 depth duration frequency (DDF) rainfall estimates (FEH 2013) produced by the UK Centre for Ecology and Hydrology. As requested by SCC, the Applicant has provided runoff rates using the FEH 2013 method as it ensures a conservative approach.

101. Existing runoff from the onshore substations and National Grid infrastructure site will flow overland and into adjacent field drains with some of the water making its way through the catchment to the Friston Watercourse.

**Table 3.6 Pre-Development Runoff Rates (using the FEH 2013 method)**

| Design Parameters / Assumptions | Onshore Substations FEH 2013 (Total) (l/s) | National Grid Infrastructure FEH 2013 (Total) (l/s) |
|---|---|---|
| 2 l/s/ha | 17.78 | 12.9 |
| 1 Year Return | 6.88 | 4.81 |
| **2 Year Return ($Q_{BAR}$)[5]** | **7.91** | **5.52** |
| 30 Year Return | 19.38 | 13.53 |
| 100 Year Return | 28.15 | 19.66 |
| 200 Year Return | 33.3 | 23.25 |

## 3.10 Existing Site Characteristics

102. Currently, there are three natural depressions at the onshore substations and National Grid substation locations (as shown in ***Appendix 4***, ***Appendix 6*** and ***Appendix 8***) which act as natural water storage basins. At this stage of the Project's initial design, the Applicant proposes that one is relocated, and that two will remain where they are currently situated. However, subject to hydraulic catchment modelling it has been raised that the existing depression adjacent to the substations (as shown in ***Appendix 4***, ***Appendix 6*** and ***Appendix 8***) may

[5] Discharge from the onshore substation, National Grid infrastructure, operational access road and permanent access road would be limited to the $Q_{BAR}$ rate currently calculated as above and to be confirmed during the detailed design stage. $Q_{BAR}$ is the peak rate of flow from a catchment for the mean annual flood.

no longer fulfil its function and therefore its volume has been included within the SuDS design calculations in ***Section 6*** and ***Section 7***. This volume has been included as a worst-case scenario and will only be accounted for if the hydraulic catchment modelling shows it to be necessary.

103. There is also a natural surface water conveyance route which runs through the National Grid substation location, as show in ***Figure 4*** of ***Appendix 1***. During detailed design the Applicant will ensure that the surface water conveyance route is diverted around the northern perimeter of the National Grid substation. No culverting or piping will be used to divert this flow route, instead the Applicant will seek to work with and refine the natural topography of the area to accommodate the flow, as well as the realignment of existing ordinary watercourses.

104. The Applicant will ensure that any SuDS design developed will account for and work with these natural, existing features and will be reflected in the final design and positioning of the onshore substations and National Grid infrastructure. In limiting runoff from the Project, the site specific SuDS design will reduce the flood risk to the site and to Friston village.

# 4 Sustainable Drainage Principles for the Projects

## 4.1 Overview

105. The Applicant has considered the requirements of the ESC Suffolk Coastal Local Plan (adopted September 2020) with regard to Policy SCLP9.6: Sustainable Drainage Systems, noting that the proposed SuDS are also considered as part of the integration into the landscaping scheme and green infrastructure provision for the development, the extent and nature of which is to be finalised at detailed design.

106. The drainage strategy for the final ODMP will be developed according to the principles of SCC's SuDS hierarchy (2018) and LFRMS (SCC, 2016) as follows:

   i. into the ground (infiltration) (see ***section 4.2***);

   ii. to a surface water body (attenuation) (see ***section 4.3***);

   iii. to a surface water sewer, highway drain or another drainage system (conveyance) (see ***section 4.4***); or

   iv. to a combined sewer.

107. The first three principles are described in more detail in the subsequent sections.

## 4.2 Infiltration

108. Infiltration refers to allowing or encouraging water to soak into the ground, through the natural hydrologic processes. This is normally the most desirable solution for disposal of surface water from rainfall (and is the first principle of SCC's SuDS discharge hierarchy) as it does not create any additional runoff and contributes directly to the recharge of the underlying groundwater.

109. Pre-construction ground investigations of the onshore substations and National Grid infrastructure ground conditions will be undertaken and will inform the detailed design of the Projects and the final ODMP. As part of these investigations, percolation tests will determine the underlying permeability and the feasibility to dispose of surface water directly to ground or other engineered filtration systems, and to what degree.

## 4.3 Attenuation

110. Attenuation storage controls the rate of runoff by limiting the peak flow from the development into the receiving watercourse or drainage system. This is typically

achieved through the use of a temporary storage facility, with a restricted outlet. The attenuation is sufficiently sized to detain the runoff for a given return period, but will then allow the water to discharge, at a controlled rate, back to the receiving watercourse (in this case the Friston Watercourse), over an extended period.

111. Changes in surface water runoff as a result of the increase in impermeable area from the onshore substations and National Grid infrastructure will be attenuated and discharged at a controlled rate. Requirements relating to attenuation and discharge rates will be established in line with the principles set out in this OODMP and agreed in consultation with the LLFA (SCC) and Environment Agency.

112. For the onshore substations and National Grid infrastructure, the storage will be designed to accommodate runoff from a 1 in 100 year[6] storm event plus a 40% allowance for climate change. These measures will limit the runoff to the equivalent of the pre-development greenfield runoff rate (see ***Table 3.6***) (established by the methodology within this OODMP and which will be subject to review during the detailed design of the Projects as discussed in ***paragraph 5*** above) to ensure there is no increased risk of flooding downstream of the discharge.

113. Whilst the site is operational, drainage from the substation operational access road will continue to be managed and attenuated via the National Grid basin.

## 4.4 Conveyance

114. Conveyance is the process of transferring surface runoff from one place to another to manage the flow and to link the various SuDS components together. Rainfall collected in impermeable areas such as the substation operational access road or roofs will, where possible, be conveyed utilising SuDS methods (such as swales). In areas where this is not feasible, rainfall will be carried via underground pipes within the drainage system to the various elements of the SuDS system to allow attenuation to take place. Similarly, perforated filter drains will collect water percolating through permeable areas and convey the same to the SuDS attenuation features.

## 4.5 Pollutant Removal

115. Precautionary measures will be incorporated within the surface water and foul water design to ensure that in the unlikely event of pollutants entering the surface water system from the onshore substations or National Grid

[6] For clarity the '1 in 200' rate from the ES and FRA is comparable to 1 in 100yr + 20% for climate change.

infrastructure, these will either be removed or suitably treated prior to discharge, to ensure there is no wider adverse environmental impact.

116. A review of the pollutant removal measures will be carried out in accordance with CIRIA C753 SuDS Manual (CIRIA, 2015). Further details will be set out in the final ODMP. The approach adopted will identify and consider the source and types of pollutants that may occur in the surface and wastewaters and show how these will be managed to prevent pollution of the receiving watercourses.

117. The normal surface water drainage is unlikely to contain elevated suspended solids, or other pollutants, in the operational phase but the drainage design includes the provision to detain and therefore aid in the settlement of any solids in the SuDS basins. The requirements for the management of foul or waste water is further described in ***section 9*** below.

118. In the operational phase, surface water collected from within the transformer bunds, or other oil-filled plant, has the potential to contain oil residues. Water from these areas will be discharged to the surface water drainage system, only after passing through a Class 1 full retention oil interceptor, provided with an oil detection and automatic device which will prevent any discharge in the case of a sudden unexpected influx of oil.

## 4.6 Application to the Project

119. The Applicant notes that the application of the SuDS hierarchy (SCC, 2018) is dependent on site-specific conditions which will be applied to identify an optimal drainage solution, and not wholly based on the application of a single hierarchy measure as proposed by Suffolk County Council.

120. ***Section 5*** provides an overview of SuDS whilst presenting indicative assumptions for calculating a range of runoff rates and storage volumes so that the SuDS hierarchy can be applied to the site of the onshore substations and National Grid infrastructure.

121. In accordance with the SuDS hierarchy, the Applicant presents an assessment of the viability of the primary option comprising an infiltration only scheme in ***section 6***, an assessment of a hybrid scheme, utilising both infiltration and attenuation, in ***section 7*** and an assessment of an attenuation only scheme in ***section 8***. The hybrid scheme and attenuation only scheme have been presented as a contingency approach should the infiltration only scheme prove unviable following site investigations. The final details related to the application of the SuDS hierarchy will be determined during detailed design once site specific percolation testing and hydraulic modelling has been undertaken.

122. ***Section 9*** considers foul water drainage produced by the onshore substations and National Grid infrastructure in their operational phase, comprising the foul water from the welfare facilities.

123. ***Section 10*** presents the Applicant's position on the optimal drainage design for the onshore substations and National Grid infrastructure, during the operational phase.

124. Drainage during the construction phase will be subject to a separate construction phase surface water and drainage management plan to be produced post consent under Requirement 22(2)(a) of the ***draft DCO*** (document updated at Deadline 8, document reference 3.1)***.***

# 5 Surface Water Drainage

125. This section presents the surface water drainage commitments the Applicant has made (***section 5.1***), an overview of SuDS system components (***section 5.2***) and the methodology for calculating infiltration rates (***section 5.3***).

## 5.1 Commitments

126. When considering pre and post development surface water drainage the Applicant commits to the following:

- If an infiltration only design is shown to be practicable through percolation testing, establishment of the ground water levels and consideration of other land use such as landscaping, biodiversity and access, then an infiltration only SuDS design will be adopted;
- If attenuation is required for any element of the SuDS design, then there will be no increase in the pre- development greenfield run-off rate to the receiving Friston Watercourse catchment;
- Any reduction or removal of existing storage depressions, if required, will be offset and accommodated within the final SuDS design;
- Existing watercourses and flow routes will be appropriately managed to ensure continued conveyance around the northern perimeter of the National Grid substation site; and
- Application of an appropriate Factor of Safety (FoS), currently the FoS applied within the OOMDP is 10.

## 5.2 Sustainable Drainage System Components

127. The existing topography of the onshore substations and National Grid infrastructure is located on naturally sloping land, with gradients falling away towards the field drains to the west and south west of the site, so there is natural conveyance in these general directions. The surface water drainage system will be designed to utilise and support this natural change in elevation.

128. The overall drainage layout will be produced in the final ODMP following detailed design post-consent; the key components of this are described below.

### 5.2.1 Substation Operational Access Road

129. As part of the onshore substations and National Grid infrastructure a permanent substation operational access road will be built to connect Saxmundham Road to the onshore substations and National Grid infrastructure. Parts of the substation operational access road are likely to cross areas at both high risk of surface water flooding (i.e. greater than 1 in 30 annual probability of surface

water flooding) and medium risk of surface water flooding (i.e. between 1 in 100 and 1 in 30 annual probability of surface water flooding). For the purposes of the current concept design and assessment it has been assumed that the substation operational access road is 100% impermeable.

130. Should there be a need for the permanent substation operational access road to be located over an existing surface water flood storage basin, either it will be relocated to an alternative suitable location (as shown in ***Appendix 4, Appendix 6*** and ***Appendix 8***) or the existing volume reduction will be offset and accommodated within the final SuDS design.

### 5.2.2 SuDS Detention / Infiltration Basins

131. SuDS detention / infiltration basins (provided as part of the SuDS) will be included at the onshore substations and National Grid infrastructure in the overall drainage layout. This layout will be informed by the detailed design of the Projects; collation of existing ground conditions data (***section 3***); the production of a catchment hydraulic model (***section 3.7.3***); and agreement through consultation with the LLFA (SCC) of an appropriate infiltration rate and discharge rate into the Friston Watercourse as necessary (***section 5.3***) (based on the existing greenfield runoff rate).

132. In addition, the Applicant retains the option to install further infiltration or attenuation measures along the existing conveyance route during the detailed design phase. The purpose of this is to reduce water in-flow rates to the onshore substation and National Grid infrastructure area and potentially reduce flood risk for the village of Friston. This is in addition to the surface water drainage strategy currently proposed.

133. The specifications of this additional 'surface water management SuDS basin' will require development of an appropriate catchment hydraulic model. The detailed design of the onshore substations and National Grid infrastructure will include the size, volume and location of this basin.

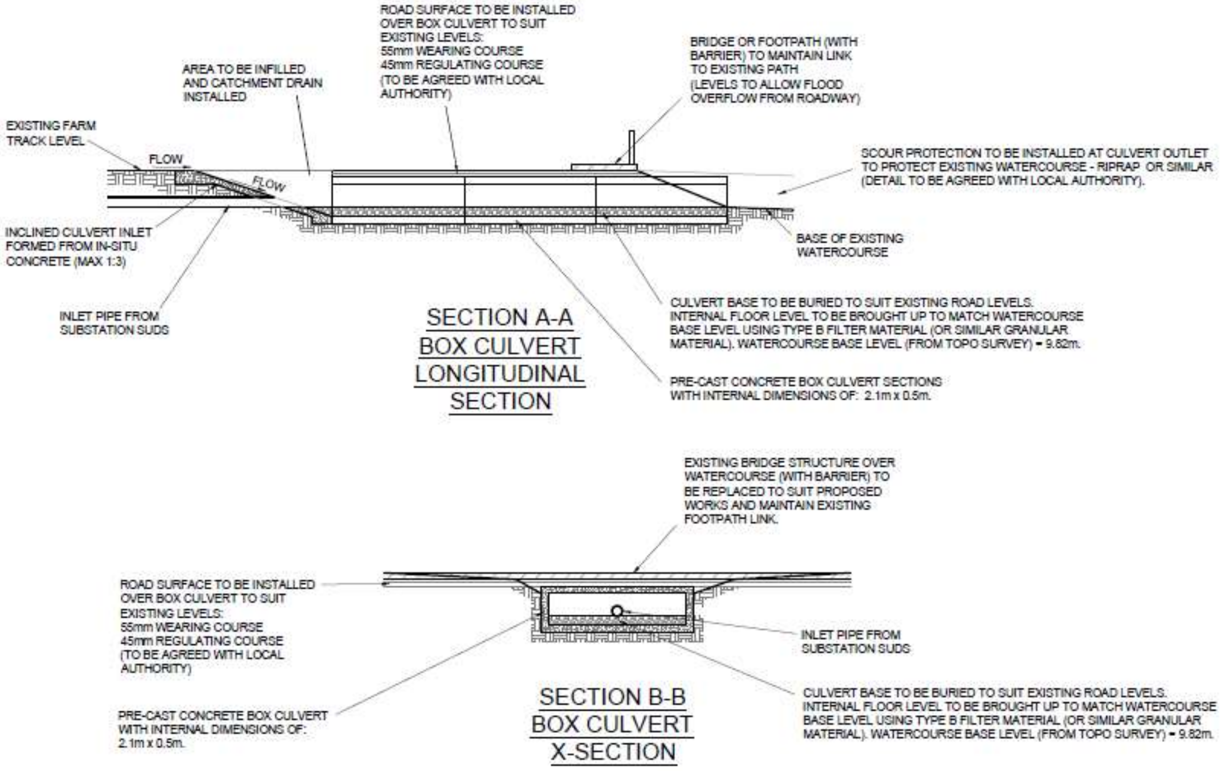
134. As none of the proposed detention basins will be larger than 25,000m$^3$ or are currently designed to be raised above the surrounding ground level, they will not fall under the Reservoirs Act (1975). Nevertheless, they will be appropriately designed in line with current standards and undergo regular inspection and maintenance by a suitably qualified engineer, as summarised in ***section 5.4***.

### 5.2.3 Outfall Pipe

135. A new outfall pipe will be installed to manage runoff from the onshore substations and National Grid infrastructure. This outfall pipe is proposed to run Southwards from the site, then to be located below ground, beneath the existing track and connect to the existing Friston Watercourse in the vicinity of Church

Road. An indicative design for the cross section of the outfall pipe can be seen in ***Plate 3*** (see ***Appendix 2*** for full figure including connection to the Friston Watercourse).

**Plate 3. Indicative Cross Sections of the proposed Box Culvert for the Connection to the Friston Watercourse**




## 5.3 Infiltration Rate or Discharge Rate to the Friston Watercourse

136. The infiltration rate and/or discharge rate to the Friston Watercourse will be calculated based on the results of site specific geotechnical surveys and infiltration testing (as per ***section 3.4*** and ***3.5***). The acceptable discharge rate will be informed by the engineering design work during the detailed design of the Projects; collation of data on the existing site conditions (***section 3***); and the production of a catchment hydraulic model (***section 3.7.3***). If discharge to the Friston Watercourse is required, this discharge rate will be set at the existing greenfield runoff rate established through the catchment hydraulic model. This will be agreed in consultation with the LLFA (SCC) and included as part of the design presented within the final ODMP.

137. ***Section 6*** and ***section 7*** provide further details regarding the embedded flexibility of the development area and the ability to adopt reduced discharge rates (<7.91l/s and <5.52l/s for the onshore substations and National Grid substation respectively) to be reflected in the SuDS detailed design, if attenuation is required. The reduced discharge rates reflect the potential

variability of the existing greenfield runoff rates which will be established from the catchment hydraulic model.

## 5.4 Inspection and Maintenance

138. Inspection and maintenance of the onshore substations and National Grid infrastructure drainage systems (to the point of connection to the Friston Watercourse) will be the responsibility of the site operator during the operational phase of the Projects (until the site is decommissioned).

139. The maintenance of the operational drainage will be secured through the approved final Operational Drainage Management Plan. The undertaker will ensure that appropriate and clear responsibilities are set out within the approved plan. Given the importance of the infrastructure, maintenance is likely to remain with the operator of the onshore substation.

140. If separate provision is made for the National Grid infrastructure then maintenance may pass to that entity in respect of that infrastructure. The appropriate time to resolve these matters is once the detailed design has been completed.

141. The SuDS features will be included in a routine inspection and maintenance schedule carried out for the onshore substations and National Grid infrastructure, along with the landscape maintenance as described in the ***Outline Landscape and Ecological Management Strategy*** (updated version submitted at Deadline 8, document reference 8.7) to ensure they remain in effective operation. This will include checking of the various inlets and outfalls and other structures, if required, for ongoing function and integrity. There will be a need for occasional cutting and removal of the vegetative growth on the inner slopes of any basins and swales and appropriate maintenance of any trees in the wet woodland area of the basins.

142. The maintenance schedule for the various surface water features will be included in the final ODMP once the final design has been confirmed.

## 5.5 Ordinary Watercourse Consent

143. Land Drainage Consent associated with temporary and permanent works at the Projects' and National Grid infrastructure would be applied for separately to Land Drainage Consent for temporary construction works along the onshore cable route. An application for Land Drainage Consent in respect of the onshore substations and National Grid infrastructure works will be submitted to the LLFA post-consent and will include details of the measures to be implemented in relation to any affected Ordinary Watercourses.

# 6 Infiltration Only Scheme

## 6.1 Guidance

144. SCC's SuDS guidance (2018) has informed the illustrative infiltration design. Section 5 of the guidance (Suffolk Design Principles) indicates that "*soakage rates need to be above 5-10mm/hr for infiltration to be the sole means of drainage*" (i.e. the first option within the surface water drainage hierarchy).

145. As agreed in Table 13 in the ***Statement of Common Ground with SCC and ESC*** (updated document submitted at Deadline 8, document reference ExA.SoCG-2.D8.V4), the Applicant has therefore tested the SuDS design at an infiltration rate of 10mm/hr, which is deemed to be a reasonable worst-case feasible infiltration rate.

146. Additionally, a half drain time of 24 hours has been considered within the calculations below, as per SCC guidance.

## 6.2 Modelling Design Parameters

147. The following parameters have been modelled:

- Infiltration rate of 10mm/hr;
- 100% impermeable surface area for the onshore substations and National Grid infrastructure areas of hardstanding (see ***Table 6.1***);
- 100% impermeable area for the permanent operational access road (see ***Table 6.1***);
- Requirement to provide replacement volume as a result of the potential removal of the existing natural depression adjacent to the substations (see ***Appendix 4, Appendix 6*** and ***Appendix 8***); and
- Attenuation of water during the 1 in 100 year plus 40% climate change scenario.

148. An additional, secondary assessment was also undertaken, as requested by SCC. This included the parameters set out in paragraph 147 and additionally considered attenuation of water during a 1 in 10 year storm event (plus 40% climate change scenario), 24 hours after the initial 1 in 100 year (plus 40% climate change scenario) storm event.

149. The modelling has used Flood Estimation Handbook (FEH) (1999) 2013 DDF rainfall data produced by the UK Centre for Ecology and Hydrology[7].

[7] https://fehweb.ceh.ac.uk/

150. A FoS of 10 has also been incorporated in the calculations for the indicative infiltration design. This is a conservative approach based on the guidance set out in Table 25.2 of the CIRIA SuDS Manual (2015), the nature of the Projects and in line with requests from SCC.

151. The design parameters of the onshore substation and National Grid infrastructure are summarised in ***Table 6.1.***

**Table 6.1 Onshore Substation Infiltration Design Impermeable Areas (all parameters are 100% impermeable)**

| Component | East Anglia TWO ($m^2$) | East Anglia ONE North ($m^2$) | National Grid Infrastructure ($m^2$) |
|---|---|---|---|
| Overall substation operational footprint | 32,300 | 32,300 | 44,950 |
| Operational access road | 13,600 | | N/A |
| Overall cable sealing end compound operational footprint | N/A | | 10,000 |
| Permanent access road to cable sealing end compound | N/A | | 1,850 |
| SuDS basin footprint (including perimeter access track) | 27,383 | | 17,508 |
| **Total impermeable area** | **105,583** | | **74,308** |

152. From the above, infiltration storage requirements can be calculated and are summarised below in **Table 6.2** (see ***Appendix 3*** for all calculations).

**Table 6.2 Infiltration Storage Requirements and Provision**

| Infiltration Storage ($m^3$) | East Anglia TWO ($m^3$) | East Anglia ONE North ($m^3$) | National Grid Infrastructure ($m^3$) | Total ($m^3$) |
|---|---|---|---|---|
| **Storage Required** | | | | |
| 1 in 100 year (+40% for climate change) | 12,760 | | 9,082 | 21,842 |
| 1 in 10 year (+40% for climate change) | 6,944 | | 4,995 | 11,939 |
| Potential offset of existing depression | 3,300 | | N/A | 3,300 |

| Infiltration Storage ($m^3$) | East Anglia TWO ($m^3$) | East Anglia ONE North ($m^3$) | National Grid Infrastructure ($m^3$) | Total ($m^3$) |
|---|---|---|---|---|
| adjacent to proposed substation | | | | |
| **Total Storage Required** | 23,004 | | 14,077 | 37,081 |
| **Total Storage Provided**[8] | **23,152** | | **14,236** | **37,388** |

## 6.3 Results

153. The Applicant notes SCC's comments at Deadline 3 (REP3-101) and Deadline 4 (REP4-064) regarding the need for an infiltration only design to achieve a half drain time of 24 hours under a 1 in 100 year plus 40% for climate change scenario. As shown in ***Appendix 3,*** when applying a FoS of 10 to the parameters detailed in ***section 6.2***, the drainage time is in exceedance of 7 days and therefore does not meet SCC's specification for an infiltration only design. Pre-construction ground investigations including infiltration testing will be conducted in order to determine whether the baseline infiltration rate is greater than 10mm/hr. This will inform the extent to which infiltration measures can be prioritised and incorporated into the final SuDS design.

154. As the half drain time exceeded 24 hours, a secondary assessment was undertaken, as requested by SCC. This considered a 1 in 10 year storm event 24 hours after a 1 in 100 year storm event (both accounting for 40% climate change scenario and a FoS of 10). This assessment did not achieve a 24 hour half drain time, and concluded a half drain time of 8,592 minutes, which is approximately 6 days (see ***Appendix 3*** for all calculations).

## 6.4 Conclusion

155. When looking at both of the assessments undertaken within ***section 6.3***, it has been confirmed that for both the 1 in 100 year storm event and a 1 in 10 year storm event 24 hours after an initial 1 in 100 year storm event, using an infiltration rate of 10mm/hr, the 24 hour half drain time cannot be achieved.

156. Therefore, this model has proved that an infiltration rate of 10mm/hr would mean that an infiltration only design for the site is unviable.

[8] Figures do not include freeboard, perimeter access track and additional storage between track and basin top, however do include the volume of the existing depression adjacent to the proposed Western substation

157. However, the Applicant recognises that this is a worst-case, assumed infiltration rate and therefore this infiltration rate will differ once percolation testing has been undertaken. If percolation testing, which will be undertaken post consent, concludes a higher infiltration rate, this model will be re-run and a site-specific conclusion drawn. If percolation testing proves an infiltration only scheme to be viable, it will be adopted.

158. As the assumed infiltration rate of 10mm/hr indicates an infiltration only scheme to currently be unviable, the Applicant presents a scheme utilising both infiltration and attenuation as well as an attenuation only scheme. This is in line with the SuDS drainage hierarchy (SCC, 2018), discussed in **section 6.1**.

159. ***Section 7*** presents a scheme using both infiltration and attenuation elements, with infiltration being the primary drainage source. All attenuation elements discharge to the Friston Watercourse.

160. ***Section 8*** goes on to consider an attenuation only scheme based on the use of attenuation features and discharge to the Friston Watercourse. Both the hybrid infiltration and attenuation scheme (***section 7***) and attenuation only scheme (***section 8***) consider peak flows and total flows.

# 7 Hybrid Infiltration and Attenuation Scheme

161. Based on the pre-development greenfield runoff rate established in ***section 3.9*** and the onshore substation and National Grid infrastructure footprints in ***Table 7.1***, the design parameters for the onshore substations and National Grid infrastructure are summarised in ***Table 7.2.***

162. Within this section, the same worst-case infiltration rate of 10mm/hr, as assumed above will be adopted, as agreed in Table 13 in the ***Statement of Common Ground with SCC and ESC*** (updated document submitted at Deadline 8, document reference ExA.SoCG-2.D8.V4).

**Table 7.1 Onshore Substation Hybrid Design Impermeable Areas (all parameters are 100% impermeable)**

| Component | East Anglia TWO ($m^2$) | East Anglia ONE North ($m^2$) | National Grid Infrastructure ($m^2$) |
|---|---|---|---|
| Overall substation operational footprint | 32,300 | 32,300 | 44,950 |
| Operational access road | 13,600 | | N/A |
| Overal cable sealing end compounds operational footprint | N/A | | 10,000 |
| Permanent access road to cable sealing end compounds | N/A | | 1,850 |
| Infiltration/Attenuation Basin Footprint (including perimeter access track) | 19,306 | | 11,570 |
| **Total impermeable area** | **97,506** | | **69,122** |

163. From the information within ***Table 7.1***, infiltration and attenuation storage requirements can be calculated and are summarised below in ***Table 7.2*** (see ***Appendix 5*** for all calculations).

**Table 7.2 Hybrid Storage Requirements and Provision**

| Storage ($m^3$) | East Anglia TWO ($m^3$) | East Anglia ONE North ($m^3$) | National Grid Infrastructure ($m^3$) | Total ($m^3$) |
|---|---|---|---|---|
| **Storage Required** | | | | |
| Infiltration storage for 1 in 100 year (+40% for climate change) | 8,715 | | 5,268 | 13,983 |
| Attenuation storage using FEH 2013 rainfall method | 3,918 | | 3,783 | 7,701 |
| Additional attenuation storage for 1 in 10 year (+40% for climate change) | 6,556 | | 4,633 | 11,189 |
| Potential offset of existing depression adjacent to proposed substation | 3,300 | | N/A | 3,300 |
| **Total Storage Required** | 22,489 | | 13,684 | 36,173 |
| **Total Storage Provided**[9] | **23,127** | | **13,786** | **36,913** |

164. In ***Table 7.2*** the additional secondary test of a 1 in 10 year storm event (plus 40% climate change scenario), 24 hours after the initial 1 in 100 year (plus 40% climate change scenario) storm event has been included as the initial 1 in 100 year (plus 40% climate change scenario) did not have a 24 hour half drain time.

165. As shown in ***Table 7.2***, the estimated storage requirements for an infiltration only scheme are slightly larger than the storage required for a hybrid scheme. ***Appendix 5*** provides detailed calculations of the above figures and ***Appendix 6*** shows an indicative layout of the infiltration and attenuation basins.

166. By limiting the runoff from the Project to the $Q_{BAR}$ pre-development greenfield runoff rate for all events up to and including the 1 in 100 year plus 40% allowance for climate change, it is considered that both the peak flows and total flows from the proposed development have been taken into consideration.

[9] Figures do not include freeboard, perimeter access track and additional storage between track and basin top, however, they do include the volume of the existing depression adjacent to the proposed substation

167. This is in accordance with the guidance set out in the SCC FRMS Appendix A – Sustainable Drainage Systems (SuDS) A Local Design Guide Section 5 Suffolk Design Principles in the table entitled Volume Control that:

*“SCC recommend that for all sites discharging to a watercourse, the final permitted discharge rate for the entire site is 2l/s/ha or Qbar for all events up to the 1in 100 + Climate Change event (Approach 2) – this then accounts for any volume control needed as per section 3.2 in EA document.”*

168. The ability to accommodate a reduction in pre-development discharge rates is discussed further in ***section 8.1***.

## 7.1 Conclusion

169. In conclusion, a hybrid infiltration and attenuation scheme can be accommodated within the site, based on the 10mm/hr infiltration rate and discharge using the FEH 2013 greenfield run-off rate.

170. As the 24 hour drain time was not viable the Applicant assessed the storage required for a secondary 1 in 10 year storm event (plus 40% climate change scenario), 24 hours after the initial 1 in 100 year (plus 40% climate change scenario) storm event, as requested by SCC. By adopting these parameters it has been confirmed that sufficient storage can be provided within the Order Limits for the hybrid scheme.

# 8 Attenuation Only Scheme

171. Based on the pre-development greenfield runoff rate established in ***section 3.9*** and the onshore substation and National Grid infrastructure footprints in ***Table 8.1***, the design parameters for the onshore substations and National Grid infrastructure are summarised in ***Table 8.2.***

**Table 8.1 Onshore Substation Attenuation Design Impermeable Areas (all parameters are 100% impermeable)**

| Component | East Anglia TWO ($m^2$) | East Anglia ONE North ($m^2$) | National Grid Infrastructure ($m^2$) |
|---|---|---|---|
| Overall substation operational footprint | 32,300 | 32,300 | 44,950 |
| Operational access road | 13,600 | | N/A |
| Overal cable sealing end compounds operational footprint | N/A | | 10,000 |
| Permanent access road to cable sealing end compounds | N/A | | 1,850 |
| Attenuation Basin Footprint (including perimeter access track) | 18,300 | | 10,602 |
| **Total impermeable area** | **96,500** | | **67,402** |

172. From the information within ***Table 8.1***, attenuation storage requirements can be calculated and are summarised below in ***Table 8.2*** (see ***Appendix 7*** for all calculations).

**Table 8.2 Attenuation Storage Requirements and Provision**

| Attenuation Storage ($m^3$) | East Anglia TWO ($m^3$) | East Anglia ONE North ($m^3$) | National Grid Infrastructure ($m^3$) | Total ($m^3$) |
|---|---|---|---|---|
| **Storage Required** | | | | |
| Attenuation storage using FEH 2013 rainfall method | 11,593 | | 8,025 | 19,618 |
| Potential offset of existing depression | 3,300 | | N/A | 3,300 |

| Attenuation Storage ($m^3$) | East Anglia TWO ($m^3$) | East Anglia ONE North ($m^3$) | National Grid Infrastructure ($m^3$) | Total ($m^3$) |
|---|---|---|---|---|
| adjacent to proposed substation | | | | |
| **Total Storage Required** | 14,893 | | 8,024 | 22,917 |
| **Total Storage Provided**[10] | **14,962** | | **8,041** | **23,032** |

173. As shown in ***Table 8.2***, the estimated storage requirements for an infiltration only scheme is larger than the storage required for an attenuation only scheme. ***Appendix 7*** provides detailed calculations of the above figures and ***Appendix 8*** shows an indicative layout of the attenuation basins.

174. By limiting the runoff from the proposed development to the $Q_{BAR}$ pre-development greenfield runoff rate for all events up to and including the 1 in 100 year plus 40% allowance for climate change, it is considered that both the peak flows and total flows from the proposed development have been taken into consideration.

175. This is in accordance with the guidance set out in the SCC FRMS Appendix A – Sustainable Drainage Systems (SuDS) A Local Design Guide Section 5 Suffolk Design Principles in the table entitled Volume Control that:

*"SCC recommend that for all sites discharging to a watercourse, the final permitted discharge rate for the entire site is 2l/s/ha or Qbar for all events up to the 1in 100 + Climate Change event (Approach 2) – this then accounts for any volume control needed as per section 3.2 in EA document."*

## 8.1 Ability to Accommodate Reduction in Pre-development Discharge Rate

176. As discussed above, the SuDS basin will be designed to provide attenuation and a controlled onward flow, limiting the outfall discharge rates to that of the pre-development greenfield runoff rate. This is designed to ensure there is no detrimental impact on the receiving watercourse as a result of increased storm related flows from the development of the onshore substations and National Grid infrastructure and the introduction of an increased impermeable area.

[10] Figures do not include freeboard, perimeter access track and additional storage between track and basin top, however, they do include the volume of the existing depression adjacent to the proposed substation

177. The existing greenfield runoff rate will be confirmed during the detailed design stage in line with this OODMP and will not be exceeded post-development.

178. For the purpose of establishing a realistic indicative SuDS attenuation basin design and existing greenfield runoff rate, in compliance with the relevant guidelines set out in ***section 2*** of this document, the Applicant has assessed the storage requirements based on the footprints in ***Table 7.1*** and ***Table 7.2***.

179. As demonstrated by the design assumptions in ***Appendix 7***, these attenuation storage requirements, as summarised in ***Table 8.2***, would allow the discharge rate to be limited to the $Q_{BAR}$ pre-development greenfield runoff rate of 7.91l/s and 5.52l/s for the onshore substations and the National Grid substation respectively. Once detailed hydraulic modelling has been undertaken post consent, the actual $Q_{BAR}$ pre-development greenfield runoff rate will be confirmed and these runoff rates adopted for discharge to the Friston Watercourse.

180. Should the $Q_{BAR}$ rates stated in **paragraph 179** reduce as a result of establishing the actual $Q_{BAR}$ rate during the detailed design process (i.e. with reference to the results of detailed hydraulic modelling), the discharge rate to the Friston Watercourse would be reduced by the Applicant accordingly. This would require an increase in capacity of the SuDS attenuation basins.

181. ***Table 8.3*** and ***Table 8.4*** demonstrate that larger storage basins can be accommodated within the Order limits and in conjunction with the ***Outline Landscape and Ecological Management Strategy*** (updated version submitted at Deadline 8, document reference 8.7), should this be required.

182. ***Table 8.3*** and ***Table 8.4*** also show that there is flexibility to design a surface water management scheme to reflect the actual pre-development greenfield runoff rates, whilst considering factors such as landscaping, ecology and optimal land use. Note that in both ***Table 8.3*** and ***Table 8.4***, there are no $Q_{BAR}$ rates below 5l/s, as these are generally taken to be the lower limits for discharge due to the technical design constraints related to the risk of blockage to outlets and ensuring that pipes etc can self-cleanse; however, the practicalities associated with this parameter would need to be subject to further consideration during the detailed design.

**Table 8.3 Onshore Substations $Q_{BAR}$ Flexibility, Storage Requirements and Order Limit Capacity**

| Discharge Rate (l/s) | Storage Requirement ($m^3$) | Storage Capacity in Existing Outline Basin Design? | Accomodated within Order Limits? |
|---|---|---|---|
| **7.9 ($Q_{BAR}$)** | **14,893** | **Y** | **Y** |
| 7.5 | 14,945 | Y | Y |
| 7.0 | 15,029 | Y | Y |
| 6.5 | 15,113 | Y | Y |
| 6.0 | 15,199 | Y | Y |
| 5.5 | 15,283 | Y | Y |
| 5.0 | 15,379 | Y | Y |

**Table 8.4 National Grid Substation $Q_{BAR}$ Flexibility, Storage Requirements and Order Limit Capacity**

| Discharge Rate (l/s) | Storage Requirement ($m^3$) | Within Existing Outline Basin Design? | Accomodated within Order Limits? |
|---|---|---|---|
| **5.5 ($Q_{BAR}$)** | **8,024** | **Y** | **Y** |
| 5.0 | 8,088 | Y | Y |

# 9 Foul Water Drainage

## 9.1 Introduction

183. The wastewater produced by the onshore substations and National Grid substation in their operational phase comprise the foul water from the welfare facilities. A sustainable approach will be adopted, which is considered appropriate for each type of wastewater and which is also in line with the overall drainage strategy. It is noted that foul water drainage is not a matter for the LLFA but is included within this OODMP for completeness. The final ODMP will confirm the foul water drainage solution to be adopted.

## 9.2 Onshore Substations and National Grid Substation Foul Water

184. As a first preference, foul drainage at the onshore substations and National Grid substation will be collected through a mains connection to the existing sewer system (where a suitable connection is available) or collected in a septic tank located within the onshore development area and periodically transported off site for disposal at a licensed facility. It is acknowledged that the use of a septic tank may not be appropriate at some locations, and that alternative options would be considered in consultation with the Environment Agency if mains collections are not achievable.

185. Site surveys will inform the approach to be taken for the management of foul water. Subject to permeability, foul water from the onshore substations and National Grid substation will be collected via a piped drainage system and conveyed to be held in a sealed cess tank. Alternatively, a septic tank and soakaway system could be considered if practicable. The location of the building drainage system and cess tank will be confirmed at the detailed design stage and in the final ODMP.

186. If foul water cannot be discharged on site, the cess tank will be designed to have sufficient storage capacity to contain the wastewater generated by the welfare facilities, for a minimum period of three months, sized to minimise the frequency of emptying required. A tank with a capacity to accommodate 8.3m$^3$ would be sufficient for this period, allowing for a 20% factor of safety. The cess tank will also be fitted with a monitoring device and high-level alarm system to alert maintenance staff to the need for emptying. The cess tank will be situated adjacent to the substation operational access road near the substation entrance to provide ease of access for a tanker for the routine emptying of contents and their disposal to a suitably licenced wastewater treatment and disposal facility.

## 9.3 Maintenance

187. The equipment provided to treat the foul and wastewater from the onshore substations and National Grid substation will be included in routine maintenance schedules to ensure they remain fully effective. This would include the routine emptying (if required) and maintenance of the cess tank to remove sewage from site and regular checks on the oil interceptors, auto shut off valves, sensors and alarms to ensure they are all functioning correctly. All maintenance activities shall also be recorded.

# 10 Summary

188. This OODMP identifies the different elements of the surface water and foul water arising from the operation of the onshore substations and National Grid infrastructure. In considering and outlining how these will be managed and controlled, it addresses the location of the development, hydrology and hydrogeological setting and considers the ways in which the potential impacts of water from the onshore substations and National Grid infrastructure, once operational, will be minimised.

189. The overall strategy adopted must therefore be able to ensure that, through the introduction and implementation of suitable control measures, there will be no measurable impacts on the receiving water catchment. This forms the cornerstone of the Applicant's surface water drainage solution.

190. As discussed in ***section 6***, although an infiltration only scheme is currently proving unviable due to the worst case 10mm/hr infiltration rate assumed, this is a worst-case scenario and is likely to change once percolation testing has been undertaken. If an infiltration only design proves viable once percolation testing has been undertaken and ground water levels are established, it will be implemented as the final SuDS design.

191. As outlined in ***section 7*** and ***section 8,*** a hybrid infiltration and attenuation scheme and an attenuation only scheme have both proved viable and are considered acceptable as a means of surface water management in line with the SuDS hierarchy (SCC, 2018). Although it is not the Applicant's preference to adopt either of these schemes, they have been presented to provide a comprehensive assessment should an infiltration only scheme not prove practicable.

192. As presented in ***section 7*** and ***section 8***, if a hybrid infiltration and attenuation, or an attenuation only scheme were to be adopted, there is flexibility in the outline attenuation design to accommodate a reduced $Q_{BAR}$ rate and increased storage capacity within the Order limits if required. Ground investigations at the location of the onshore substations and National Grid infrastructure will be undertaken and will inform the final ODMP. Percolation tests will be undertaken as part of the detailed design process to determine the underlying permeability and the feasibility of adopting an infiltration, hybrid infiltration / attenuation or attenuation only SuDS design with a connection to the Friston Watercourse. This process is summarised below in ***Plate 4.***

193. The uncontaminated waters from roofs and hardstanding (including the substation operational access road and water percolating through permeable

construction (platform)) will be collected and routed to a detention basin. This basin will be designed to provide either infiltration, hybrid infiltration and attenuation or attenuation of the uncontaminated waters and therefore potentially a controlled onward flow. If an onward flow is required, the $Q_{BAR}$ discharge rate will be limited to that of the pre-development greenfield runoff rate. This is designed to ensure there would be no detrimental impact on the receiving watercourse as a result of increased storm related flows from the development of the onshore substations and National Grid infrastructure and the introduction of an increased area of impermeable drainage.

194. In addition, it is recognised that the onshore substations and National Grid infrastructure are situated within an area of existing conveyance routes and watercourses. The Applicant is committed to ensuring that these flow routes are appropriately managed and will ensure continued conveyance around the northern perimeter of the National Grid substation. The Applicant also recognises that there are existing surface water flood storage depressions (as shown in ***Appendix 4, Appendix 6*** and ***Appendix 8***) and commits to offsetting any reduction in volume within the final drainage scheme. This process will be influenced by the detailed design process of the onshore substations and National Grid infrastructure.

195. Finally, the treatment and management of foul water is considered and outlined. As a first preference, foul drainage at the onshore substations and National Grid substation will be collected through a mains connection to the existing Local Authority sewer system. Alternatively, foul sewage will be contained in a sealed cess tank and tankered off-site for disposal, potentially with a soakaway system incorporated depending on ground permeability.

196. Additional sensors, auto shut off valves and alarms will also be added to the drainage equipment installed as appropriate, to provide operators with a warning of any potential problem with pollution control equipment installed, to ensure they can take appropriate action. All equipment and the SuDS elements will be included in routine maintenance to ensure they remain fully effective.

**Plate 4. Flow Chart Summarising the Applicant's Application of the SuDS Hierarchy and Strategy Post-Consent**

# 11 References

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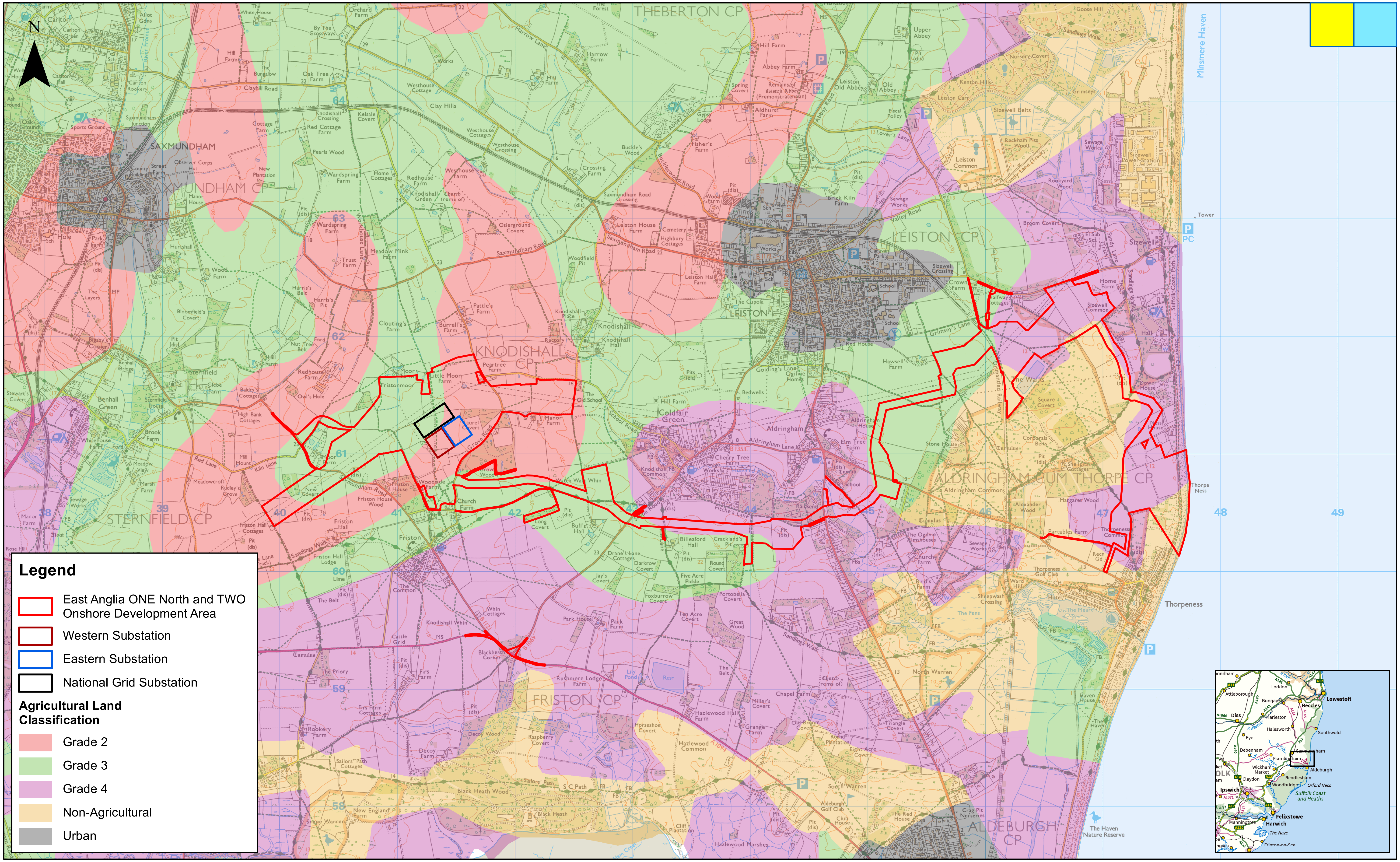
# Appendix 1: Figures




| Rev | Date | By | Comment |
|---|---|---|---|
| 4 | 22/02/2021 | AB | Fourth Issue. |
| 3 | 04/12/2020 | AB | Third Issue. |
| 2 | 05/11/2020 | AB | Second Issue. |

Prepared: AB
Checked: TF
Approved: FM

1:30,000
Scale @ A3

0 0.5 1 Km



# East Anglia ONE North and TWO

## Outline Operational Drainage Management Plan

## Agricultural Land Classification

| | |
|---|---|
| Drg No | EA1N-EA2-DEV-DRG-IBR-001128 |
| Rev | 4 |
| Date | 22/02/21 |
| Figure | 1 |

Coordinate System: BNG
Datum: OSGB36

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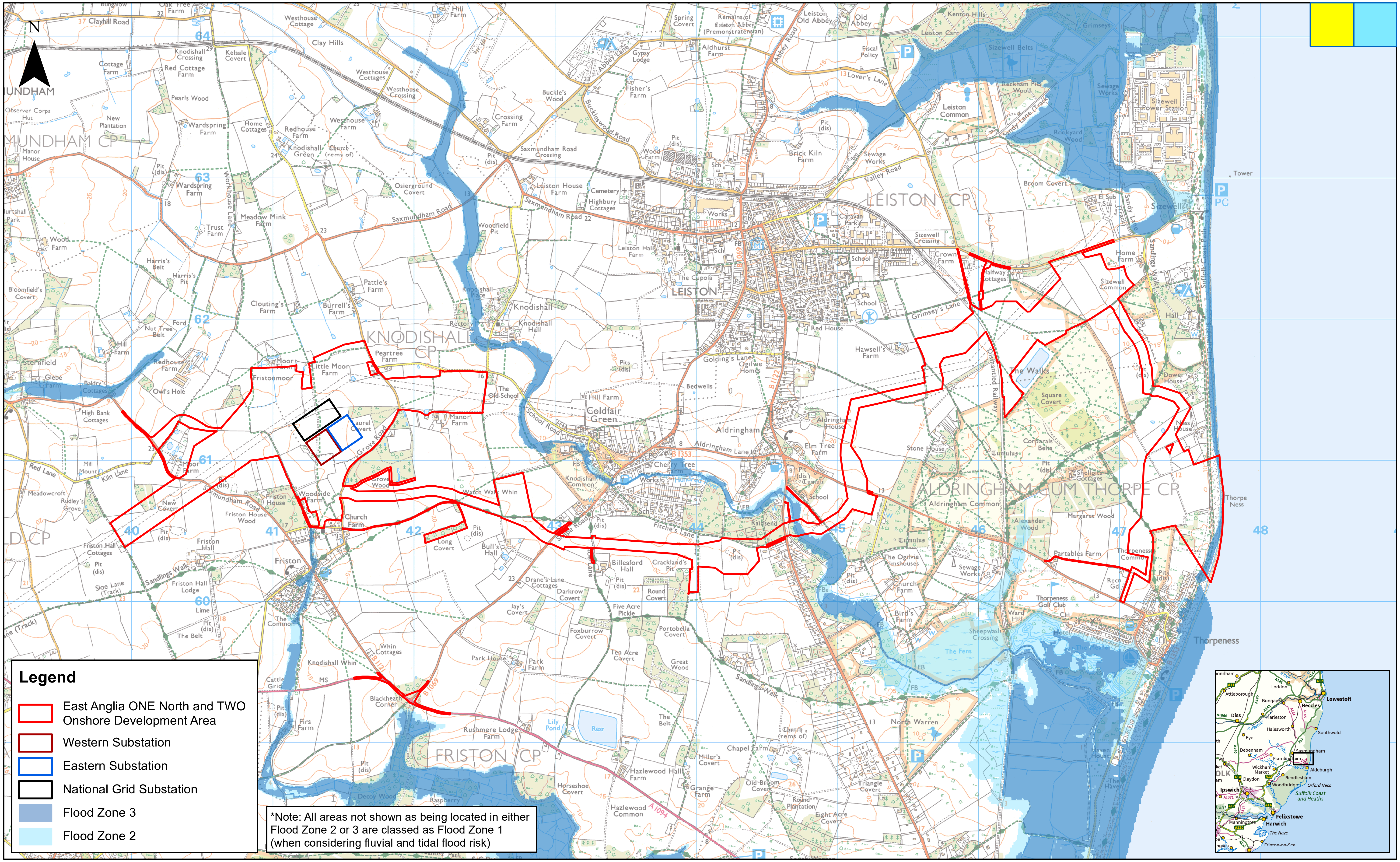


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|---|---|---|---|---|---|---|---|
| 4 | 22/02/2021 | AB | Fourth Issue. | | | 1:25,000 | |
| 3 | 04/12/2020 | AB | Third Issue. | Prepared: | AB | Scale @ A3 | 0 0.5 1 Km |
| 2 | 05/11/2020 | AB | Second Issue. | Checked: | TF | | |
| Rev | Date | By | Comment | Approved: | FM | | |

SCOTTISHPOWER RENEWABLES



# East Anglia ONE North and TWO
## Outline Operational Drainage Management Plan
## Environment Agency Flood Zones

| | | |
|---|---|---|
| Drg No | EA1N-EA2-DEV-DRG-IBR-001129 | |
| Rev | 4 | Coordinate System: BNG |
| Date | 22/02/21 | Datum: OSGB36 |
| Figure | 2 | |

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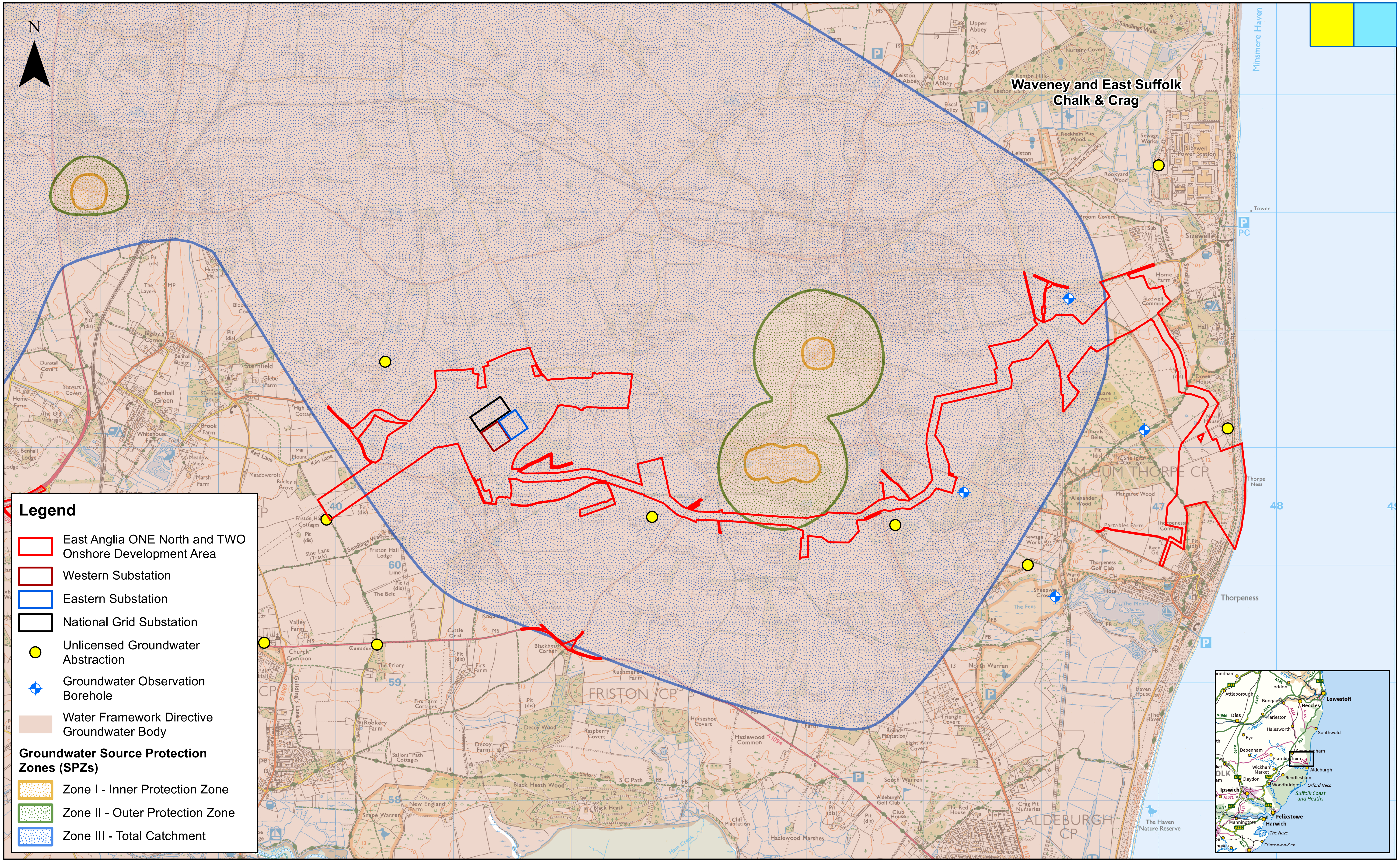


| Rev | Date | By | Comment | | |
|---|---|---|---|---|---|
| 4 | 22/02/2021 | AB | Fourth Issue. | | |
| 3 | 22/02/2021 | AB | Third Issue. | Prepared: | AB |
| 2 | 05/11/2020 | AB | Second Issue. | Checked: | TF |
| | | | | Approved: | FM |

SCOTTISHPOWER RENEWABLES

1:30,000 Scale @ A3

0 0.5 1 Km

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**East Anglia ONE North and TWO**

Outline Operational Drainage Management Plan

Groundwater Receptors

| | |
|---|---|
| Drg No | EA1N-EA2-DEV-DRG-IBR-001130 |
| Rev | 4 |
| Date | 22/02/21 |
| Figure | 3 |

Coordinate System: BNG
Datum: OSGB36

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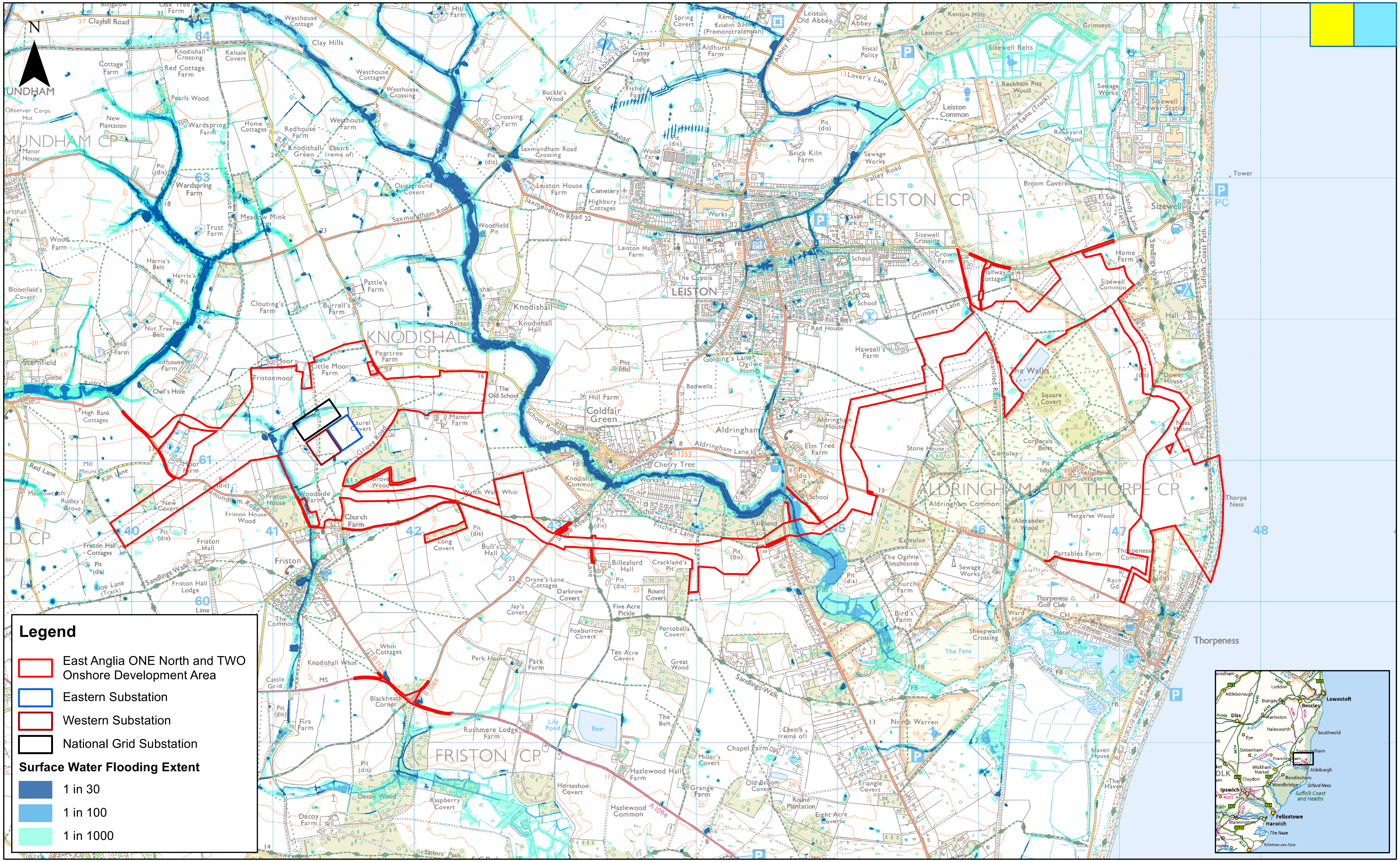


# East Anglia ONE North and TWO

## Outline Operational Drainage Management Plan

## Surface Water Flood Risk

| Rev | Date | By | Comment |
|---|---|---|---|
| 4 | 22/02/2021 | AB | Fourth Issue. |
| 3 | 04/12/2020 | AB | Third Issue. |
| 2 | 05/11/2020 | AB | Second Issue. |

Prepared: AB
Checked: TF
Approved: FM

1:25,000 Scale @ A3

0 0.5 1 Km



SCOTTISHPOWER RENEWABLES

| | |
|---|---|
| Drg No | EA1N-EA2-DEV-DRG-IBR-001133 |
| Rev | 4 |
| Date | 22/02/21 |
| Figure | 4 |

Coordinate System: BNG
Datum: OSGB36

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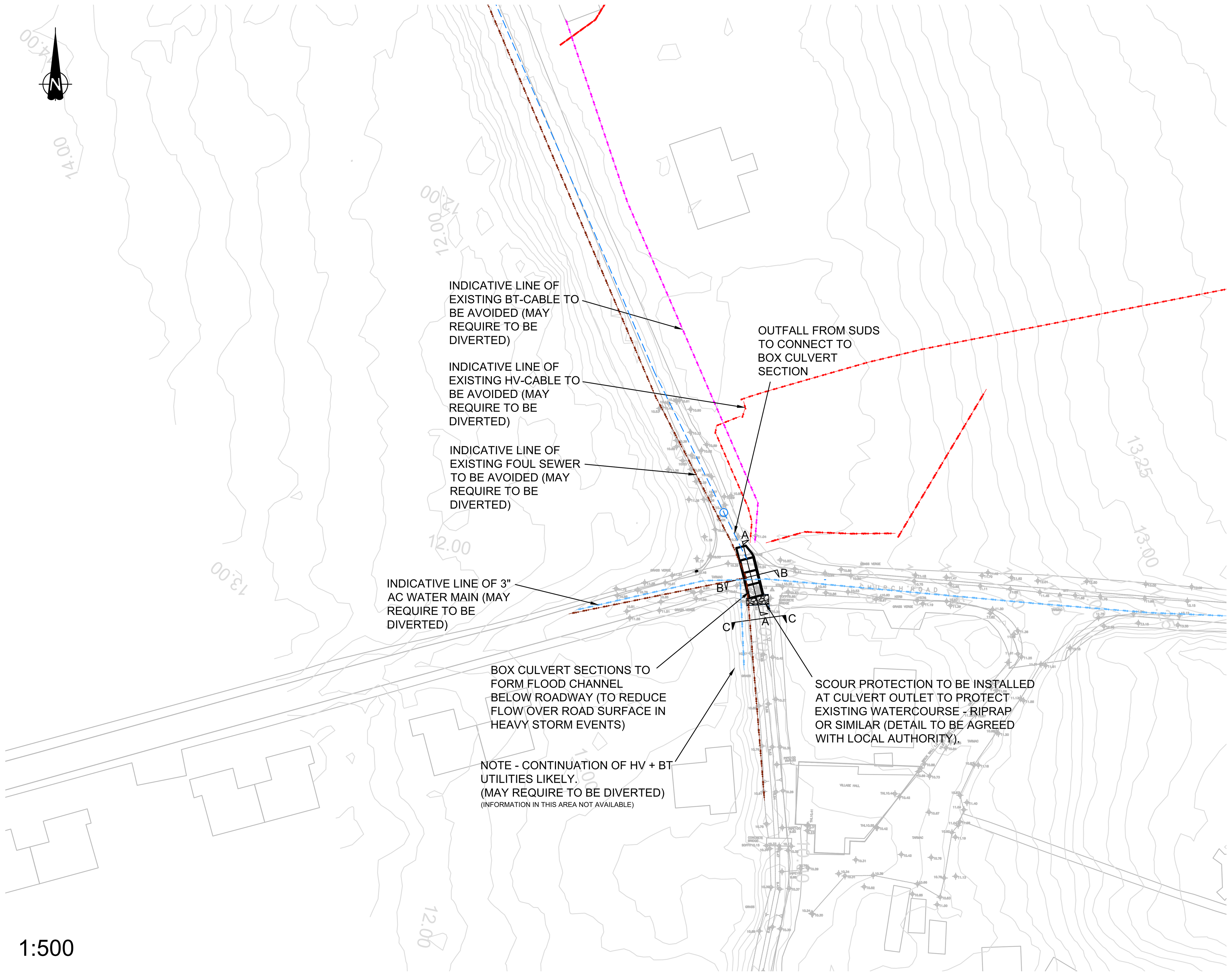
# Appendix 2: SuDS Outfall Concept Design to the Friston Watercourse

DO NOT SCALE FROM THIS DRAWING




1:500

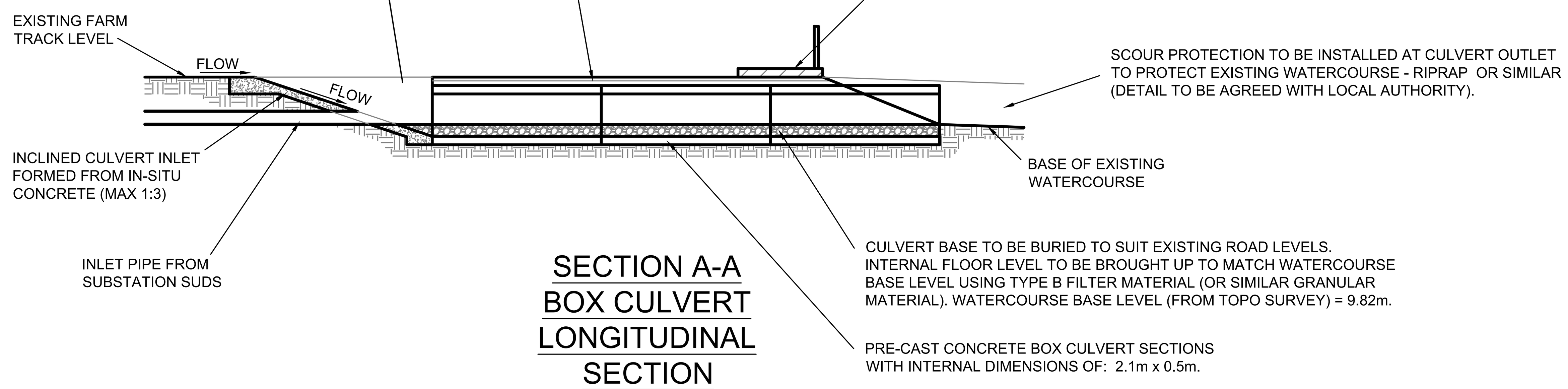
UTILITIES

UTILITIES INFORMATION SHOWN HAS BEEN DIGITISED BASED ON AVAILABLE UTILITIES PLANS AND AS SUCH MAY NOT MATCH WHAT'S PRESENT ON SITE.

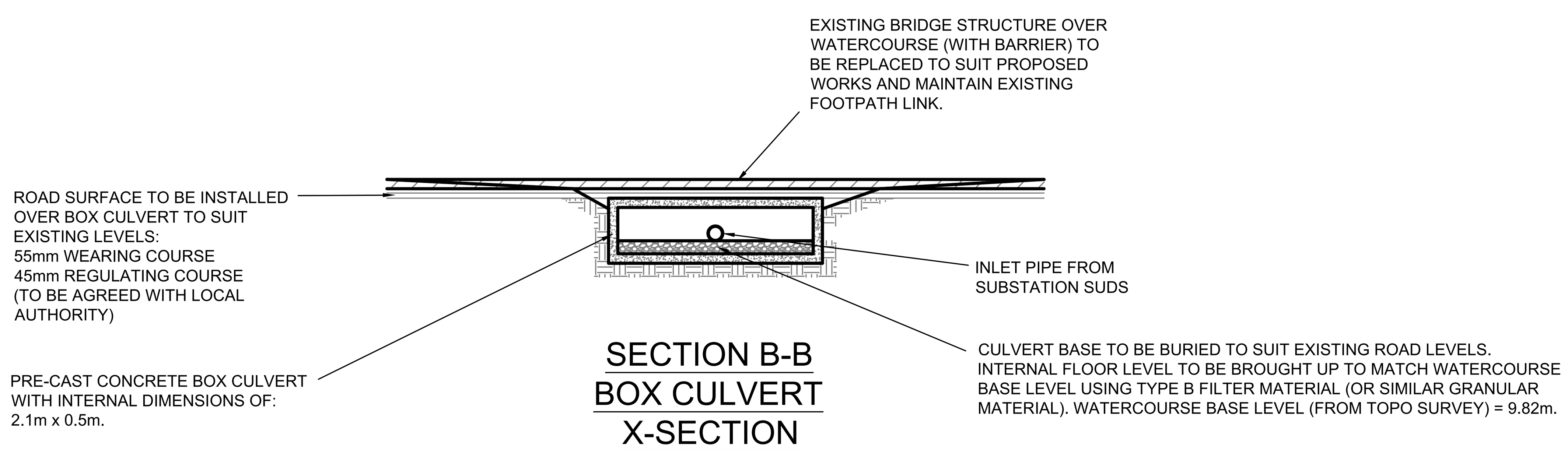
THE EXACT LINE, LOCATIONS AND DEPTHS ARE UNKNOWN AND AS SUCH ARE INDICATIVE ONLY AND SHOULD NOT BE WHOLLY RELIED UPON.

ADDITIONAL UNKNOWN UTILITIES NOT PRESENT ON ANY RECORD DRAWINGS MAY ALSO BE PRESENT IN THE VICINITY OF THE WORKS.

DETAILED UTILITIES SURVEYS SHOULD BE CARRIED OUT ON SITE WELL IN ADVANCE OF ANY WORKS BEING CARRIED OUT TO DETERMINE ANY DIVERSION OR MITIGATION WORKS REQUIRED.




SECTION A-A
BOX CULVERT
LONGITUDINAL
SECTION




SECTION B-B
BOX CULVERT
X-SECTION

General Notes

1) This drawing is to read in conjunction with the relevant specification and all other relevant drawings issued by the engineer and architect.

2) All dimensions and levels to be checked on site and the engineer notified of any discrepancies prior to commencement of work.

3) All switched off, frozen, or not schedules to print layers within electronic issues of this drawing should be disregarded.

4) All dimensions are in metres unless noted otherwise. All levels are in metres.

5) Contours shown are obtained from Lidar survey. Spot heights shown are from topographic survey.

6) Utilities indicated for information only. Exact locations to be confirmed on site prior to works commencing.

**Drainage Systems**
- FW-D — Foul Drainage
- Proposed Surface Water Drainage

**Electrical Systems**
- HV-D — High Voltage
- HV/OH-D — High Voltage Overhead

**Telecom Systems**
- BT-D — British Telecom

**Water Systems**
- POT-D — Potable Supply

| REVISION | DETAILS | DATE | DRAWN | CHK'D | APP'D |
|---|---|---|---|---|---|

CLIENT
Haskoning DHV UK Limited

PROJECT
East Anglia Offshore Wind
EA1N & EA2

DRAFT

DRAWING TITLE
SUDS Basin Outfall
Church Lane Box Culvert
Storm Water Diversion Concept

| DRG No. | REV |
|---|---|
| ED11892-GE-3015 | A |

| DRG SIZE | SCALE | DATE |
|---|---|---|
| A1 | As Shown | 23/03/2021 |

| DRAWN BY | CHECKED BY | APPROVED BY |
|---|---|---|
| CS | CS | SH |

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N:\ED\ED11892 - EAST ANGLIA OFFSHORE WIND EA 1103 - DESIGN\AUTOCAD\SCRATCHPAD\OUTFALL CONCEPT DESIGN\OUTFALL CONCEPT DESIGN 2 (TIFF FILES REMOVED) NEW ACCESS TRACK BASIC PROPOSAL.DWG

# Appendix 3: Infiltration Only Scheme Model Outputs

| SUDS Design Summary - Infiltration | | | | |
|---|---|---|---|---|
| **Notes:**<br>1. SUDS design proposal to attenuate surface water flows from hardstanding areas associated with EA2 / EA1N and National Grid substations (including access roads and cable sealing compounds).<br>2. Separate SUDS required for EA2/EA1N project substations and National Grid infrastructure.<br>3. EA2/EA1N project substations and access roads discharge to SUDS Basin then to ground via infiltration.<br>4. NG substation and sealing end compounds discharge to SUDS Basin then to ground via infiltration.<br>5. Worst case infiltration rates estimated as 10mm/hr.<br>6. Design checked for half drain down times of 24 hours.<br>7. SUDS design undertaken in line with national and local guidance set out in The SUDS Manual (C753) & Suffolk County Council Sustainable Drainage Systems (SUDS) a Local Design Guide.<br>8. SUDS sizing estimated using FEH13 Rainfall and Micro Drainage design software.<br>9. Safety factor of 1 used in initial design for 24 hour half drain down. An additonal check for a safety factor of 10 (per SCC request) has been undertaken with an allowance for influx of an additional 1 in 10 year + 40% climate change event.<br>10. Additional SUDS to be provided as source control / treatment during detailed design. | | | | |
| **Design Parameters / Assumptions** | **EA2** | **EA1N** | **National Grid** | **Change Notes** |
| **Hardstanding (all footprints assumed 100% impermeable)** | | | | Updated with reduced EA2 & EA1N substation footprints and added areas of SUDS basin footprint (including perimeter access tracks) - SUDS basin footprint varies based on design sizing. Total areas shown for 24hr drain down. |
| Substation operational footprint | 32,300 $m^2$ | 32,300 $m^2$ | 44,950 $m^2$ | |
| Operational access road | 13,600 $m^2$ | | - | |
| Cable sealing end compound operational footprint | - | | 10,000 $m^2$ | |
| Permanent access road to sealing end compound | - | | 1,850 $m^2$ | |
| SUDS Basin Footprint (including perimeter access track) | 27,383 $m^2$ | | 17,508 $m^2$ | |
| Total | **105,583 $m^2$** | | **74,308 $m^2$** | |
| **Additional Volumes** | | | | 10.02.21<br>Added note on additional volume allowed for existing depression adjacent EA1N substation. |
| Existing depression adjacent EA1N substation. Estimated volume to be allowed for in SUDS design (see additional design requirements below). | **3,300 $m^3$** | | - | |
| **Design Infiltration Rates** | **10mm/hr** | | | Estimated Worst Case |
| **Design Storm Event** | **1 in 100 year + 40% climate change.** | | | 40% sensitivity check as per SCC guidance. |
| **Attenuation Storage Required (calculated from FEH13 Rainfall using Micro Drainage design software)** | | | | |
| Half Drain Down Time | < 24hr | | < 24hr | Half drain down time of 24 hours checked (safety factor of 1). |
| All Hardstanding Areas | **8,461.6 m3** | | **6,158.5 m3** | |
| **Attenuation Dimensions** | | | | |
| **Detention Basins** | | | | Updated to 1m design depth with 0.3m freeboard, 0.1m access track and 0.1m to top, overall depth of 1.5m. |
| Design Top area (1m Deep) | 24,302 $m^2$ | | 15,116 $m^2$ | |
| Freeboard Top area (1.3m Deep) | 25,012 $m^2$ | | 15,664 $m^2$ | |
| Perimeter access track top area (1.4m Deep) | 27,135 $m^2$ | | 17,314 $m^2$ | |
| Basin Top area(1.5m Deep) | 27,383 $m^2$ | | 17,508 $m^2$ | |
| Base area | 22,002 $m^2$ | | 13,356 $m^2$ | |
| Design storage depth | 0.7 m | | 0.7 m | |
| Design freeboard + 0.3m (1.0m Deep) | 0.3 m | | 0.3 m | |
| Overall depth | 1 m | | 1 m | |
| Side slopes | 1 in 4 | | 1 in 4 | |
| **Attenuation Storage Provided** | | | | |
| **Detention Basins** | | | | Checked storage volumes as per the above. |
| Design | 23,152 $m^3$ | | 14,236 $m^3$ | |
| Freeboard | 7,397.1 $m^3$ | | 4,617 $m^3$ | |
| Perimeter access track | 2,607.35 $m^3$ | | 1,648.9 $m^3$ | |
| Additional storage between track and basin top | 2,725.9 $m^3$ | | 1,741.1 $m^3$ | |
| Total (design) | **23,152 $m^3$** | | **14,236 $m^3$** | |
| Total (inc. freeboard and access track) | 35,882.35 $m^3$ | | 22,243 $m^3$ | |
| **Design storage required < attenuation storage provided?** | **YES = OK** | | **YES = OK** | |
| **Additional Design Requirements** | | | | Safety factor increased to 10 as per SCC request. Half drain down time exceeds 7 days. Added allowance for additional influx of 1 in 10 year + 40% climate change event. |
| Safety Factor Check (Safety Factor increased from 1 to 10) | | | | |
| Attenuation Storage Required (1 in 100 year + 40% CC) | 12,759.6 m3 | | 9,082.3 m3 | |
| | Half drain down time now exceeds 7 days. Allow for additional influx from 1 in 10 year event + 40% CC. | | Half drain down time now exceeds 7 days. Allow for additional influx from 1 in 10 year event + 40% CC. | |
| Additional Attenuation Storage Required (1 in 10 year + 40% CC) | 6,944.2 m3 | | 4,994.8 m3 | |
| Offset removal of depression adjacent EA1N substation by allowing additional storage in basin design depth. Additional storage required: | 3,300 m3 | | N/A | |
| Total Attenuation Storage Required | **23,003.8 m3** | | **14,077.1 m3** | |
| | Additional influx from 1 in 10 year + 40% event and offset of loss of existing depression catered for within 1m design depth. | | Additional influx from 1 in 10 year + 40% event catered for within 1m design depth. | |
| **Design storage required < attenuation storage provided?** | **YES = OK** | | **YES = OK** | |
| **Discharge Location** | **To ground via infiltration.** | | **To ground via infiltration.** | **Design flows up to 1:100 year + 40% CC are attenuated within the basin design depth (1m) - including allowance for additional 1:10 year + 10% CC influx and loss of existing depression adjacent to EA1N substation.**<br>**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).** |

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

Half Drain Time exceeds 7 days.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 15 min Summer | 14.609 | 0.109 | 6.3 | 2415.6 | O K |
| 30 min Summer | 14.647 | 0.147 | 6.3 | 3260.6 | O K |
| 60 min Summer | 14.686 | 0.186 | 6.4 | 4136.7 | O K |
| 120 min Summer | 14.735 | 0.235 | 6.4 | 5224.8 | O K |
| 180 min Summer | 14.769 | 0.269 | 6.5 | 5998.6 | O K |
| 240 min Summer | 14.796 | 0.296 | 6.5 | 6612.2 | O K |
| 360 min Summer | 14.838 | 0.338 | 6.5 | 7563.7 | O K |
| 480 min Summer | 14.870 | 0.370 | 6.6 | 8285.0 | O K |
| 600 min Summer | 14.894 | 0.394 | 6.6 | 8840.7 | O K |
| 720 min Summer | 14.913 | 0.413 | 6.6 | 9282.1 | O K |
| 960 min Summer | 14.941 | 0.441 | 6.7 | 9919.4 | O K |
| 1440 min Summer | 14.973 | 0.473 | 6.7 | 10653.8 | O K |
| 2160 min Summer | 14.993 | 0.493 | 6.7 | 11114.7 | O K |
| 2880 min Summer | 15.000 | 0.500 | 6.8 | 11278.4 | O K |
| 4320 min Summer | 14.998 | 0.498 | 6.8 | 11242.0 | O K |
| 5760 min Summer | 14.991 | 0.491 | 6.7 | 11070.9 | O K |
| 7200 min Summer | 14.500 | 0.000 | 0.0 | 0.0 | O K |
| 8640 min Summer | 14.500 | 0.000 | 0.0 | 0.0 | O K |
| 10080 min Summer | 14.500 | 0.000 | 0.0 | 0.0 | O K |
| 15 min Winter | 14.622 | 0.122 | 6.3 | 2705.8 | O K |
| 30 min Winter | 14.665 | 0.165 | 6.3 | 3652.6 | O K |
| 60 min Winter | 14.708 | 0.208 | 6.4 | 4634.5 | O K |
| 120 min Winter | 14.763 | 0.263 | 6.4 | 5855.0 | O K |
| 180 min Winter | 14.801 | 0.301 | 6.5 | 6723.5 | O K |
| 240 min Winter | 14.831 | 0.331 | 6.5 | 7413.1 | O K |
| 360 min Winter | 14.878 | 0.378 | 6.6 | 8483.1 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Time-Peak (mins) |
|---|---|---|---|
| 15 min Summer | 122.248 | 0.0 | 19 |
| 30 min Summer | 82.572 | 0.0 | 34 |
| 60 min Summer | 52.458 | 0.0 | 64 |
| 120 min Summer | 33.215 | 0.0 | 124 |
| 180 min Summer | 25.480 | 0.0 | 184 |
| 240 min Summer | 21.109 | 0.0 | 244 |
| 360 min Summer | 16.158 | 0.0 | 364 |
| 480 min Summer | 13.321 | 0.0 | 484 |
| 600 min Summer | 11.410 | 0.0 | 604 |
| 720 min Summer | 10.016 | 0.0 | 724 |
| 960 min Summer | 8.080 | 0.0 | 964 |
| 1440 min Summer | 5.860 | 0.0 | 1444 |
| 2160 min Summer | 4.154 | 0.0 | 2164 |
| 2880 min Summer | 3.224 | 0.0 | 2884 |
| 4320 min Summer | 2.228 | 0.0 | 4324 |
| 5760 min Summer | 1.712 | 0.0 | 5760 |
| 7200 min Summer | -0.012 | 0.0 | 0 |
| 8640 min Summer | -0.010 | 0.0 | 0 |
| 10080 min Summer | -0.008 | 0.0 | 0 |
| 15 min Winter | 122.248 | 0.0 | 19 |
| 30 min Winter | 82.572 | 0.0 | 34 |
| 60 min Winter | 52.458 | 0.0 | 64 |
| 120 min Winter | 33.215 | 0.0 | 124 |
| 180 min Winter | 25.480 | 0.0 | 184 |
| 240 min Winter | 21.109 | 0.0 | 242 |
| 360 min Winter | 16.158 | 0.0 | 362 |

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

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 480 min Winter | 14.914 | 0.414 | 6.6 | 9295.5 | O K |
| 600 min Winter | 14.941 | 0.441 | 6.7 | 9922.3 | O K |
| 720 min Winter | 14.963 | 0.463 | 6.7 | 10421.2 | O K |
| 960 min Winter | 14.994 | 0.494 | 6.7 | 11144.3 | O K |
| 1440 min Winter | 15.030 | 0.530 | 6.8 | 11986.1 | O K |
| 2160 min Winter | 15.054 | 0.554 | 6.8 | 12531.2 | O K |
| 2880 min Winter | 15.063 | 0.563 | 6.8 | 12743.6 | O K |
| 4320 min Winter | 15.064 | 0.564 | 6.8 | 12759.6 | O K |
| 5760 min Winter | 15.058 | 0.558 | 6.8 | 12627.6 | O K |
| 7200 min Winter | 14.500 | 0.000 | 0.0 | 0.0 | O K |
| 8640 min Winter | 14.500 | 0.000 | 0.0 | 0.0 | O K |
| 10080 min Winter | 14.500 | 0.000 | 0.0 | 0.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Time-Peak (mins) |
|---|---|---|---|
| 480 min Winter | 13.321 | 0.0 | 482 |
| 600 min Winter | 11.410 | 0.0 | 602 |
| 720 min Winter | 10.016 | 0.0 | 720 |
| 960 min Winter | 8.080 | 0.0 | 956 |
| 1440 min Winter | 5.860 | 0.0 | 1430 |
| 2160 min Winter | 4.154 | 0.0 | 2140 |
| 2880 min Winter | 3.223 | 0.0 | 2852 |
| 4320 min Winter | 2.228 | 0.0 | 4276 |
| 5760 min Winter | 1.712 | 0.0 | 5648 |
| 7200 min Winter | -0.012 | 0.0 | 0 |
| 8640 min Winter | -0.010 | 0.0 | 0 |
| 10080 min Winter | -0.008 | 0.0 | 0 |

## 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 641300 260300 TM 41300 60300 | Shortest Storm (mins) | 15 |
| Data Type | Catchment | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +40 |

## Time Area Diagram

Total Area (ha) 10.558

| **Time (mins) From:** | **To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 10.558 |

## Model Details

Storage is Online Cover Level (m) 16.000

## Infiltration Basin Structure

Invert Level (m) 14.500 Safety Factor 10.0
Infiltration Coefficient Base (m/hr) 0.01000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.01000

| **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** |
|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 22002.0 | 1.000 | 24301.0 | 1.300 | 25011.0 | 1.400 | 27135.0 | 1.500 | 27383.0 |

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

Half Drain Time exceeds 7 days.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 15 min Summer | 15.276 | 0.126 | 3.8 | 1700.5 | O K |
| 30 min Summer | 15.320 | 0.170 | 3.9 | 2295.5 | O K |
| 60 min Summer | 15.365 | 0.215 | 3.9 | 2912.7 | O K |
| 120 min Summer | 15.421 | 0.271 | 4.0 | 3679.9 | O K |
| 180 min Summer | 15.460 | 0.310 | 4.0 | 4225.8 | O K |
| 240 min Summer | 15.491 | 0.341 | 4.0 | 4659.1 | O K |
| 360 min Summer | 15.539 | 0.389 | 4.1 | 5331.6 | O K |
| 480 min Summer | 15.576 | 0.426 | 4.1 | 5842.1 | O K |
| 600 min Summer | 15.604 | 0.454 | 4.2 | 6236.1 | O K |
| 720 min Summer | 15.626 | 0.476 | 4.2 | 6549.6 | O K |
| 960 min Summer | 15.658 | 0.508 | 4.2 | 7004.0 | O K |
| 1440 min Summer | 15.695 | 0.545 | 4.2 | 7532.3 | O K |
| 2160 min Summer | 15.719 | 0.569 | 4.3 | 7873.8 | O K |
| 2880 min Summer | 15.728 | 0.578 | 4.3 | 8005.9 | O K |
| 4320 min Summer | 15.728 | 0.578 | 4.3 | 8013.5 | O K |
| 5760 min Summer | 15.722 | 0.572 | 4.3 | 7925.4 | O K |
| 7200 min Summer | 15.150 | 0.000 | 0.0 | 0.0 | O K |
| 8640 min Summer | 15.150 | 0.000 | 0.0 | 0.0 | O K |
| 10080 min Summer | 15.150 | 0.000 | 0.0 | 0.0 | O K |
| 15 min Winter | 15.291 | 0.141 | 3.8 | 1904.8 | O K |
| 30 min Winter | 15.340 | 0.190 | 3.9 | 2571.5 | O K |
| 60 min Winter | 15.391 | 0.241 | 3.9 | 3263.2 | O K |
| 120 min Winter | 15.453 | 0.303 | 4.0 | 4123.6 | O K |
| 180 min Winter | 15.497 | 0.347 | 4.1 | 4736.3 | O K |
| 240 min Winter | 15.532 | 0.382 | 4.1 | 5223.0 | O K |
| 360 min Winter | 15.585 | 0.435 | 4.1 | 5979.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Time-Peak (mins) |
|---|---|---|---|
| 15 min Summer | 122.248 | 0.0 | 19 |
| 30 min Summer | 82.572 | 0.0 | 34 |
| 60 min Summer | 52.458 | 0.0 | 64 |
| 120 min Summer | 33.215 | 0.0 | 124 |
| 180 min Summer | 25.480 | 0.0 | 184 |
| 240 min Summer | 21.109 | 0.0 | 244 |
| 360 min Summer | 16.158 | 0.0 | 364 |
| 480 min Summer | 13.321 | 0.0 | 484 |
| 600 min Summer | 11.410 | 0.0 | 604 |
| 720 min Summer | 10.016 | 0.0 | 724 |
| 960 min Summer | 8.080 | 0.0 | 964 |
| 1440 min Summer | 5.860 | 0.0 | 1444 |
| 2160 min Summer | 4.154 | 0.0 | 2164 |
| 2880 min Summer | 3.224 | 0.0 | 2884 |
| 4320 min Summer | 2.228 | 0.0 | 4324 |
| 5760 min Summer | 1.712 | 0.0 | 5760 |
| 7200 min Summer | -0.012 | 0.0 | 0 |
| 8640 min Summer | -0.010 | 0.0 | 0 |
| 10080 min Summer | -0.008 | 0.0 | 0 |
| 15 min Winter | 122.248 | 0.0 | 19 |
| 30 min Winter | 82.572 | 0.0 | 34 |
| 60 min Winter | 52.458 | 0.0 | 64 |
| 120 min Winter | 33.215 | 0.0 | 124 |
| 180 min Winter | 25.480 | 0.0 | 184 |
| 240 min Winter | 21.109 | 0.0 | 242 |
| 360 min Winter | 16.158 | 0.0 | 362 |

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

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 480 min Winter | 15.626 | 0.476 | 4.2 | 6553.6 | O K |
| 600 min Winter | 15.657 | 0.507 | 4.2 | 6997.7 | O K |
| 720 min Winter | 15.682 | 0.532 | 4.2 | 7351.7 | O K |
| 960 min Winter | 15.718 | 0.568 | 4.3 | 7866.4 | O K |
| 1440 min Winter | 15.760 | 0.610 | 4.3 | 8470.3 | O K |
| 2160 min Winter | 15.788 | 0.638 | 4.3 | 8871.0 | O K |
| 2880 min Winter | 15.799 | 0.649 | 4.4 | 9037.4 | O K |
| 4320 min Winter | 15.802 | 0.652 | 4.4 | 9082.3 | O K |
| 5760 min Winter | 15.798 | 0.648 | 4.3 | 9020.9 | O K |
| 7200 min Winter | 15.150 | 0.000 | 0.0 | 0.0 | O K |
| 8640 min Winter | 15.150 | 0.000 | 0.0 | 0.0 | O K |
| 10080 min Winter | 15.150 | 0.000 | 0.0 | 0.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Time-Peak (mins) |
|---|---|---|---|
| 480 min Winter | 13.321 | 0.0 | 482 |
| 600 min Winter | 11.410 | 0.0 | 602 |
| 720 min Winter | 10.016 | 0.0 | 722 |
| 960 min Winter | 8.080 | 0.0 | 960 |
| 1440 min Winter | 5.860 | 0.0 | 1430 |
| 2160 min Winter | 4.154 | 0.0 | 2144 |
| 2880 min Winter | 3.223 | 0.0 | 2852 |
| 4320 min Winter | 2.228 | 0.0 | 4276 |
| 5760 min Winter | 1.712 | 0.0 | 5656 |
| 7200 min Winter | -0.012 | 0.0 | 0 |
| 8640 min Winter | -0.010 | 0.0 | 0 |
| 10080 min Winter | -0.008 | 0.0 | 0 |

## 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 641300 260300 TM 41300 60300 | Shortest Storm (mins) | 15 |
| Data Type | Catchment | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +40 |

## Time Area Diagram

Total Area (ha) 7.431

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 7.431 |

## Model Details

Storage is Online Cover Level (m) 16.650

## Infiltration Basin Structure

| | | | |
|---|---|---|---|
| Invert Level (m) | 15.150 | Safety Factor | 10.0 |
| Infiltration Coefficient Base (m/hr) | 0.01000 | Porosity | 1.00 |
| Infiltration Coefficient Side (m/hr) | 0.01000 | | |

| Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) |
|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 13356.0 | 1.000 | 15116.0 | 1.300 | 15664.0 | 1.400 | 17314.0 | 1.500 | 17508.0 |

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

Half Drain Time : 8592 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 15 min Summer | 15.125 | 0.061 | 6.5 | 1431.5 | O K |
| 30 min Summer | 15.145 | 0.081 | 6.6 | 1883.2 | O K |
| 60 min Summer | 15.165 | 0.101 | 6.6 | 2369.7 | O K |
| 120 min Summer | 15.197 | 0.133 | 6.6 | 3106.5 | O K |
| 180 min Summer | 15.216 | 0.152 | 6.7 | 3562.2 | O K |
| 240 min Summer | 15.230 | 0.166 | 6.7 | 3885.7 | O K |
| 360 min Summer | 15.248 | 0.184 | 6.7 | 4320.5 | O K |
| 480 min Summer | 15.260 | 0.196 | 6.7 | 4599.8 | O K |
| 600 min Summer | 15.268 | 0.204 | 6.7 | 4801.1 | O K |
| 720 min Summer | 15.275 | 0.211 | 6.7 | 4954.7 | O K |
| 960 min Summer | 15.284 | 0.220 | 6.8 | 5178.2 | O K |
| 1440 min Summer | 15.295 | 0.231 | 6.8 | 5443.9 | O K |
| 2160 min Summer | 15.304 | 0.240 | 6.8 | 5653.0 | O K |
| 2880 min Summer | 15.309 | 0.245 | 6.8 | 5778.1 | O K |
| 4320 min Summer | 15.316 | 0.252 | 6.8 | 5935.6 | O K |
| 5760 min Summer | 15.319 | 0.255 | 6.8 | 6021.8 | O K |
| 7200 min Summer | 15.064 | 0.000 | 0.0 | 0.0 | O K |
| 8640 min Summer | 15.064 | 0.000 | 0.0 | 0.0 | O K |
| 10080 min Summer | 15.064 | 0.000 | 0.0 | 0.0 | O K |
| 15 min Winter | 15.133 | 0.069 | 6.6 | 1603.6 | O K |
| 30 min Winter | 15.154 | 0.090 | 6.6 | 2109.9 | O K |
| 60 min Winter | 15.177 | 0.113 | 6.6 | 2655.3 | O K |
| 120 min Winter | 15.212 | 0.148 | 6.7 | 3481.8 | O K |
| 180 min Winter | 15.234 | 0.170 | 6.7 | 3994.0 | O K |
| 240 min Winter | 15.249 | 0.185 | 6.7 | 4358.1 | O K |
| 360 min Winter | 15.270 | 0.206 | 6.7 | 4848.3 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Time-Peak (mins) |
|---|---|---|---|
| 15 min Summer | 72.520 | 0.0 | 19 |
| 30 min Summer | 47.768 | 0.0 | 34 |
| 60 min Summer | 30.128 | 0.0 | 64 |
| 120 min Summer | 19.824 | 0.0 | 124 |
| 180 min Summer | 15.209 | 0.0 | 184 |
| 240 min Summer | 12.485 | 0.0 | 244 |
| 360 min Summer | 9.315 | 0.0 | 364 |
| 480 min Summer | 7.485 | 0.0 | 484 |
| 600 min Summer | 6.289 | 0.0 | 604 |
| 720 min Summer | 5.441 | 0.0 | 724 |
| 960 min Summer | 4.316 | 0.0 | 964 |
| 1440 min Summer | 3.096 | 0.0 | 1442 |
| 2160 min Summer | 2.217 | 0.0 | 2164 |
| 2880 min Summer | 1.756 | 0.0 | 2880 |
| 4320 min Summer | 1.278 | 0.0 | 4320 |
| 5760 min Summer | 1.031 | 0.0 | 5760 |
| 7200 min Summer | -0.012 | 0.0 | 0 |
| 8640 min Summer | -0.010 | 0.0 | 0 |
| 10080 min Summer | -0.008 | 0.0 | 0 |
| 15 min Winter | 72.520 | 0.0 | 19 |
| 30 min Winter | 47.768 | 0.0 | 34 |
| 60 min Winter | 30.128 | 0.0 | 64 |
| 120 min Winter | 19.824 | 0.0 | 124 |
| 180 min Winter | 15.209 | 0.0 | 182 |
| 240 min Winter | 12.485 | 0.0 | 242 |
| 360 min Winter | 9.315 | 0.0 | 362 |

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

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 480 min Winter | 15.283 | 0.219 | 6.8 | 5164.6 | O K |
| 600 min Winter | 15.293 | 0.229 | 6.8 | 5393.8 | O K |
| 720 min Winter | 15.300 | 0.236 | 6.8 | 5569.4 | O K |
| 960 min Winter | 15.311 | 0.247 | 6.8 | 5827.4 | O K |
| 1440 min Winter | 15.324 | 0.260 | 6.8 | 6140.4 | O K |
| 2160 min Winter | 15.335 | 0.271 | 6.8 | 6398.3 | O K |
| 2880 min Winter | 15.342 | 0.278 | 6.8 | 6563.6 | O K |
| 4320 min Winter | 15.352 | 0.288 | 6.8 | 6792.0 | O K |
| 5760 min Winter | 15.358 | 0.294 | 6.9 | 6944.2 | O K |
| 7200 min Winter | 15.064 | 0.000 | 0.0 | 0.0 | O K |
| 8640 min Winter | 15.064 | 0.000 | 0.0 | 0.0 | O K |
| 10080 min Winter | 15.064 | 0.000 | 0.0 | 0.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Time-Peak (mins) |
|---|---|---|---|
| 480 min Winter | 7.485 | 0.0 | 480 |
| 600 min Winter | 6.289 | 0.0 | 598 |
| 720 min Winter | 5.441 | 0.0 | 716 |
| 960 min Winter | 4.316 | 0.0 | 954 |
| 1440 min Winter | 3.096 | 0.0 | 1428 |
| 2160 min Winter | 2.217 | 0.0 | 2136 |
| 2880 min Winter | 1.756 | 0.0 | 2824 |
| 4320 min Winter | 1.278 | 0.0 | 4196 |
| 5760 min Winter | 1.031 | 0.0 | 5584 |
| 7200 min Winter | -0.012 | 0.0 | 0 |
| 8640 min Winter | -0.010 | 0.0 | 0 |
| 10080 min Winter | -0.008 | 0.0 | 0 |

## 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 641300 260300 TM 41300 60300 | Shortest Storm (mins) | 15 |
| Data Type | Catchment | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +40 |

## Time Area Diagram

Total Area (ha) 10.558

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 10.558 |

## Model Details

Storage is Online Cover Level (m) 16.000

## Infiltration Basin Structure

Invert Level (m) 15.064 Safety Factor 10.0
Infiltration Coefficient Base (m/hr) 0.01000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.01000

| **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** |
|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 23286.0 | 0.436 | 24301.0 | 0.736 | 25011.0 | 0.836 | 27135.0 | 0.936 | 27383.0 |

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

Half Drain Time : 9770 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 15 min Summer | 15.871 | 0.069 | 4.1 | 1007.8 | O K |
| 30 min Summer | 15.893 | 0.091 | 4.1 | 1326.0 | O K |
| 60 min Summer | 15.916 | 0.114 | 4.1 | 1668.8 | O K |
| 120 min Summer | 15.952 | 0.150 | 4.2 | 2188.4 | O K |
| 180 min Summer | 15.973 | 0.171 | 4.2 | 2510.3 | O K |
| 240 min Summer | 15.989 | 0.187 | 4.2 | 2739.0 | O K |
| 360 min Summer | 16.010 | 0.208 | 4.2 | 3047.2 | O K |
| 480 min Summer | 16.023 | 0.221 | 4.2 | 3245.9 | O K |
| 600 min Summer | 16.033 | 0.231 | 4.3 | 3389.9 | O K |
| 720 min Summer | 16.040 | 0.238 | 4.3 | 3500.1 | O K |
| 960 min Summer | 16.051 | 0.249 | 4.3 | 3661.9 | O K |
| 1440 min Summer | 16.064 | 0.262 | 4.3 | 3857.7 | O K |
| 2160 min Summer | 16.075 | 0.273 | 4.3 | 4018.2 | O K |
| 2880 min Summer | 16.081 | 0.279 | 4.3 | 4119.3 | O K |
| 4320 min Summer | 16.091 | 0.289 | 4.3 | 4256.4 | O K |
| 5760 min Summer | 16.096 | 0.294 | 4.3 | 4343.4 | O K |
| 7200 min Summer | 15.802 | 0.000 | 0.0 | 0.0 | O K |
| 8640 min Summer | 15.802 | 0.000 | 0.0 | 0.0 | O K |
| 10080 min Summer | 15.802 | 0.000 | 0.0 | 0.0 | O K |
| 15 min Winter | 15.880 | 0.078 | 4.1 | 1128.9 | O K |
| 30 min Winter | 15.904 | 0.102 | 4.1 | 1485.5 | O K |
| 60 min Winter | 15.930 | 0.128 | 4.2 | 1869.9 | O K |
| 120 min Winter | 15.970 | 0.168 | 4.2 | 2452.7 | O K |
| 180 min Winter | 15.994 | 0.192 | 4.2 | 2814.3 | O K |
| 240 min Winter | 16.011 | 0.209 | 4.2 | 3071.7 | O K |
| 360 min Winter | 16.035 | 0.233 | 4.3 | 3419.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Time-Peak (mins) |
|---|---|---|---|
| 15 min Summer | 72.520 | 0.0 | 19 |
| 30 min Summer | 47.768 | 0.0 | 34 |
| 60 min Summer | 30.128 | 0.0 | 64 |
| 120 min Summer | 19.824 | 0.0 | 124 |
| 180 min Summer | 15.209 | 0.0 | 184 |
| 240 min Summer | 12.485 | 0.0 | 244 |
| 360 min Summer | 9.315 | 0.0 | 364 |
| 480 min Summer | 7.485 | 0.0 | 484 |
| 600 min Summer | 6.289 | 0.0 | 604 |
| 720 min Summer | 5.441 | 0.0 | 724 |
| 960 min Summer | 4.316 | 0.0 | 964 |
| 1440 min Summer | 3.096 | 0.0 | 1442 |
| 2160 min Summer | 2.217 | 0.0 | 2164 |
| 2880 min Summer | 1.756 | 0.0 | 2884 |
| 4320 min Summer | 1.278 | 0.0 | 4320 |
| 5760 min Summer | 1.031 | 0.0 | 5760 |
| 7200 min Summer | -0.012 | 0.0 | 0 |
| 8640 min Summer | -0.010 | 0.0 | 0 |
| 10080 min Summer | -0.008 | 0.0 | 0 |
| 15 min Winter | 72.520 | 0.0 | 19 |
| 30 min Winter | 47.768 | 0.0 | 34 |
| 60 min Winter | 30.128 | 0.0 | 64 |
| 120 min Winter | 19.824 | 0.0 | 124 |
| 180 min Winter | 15.209 | 0.0 | 182 |
| 240 min Winter | 12.485 | 0.0 | 242 |
| 360 min Winter | 9.315 | 0.0 | 362 |

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

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 480 min Winter | 16.050 | 0.248 | 4.3 | 3643.9 | O K |
| 600 min Winter | 16.061 | 0.259 | 4.3 | 3807.5 | O K |
| 720 min Winter | 16.069 | 0.267 | 4.3 | 3933.4 | O K |
| 960 min Winter | 16.081 | 0.279 | 4.3 | 4119.6 | O K |
| 1440 min Winter | 16.097 | 0.295 | 4.3 | 4349.2 | O K |
| 2160 min Winter | 16.110 | 0.308 | 4.3 | 4544.5 | O K |
| 2880 min Winter | 16.118 | 0.316 | 4.3 | 4674.0 | O K |
| 4320 min Winter | 16.131 | 0.329 | 4.4 | 4861.5 | O K |
| 5760 min Winter | 16.140 | 0.338 | 4.4 | 4994.8 | O K |
| 7200 min Winter | 15.802 | 0.000 | 0.0 | 0.0 | O K |
| 8640 min Winter | 15.802 | 0.000 | 0.0 | 0.0 | O K |
| 10080 min Winter | 15.802 | 0.000 | 0.0 | 0.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Time-Peak (mins) |
|---|---|---|---|
| 480 min Winter | 7.485 | 0.0 | 480 |
| 600 min Winter | 6.289 | 0.0 | 598 |
| 720 min Winter | 5.441 | 0.0 | 716 |
| 960 min Winter | 4.316 | 0.0 | 954 |
| 1440 min Winter | 3.096 | 0.0 | 1428 |
| 2160 min Winter | 2.217 | 0.0 | 2136 |
| 2880 min Winter | 1.756 | 0.0 | 2828 |
| 4320 min Winter | 1.278 | 0.0 | 4232 |
| 5760 min Winter | 1.031 | 0.0 | 5592 |
| 7200 min Winter | -0.012 | 0.0 | 0 |
| 8640 min Winter | -0.010 | 0.0 | 0 |
| 10080 min Winter | -0.008 | 0.0 | 0 |

## 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 641300 260300 TM 41300 60300 | Shortest Storm (mins) | 15 |
| Data Type | Catchment | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +40 |

## Time Area Diagram

Total Area (ha) 7.431

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 7.431 |

## Model Details

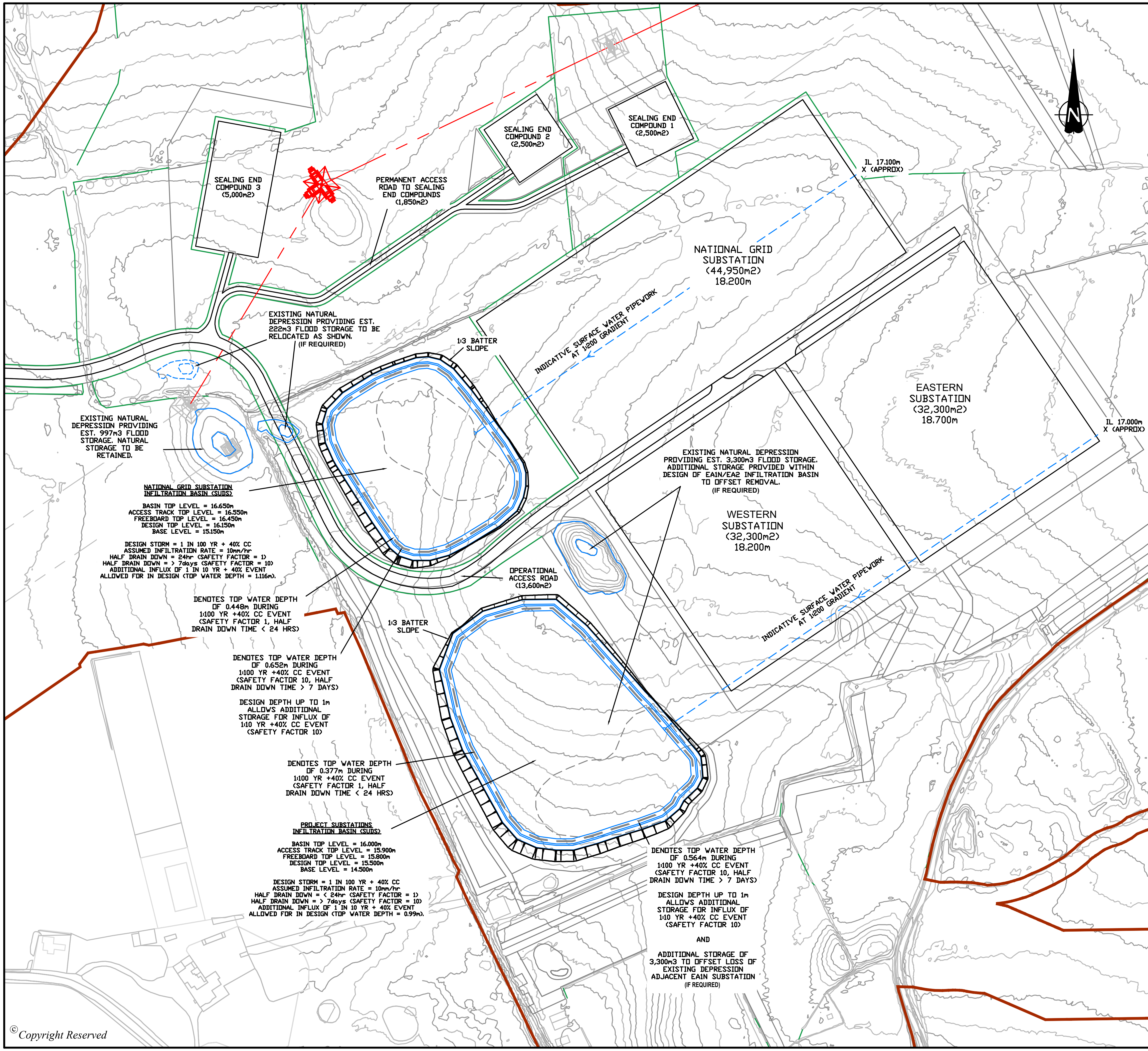
Storage is Online Cover Level (m) 16.650

## Infiltration Basin Structure

Invert Level (m) 15.802 Safety Factor 10.0
Infiltration Coefficient Base (m/hr) 0.01000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.01000

| **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** |
|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 14492.0 | 0.348 | 15116.0 | 0.648 | 15664.0 | 0.748 | 17314.0 | 0.848 | 17508.0 |

# Appendix 4: Infiltration Only Scheme Figures






DO NOT SCALE FROM THIS DRAWING

NOTES:

INFILTRATION BASINS ARE SHOWN INDICATIVELY FOR ILLUSTRATION PURPOSES ONLY. DETAILED DESIGN OF BASINS WOULD BE REQUIRED TO CONFIRM EXACT ELEVATIONS, SHAPES AND LOCATIONS AS APPROPRIATE AND AS PART OF THE MASTERPLANNING PROCESS.

DENOTES DCO ORDER LIMITS

DENOTES INDICATIVE SURFACE WATER PIPEWORK

DENOTES INDICATIVE SUDS FEATURE (SEE ANNOTATION)

| REVISION | DETAILS | DATE | DRN | CHK'D | APP'D |
|---|---|---|---|---|---|
| G | UPDATED TO SUIT RHDHV COMMENTS | 10.02.21 | CS | CS | SH |
| F | DESIGN UPDATED | 29.01.21 | CS | CS | SH |
| E | DRAWING UPDATED TO INCORPORATE REVISED HARDSTANDING AREAS AND 100% IMPERMEABILITY. | 24.12.20 | CS | CS | SH |
| D | DRAWING UPDATED TO ADDRESS SPR COMMENTS. | 17.11.20 | SH | SH | SH |
| C | DRAWING UPDATED FOR CLARITY | 06.10.20 | JN | JN | SH |
| B | INFILTRATION BASINS UPDATED. | 17.09.20 | JN | CS | SH |
| A | FIRST ISSUE | 10.09.20 | JN | CS | SH |

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Haskoning DHV UK Limited

PROJECT
EAST ANGLIA OFFSHORE WIND
EA1N & EA2

SKETCH

DRAWING TITLE
INFILTRATION BASIN
10mm PER HOUR
OPTIONS SKETCH

| DRG No. | | REV |
|---|---|---|
| ED11892-C-SK10 | | G |
| DRG SIZE: A3 | SCALE: NTS | DATE: SEPT'20 |
| DRAWN BY: JN | CHECKED BY: CS | APPROVED BY: SH |

wardell armstrong

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WWW.WARDELL-ARMSTRONG.COM

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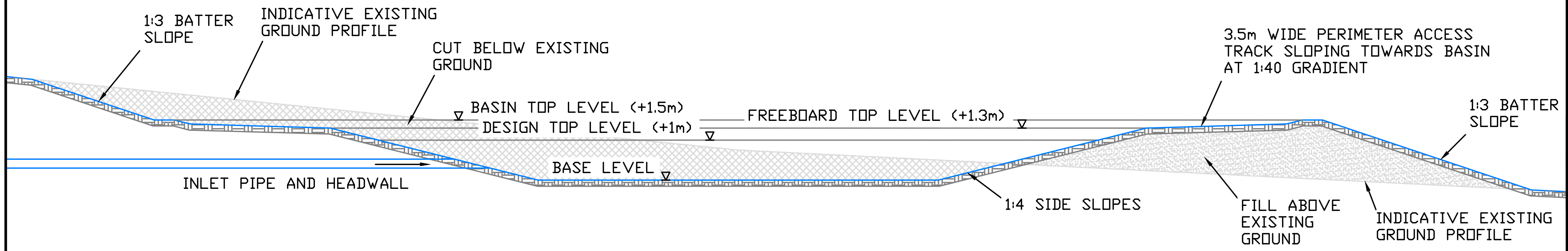
☐ CARDIFF ☐ MANCHESTER
☐ CARLISLE ☐ NEWCASTLE UPON TYNE
☐ GLASGOW ☐ STOKE ON TRENT

N:\ED\ED11892 - EAST ANGLIA OFFSHORE WIND EA 1\03 - DESIGN\AUTOCAD\ED11892-C-SK10-G SK13-A - INFILTRATION BASINS.DWG




TYPICAL INFILTRATION BASIN CROSS SECTION

DO NOT SCALE FROM THIS DRAWING

NOTES:

INFILTRATION BASINS ARE SHOWN INDICATIVELY FOR ILLUSTRATION PURPOSES ONLY. DETAILED DESIGN OF BASINS WOULD BE REQUIRED TO CONFIRM EXACT ELEVATIONS, SHAPES AND LOCATIONS AS APPROPRIATE AND AS PART OF THE MASTERPLANNING PROCESS.

| REVISION | DETAILS | DATE | DR'N | CHK'D | APP'D |
|---|---|---|---|---|---|
| B | UPDATED TO SHOW INDICATIVE EXISTING GROUND PROFILE AND BATTER SLOPES. | 24.02.21 | CS | CS | SH |
| A | FIRST ISSUE | 10.02.21 | CS | CS | SH |

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PROJECT
EAST ANGLIA OFFSHORE WIND
EA1N & EA2

SKETCH

DRAWING TITLE
INFILTRATION BASIN
1 IN 100 YR + 40% CC DESIGN
TYPICAL BASIN CROSS SECTION

| DRG No. | | REV |
|---|---|---|
| ED11892-C-SK13 | | B |
| DRG SIZE: A3 | SCALE: NTS | DATE: FEB'21 |
| DRAWN BY: CS | CHECKED BY: CS | APPROVED BY: SH |

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N:\ED\ED11892 - EAST ANGLIA OFFSHORE WIND EA 1\03 - DESIGN\AUTOCAD\ED11892-C-SK10-G SK13-B - INFILTRATION BASINS.DWG

# Appendix 5:Hybrid Scheme Model Outputs

**SUDS Design Summary - Hybrid Design**

**Notes:**

1. SUDS design proposal to attenuate surface water flows from hardstanding areas associated with EA2 / EA1N and National Grid substations (including access roads and cable sealing compounds).

2. Separate SUDS required for EA2/EA1N project substations and National Grid infrastructure.

3. EA2/EA1N project substations and access roads discharge to SUDS Basin then to ground via infiltration with overflow outfall to existing ditch in Church Lane at pre-development run-off rate. To mimic existing drainage regime and achieve no net increase in flows to receiving watercourse. Only first 0.5m of basin depth designed for infiltration.

4. NG substation and sealing end compounds discharge to SUDS Basin then to ground via infiltration with overflow outfall to existing ditch in field at pre-development run-off rate. To mimic existing drainage regime and achieve no net increase in flows to receiving watercourse. Only first 0.5m of basin depth designed for infiltration.

5. Worst case infiltration rates estimated as 10mm/hr.

6. SUDS design undertaken in line with national and local guidance set out in The SUDS Manual (C753) & Suffolk County Council Sustainable Drainage Systems (SUDS) a Local Design Guide.

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

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

9. An additonal check for a safety factor of 10 (per SCC request) has been undertaken for infiltration with an allowance for influx of an additional 1 in 10 year + 40% climate change event where a 24 hour drain down time can't be met.

10. Additional SUDS to be provided as source control / treatment during detailed design.

| Design Parameters / Assumptions | EA2 | EA1N | National Grid | Change Notes |
|---|---|---|---|---|
| **Hardstanding (all footprints assumed 100% impermeable)** | | | | |
| Substation operational footprint | 32,300 $m^2$ | 32,300 $m^2$ | 44,950 $m^2$ | |
| Operational access road | 13,600 $m^2$ | | - | |
| Cable sealing end compound operational footprint | - | | 10,000 $m^2$ | |
| Permanent access road to sealing end compound | - | | 1,850 $m^2$ | |
| SUDS Basin Footprint (including perimeter access track) | 19,306 $m^2$ | | 11,570 $m^2$ | |
| Total | **97,506 $m^2$** | | **69,122 $m^2$** | |
| **Additional Volumes** | | | | |
| Existing depression adjacent EA1N substation. Estimated volume to be allowed for in SUDS design (see additional design requirements below). | **3,300 $m^3$** | | - | |
| | | | | |
| **Pre-Development Run-Off Rates (calculated from HR Wallingford Greenfield Runoff Rate Estimation Online Tool)** | | | | |
| 2 l/s/ha | 19.30 l/s | | 13.48 l/s | |
| | FEH | | FEH | |
| 1 Year Return | 6.88 l/s | | 4.81 l/s | |
| **2 Year Return ($Q_{BAR}$)** | **7.91 l/s** | | **5.52 l/s** | |
| 30 Year Return | 19.38 l/s | | 13.53 l/s | |
| 100 Year Return | 28.15 l/s | | 19.66 l/s | |
| 200 Year Return | 33.30 l/s | | 23.25 l/s | |
| | | | | |
| **Unttenuated Flow Discharging to SUDS from Harstanding (calculated from FEH13 Rainfall using Micro Drainage design software)** | | | | |
| | FEH13 | | FEH13 | |
| 1 Year Return + 40% CC | N/A | | N/A | |
| 2 Year Return + 40% CC | 68.0 l/s | | 79.2 l/s | |
| 30 Year Return + 40% CC | 173.0 l/s | | 204.8 l/s | |
| 100 Year Return + 40% CC | 285.5 l/s | | 310.2 l/s | |
| 200 Year Return + 40% CC | 362.3 l/s | | 389.5 l/s | |
| | | | | |
| **Attenuated Post Development Run-Off Rates** | **Limited to pre-development (2-year FEH) run-off rate. Provides betterment over 2 l/s/ha rate and IH124 rate.** | | | |
| | | | | |
| **Pre / Post Development Reduction In Run-Off Rates (pre development rates minus attenuated post development rates)** | | | | |
| 1 Year Return | N/A | | N/A | |
| 2 Year Return | 60.09 l/s | | 73.68 l/s | |
| 30 Year Return | 165.09 l/s | | 199.28 l/s | |
| 100 Year Return | 277.59 l/s | | 304.68 l/s | |
| 200 Year Return | 354.39 l/s | | 383.6 l/s | |
| | | | | |
| **Design Infiltration Rates** | **10mm/hr** | | | |
| | | | | |
| **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)** | FEH13 | | FEH13 | |
| All Hardstanding Areas | | | | |
| Infiltration Basin | 8,714.5 $m^3$ | | 5,267.8 $m^3$ | |
| Detention Basin | 3,917.6 $m^3$ | | 3,782.6 $m^3$ | |
| **Total storage required** | **12,632.1 $m^3$** | | **9,050.4 $m^3$** | |
| | | | | |
| **Attenuation Dimensions** | | | | |
| Infiltration Basin Design Top Area (0.5m Deep) | 14,949 $m^2$ | | 8,815 $m^2$ | |
| Detention Basin Design Top area (1.5m Deep) | 16,799 $m^2$ | | 10,292 $m^2$ | |
| Freeboard Top area (1.8m Deep) | 17,374 $m^2$ | | 10,755 $m^2$ | |
| Perimeter access track top area (1.9m Deep) | 19,104 $m^2$ | | 12,157 $m^2$ | |
| Basin Top area (2.0m Deep) | 19,306 $m^2$ | | 12,322 $m^2$ | |
| Base area | 14,062 $m^2$ | | 8,114 $m^2$ | |
| Infiltration Basin Design storage depth | 0.5 m | | 0.5 m | |
| Detention Basin Design storage depth | 1.0 m | | 1.0 m | |
| Design freeboard + 0.3m (1.8m Deep) | 0.3 m | | 0.3 m | |
| Overall depth | 2.0 m | | 1.5 m | |
| Side slopes | 1 in 4 | | 1 in 4 | |
| | | | | |
| **Attenuation Storage Provided** | | | | |
| **Detention Basins** | | | | |
| Infiltration Basin Design | 7,252.75 $m^3$ | | 4,232.25 $m^3$ | |
| Detention Basin Design | 15,874.00 $m^3$ | | 9,553.50 $m^3$ | |
| Freeboard | 5,125.95 $m^3$ | | 3,157.05 $m^3$ | |
| Perimeter access track | 1,823.90 $m^3$ | | 1,145.60 $m^3$ | |
| Additional storage between track and basin top | 1,920.50 $m^3$ | | 1,223.95 $m^3$ | |
| Total (design) | **23,126.75 $m^3$** | | **13,785.75 $m^3$** | |
| Total (inc. freeboard, access track etc) | 31,997.1 $m^3$ | | 19,312.35 $m^3$ | |
| **Design storage required < attenuation storage provided?** | **YES = OK** | | **YES = OK** | |
| | | | | |
| **Additional Design Requirements** | | | | |
| Safety Factor 10 Check (>24 hr drain down time) | | | | |
| Additional attenuation Storage Required (1 in 10 year + 40% CC) | 6,556 $m^3$ | | 4,633 $m^3$ | |
| Offset removal of depression adjacent EA1N substation by allowing additional storage in basin design depth. Additional storage required: | 3,300 $m^3$ | | N/A | |
| Total Additional Attenuation Storage Required | **9,856 $m^3$** | | **4,633 $m^3$** | |
| Surplus storage available within basin design depth (1.5m) | **10,494.65 $m^3$** | | **4,735.35 $m^3$** | |
| **Design storage required < attenuation storage provided?** | **YES = OK** | | **YES = OK** | |
| | | | | |
| **Discharge Location** | **Existing watercourse in Church Lane via new outfall pipe as per existing drainage regime. Provides additional betterment over existing arrangment by reducing flood flows down existing farm track.** | | **Existing ditch in field. Provides betterment over existing by attenuating flows from greater return period storms.** | **Design flows up to 1:100 year + 40% CC are attenuated within the basin design depth (1.5m).<br><br>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 2.0m depth).** |
| | | | | |

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

Half Drain Time exceeds 7 days.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 15 min Summer | 14.157 | 0.157 | 4.1 | 0.0 | 4.1 | 2231.7 | O K |
| 30 min Summer | 14.211 | 0.211 | 4.1 | 0.0 | 4.1 | 3013.1 | O K |
| 60 min Summer | 14.267 | 0.267 | 4.2 | 0.0 | 4.2 | 3824.0 | O K |
| 120 min Summer | 14.337 | 0.337 | 4.2 | 0.0 | 4.2 | 4833.0 | O K |
| 180 min Summer | 14.386 | 0.386 | 4.3 | 0.0 | 4.3 | 5551.9 | O K |
| 240 min Summer | 14.424 | 0.424 | 4.3 | 0.0 | 4.3 | 6123.0 | O K |
| 360 min Summer | 14.484 | 0.484 | 4.4 | 0.0 | 4.4 | 7010.8 | O K |
| 480 min Summer | 14.526 | 0.526 | 4.4 | 17.4 | 21.8 | 7647.5 | O K |
| 600 min Summer | 14.548 | 0.548 | 4.5 | 42.7 | 47.1 | 7968.4 | O K |
| 720 min Summer | 14.556 | 0.556 | 4.5 | 54.6 | 59.0 | 8096.7 | O K |
| 960 min Summer | 14.561 | 0.561 | 4.5 | 61.2 | 65.7 | 8163.0 | O K |
| 1440 min Summer | 14.566 | 0.566 | 4.5 | 69.7 | 74.2 | 8246.9 | O K |
| 2160 min Summer | 14.567 | 0.567 | 4.5 | 71.3 | 75.8 | 8263.1 | O K |
| 2880 min Summer | 14.565 | 0.565 | 4.5 | 67.4 | 71.8 | 8224.7 | O K |
| 4320 min Summer | 14.557 | 0.557 | 4.5 | 56.0 | 60.5 | 8111.0 | O K |
| 5760 min Summer | 14.551 | 0.551 | 4.5 | 47.4 | 51.9 | 8017.8 | O K |
| 7200 min Summer | 14.000 | 0.000 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 8640 min Summer | 14.000 | 0.000 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 10080 min Summer | 14.000 | 0.000 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 15 min Winter | 14.176 | 0.176 | 4.1 | 0.0 | 4.1 | 2499.8 | O K |
| 30 min Winter | 14.237 | 0.237 | 4.1 | 0.0 | 4.1 | 3375.2 | O K |
| 60 min Winter | 14.299 | 0.299 | 4.2 | 0.0 | 4.2 | 4284.0 | O K |
| 120 min Winter | 14.376 | 0.376 | 4.3 | 0.0 | 4.3 | 5415.4 | O K |
| 180 min Winter | 14.431 | 0.431 | 4.3 | 0.0 | 4.3 | 6221.9 | O K |
| 240 min Winter | 14.474 | 0.474 | 4.4 | 0.0 | 4.4 | 6863.2 | O K |
| 360 min Winter | 14.536 | 0.536 | 4.4 | 28.2 | 32.7 | 7797.4 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 15 min Summer | 122.248 | 0.0 | 0.0 | 19 |
| 30 min Summer | 82.572 | 0.0 | 0.0 | 34 |
| 60 min Summer | 52.458 | 0.0 | 0.0 | 64 |
| 120 min Summer | 33.215 | 0.0 | 0.0 | 124 |
| 180 min Summer | 25.480 | 0.0 | 0.0 | 184 |
| 240 min Summer | 21.109 | 0.0 | 0.0 | 244 |
| 360 min Summer | 16.158 | 0.0 | 0.0 | 364 |
| 480 min Summer | 13.321 | 0.0 | 241.4 | 482 |
| 600 min Summer | 11.410 | 0.0 | 720.5 | 602 |
| 720 min Summer | 10.016 | 0.0 | 1127.0 | 720 |
| 960 min Summer | 8.080 | 0.0 | 1733.6 | 820 |
| 1440 min Summer | 5.860 | 0.0 | 2463.2 | 1024 |
| 2160 min Summer | 4.154 | 0.0 | 2968.7 | 1424 |
| 2880 min Summer | 3.224 | 0.0 | 3196.7 | 1840 |
| 4320 min Summer | 2.228 | 0.0 | 3308.1 | 2676 |
| 5760 min Summer | 1.712 | 0.0 | 3287.0 | 3512 |
| 7200 min Summer | -0.012 | 0.0 | 0.0 | 0 |
| 8640 min Summer | -0.010 | 0.0 | 0.0 | 0 |
| 10080 min Summer | -0.008 | 0.0 | 0.0 | 0 |
| 15 min Winter | 122.248 | 0.0 | 0.0 | 19 |
| 30 min Winter | 82.572 | 0.0 | 0.0 | 34 |
| 60 min Winter | 52.458 | 0.0 | 0.0 | 64 |
| 120 min Winter | 33.215 | 0.0 | 0.0 | 124 |
| 180 min Winter | 25.480 | 0.0 | 0.0 | 184 |
| 240 min Winter | 21.109 | 0.0 | 0.0 | 242 |
| 360 min Winter | 16.158 | 0.0 | 392.0 | 358 |

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

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 480 min Winter | 14.566 | 0.566 | 4.5 | 69.7 | 74.2 | 8244.8 | O K |
| 600 min Winter | 14.578 | 0.578 | 4.5 | 89.5 | 94.0 | 8423.9 | O K |
| 720 min Winter | 14.582 | 0.582 | 4.5 | 96.5 | 101.0 | 8486.1 | O K |
| 960 min Winter | 14.592 | 0.592 | 4.5 | 114.6 | 119.1 | 8639.5 | O K |
| 1440 min Winter | 14.597 | 0.597 | 4.5 | 124.0 | 128.5 | 8714.5 | O K |
| 2160 min Winter | 14.592 | 0.592 | 4.5 | 113.6 | 118.1 | 8631.2 | O K |
| 2880 min Winter | 14.584 | 0.584 | 4.5 | 100.0 | 104.5 | 8517.6 | O K |
| 4320 min Winter | 14.571 | 0.571 | 4.5 | 77.8 | 82.3 | 8320.2 | O K |
| 5760 min Winter | 14.562 | 0.562 | 4.5 | 62.7 | 67.2 | 8181.0 | O K |
| 7200 min Winter | 14.000 | 0.000 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 8640 min Winter | 14.000 | 0.000 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 10080 min Winter | 14.000 | 0.000 | 0.0 | 0.0 | 0.0 | 0.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 480 min Winter | 13.321 | 0.0 | 1113.0 | 468 |
| 600 min Winter | 11.410 | 0.0 | 1693.9 | 570 |
| 720 min Winter | 10.016 | 0.0 | 2163.8 | 648 |
| 960 min Winter | 8.080 | 0.0 | 2857.1 | 720 |
| 1440 min Winter | 5.860 | 0.0 | 3691.0 | 998 |
| 2160 min Winter | 4.154 | 0.0 | 4278.2 | 1428 |
| 2880 min Winter | 3.223 | 0.0 | 4554.2 | 1844 |
| 4320 min Winter | 2.228 | 0.0 | 4720.0 | 2680 |
| 5760 min Winter | 1.712 | 0.0 | 4737.7 | 3520 |
| 7200 min Winter | -0.012 | 0.0 | 0.0 | 0 |
| 8640 min Winter | -0.010 | 0.0 | 0.0 | 0 |
| 10080 min Winter | -0.008 | 0.0 | 0.0 | 0 |

## 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 641300 260300 TM 41300 60300 | Shortest Storm (mins) | 15 |
| Data Type | Catchment | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +40 |

## Time Area Diagram

Total Area (ha) 9.750

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 9.750 |

## Model Details

Storage is Online Cover Level (m) 16.000

## Infiltration Basin Structure

Invert Level (m) 14.000 Safety Factor 10.0
Infiltration Coefficient Base (m/hr) 0.01000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.01000

| **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** |
|---|---|---|---|---|---|
| 0.000 | 14062.0 | 1.500 | 16799.0 | 1.900 | 19104.0 |
| 0.500 | 14949.0 | 1.800 | 17374.0 | 2.000 | 19306.0 |

## Weir Overflow Control

Discharge Coef 0.544 Width (m) 2.400 Invert Level (m) 14.500

## Cascade Summary of Results for Proj Subs - Hybrid - FEH 2YR - (FEH13 100 YR + 40% CC) - Detention Only - New.SRCX

| Upstream Structures | Outflow To | Overflow To |
|---|---|---|
| Proj Subs - Hybrid - FEH 2YR - (FEH13 100 YR + 40% CC) - Infiltration Only - New.SRCX | (None) | (None) |

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 15 min Summer | 14.597 | 0.000 | 0.0 | 0.0 | O K |
| 30 min Summer | 14.597 | 0.000 | 0.0 | 0.0 | O K |
| 60 min Summer | 14.597 | 0.000 | 0.0 | 0.0 | O K |
| 120 min Summer | 14.597 | 0.000 | 0.0 | 0.0 | O K |
| 180 min Summer | 14.597 | 0.000 | 0.0 | 0.0 | O K |
| 240 min Summer | 14.597 | 0.000 | 0.0 | 0.0 | O K |
| 360 min Summer | 14.597 | 0.000 | 0.0 | 0.0 | O K |
| 480 min Summer | 14.613 | 0.016 | 0.2 | 235.4 | O K |
| 600 min Summer | 14.641 | 0.044 | 1.3 | 674.0 | O K |
| 720 min Summer | 14.665 | 0.068 | 2.7 | 1027.0 | O K |
| 960 min Summer | 14.698 | 0.101 | 5.0 | 1539.4 | O K |
| 1440 min Summer | 14.738 | 0.141 | 7.2 | 2143.2 | O K |
| 2160 min Summer | 14.762 | 0.165 | 7.6 | 2526.8 | O K |
| 2880 min Summer | 14.770 | 0.173 | 7.6 | 2647.5 | O K |
| 4320 min Summer | 14.764 | 0.167 | 7.6 | 2557.8 | O K |
| 5760 min Summer | 14.750 | 0.153 | 7.5 | 2342.1 | O K |
| 7200 min Summer | 14.597 | 0.000 | 0.0 | 0.0 | O K |
| 8640 min Summer | 14.597 | 0.000 | 0.0 | 0.0 | O K |
| 10080 min Summer | 14.597 | 0.000 | 0.0 | 0.0 | O K |
| 15 min Winter | 14.597 | 0.000 | 0.0 | 0.0 | O K |
| 30 min Winter | 14.597 | 0.000 | 0.0 | 0.0 | O K |
| 60 min Winter | 14.597 | 0.000 | 0.0 | 0.0 | O K |
| 120 min Winter | 14.597 | 0.000 | 0.0 | 0.0 | O K |
| 180 min Winter | 14.597 | 0.000 | 0.0 | 0.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 15 min Summer | 122.248 | 0.0 | 0.0 | 0 |
| 30 min Summer | 82.572 | 0.0 | 0.0 | 0 |
| 60 min Summer | 52.458 | 0.0 | 0.0 | 0 |
| 120 min Summer | 33.215 | 0.0 | 0.0 | 0 |
| 180 min Summer | 25.480 | 0.0 | 0.0 | 0 |
| 240 min Summer | 21.109 | 0.0 | 0.0 | 0 |
| 360 min Summer | 16.158 | 0.0 | 0.0 | 0 |
| 480 min Summer | 13.321 | 0.0 | 25.1 | 1132 |
| 600 min Summer | 11.410 | 0.0 | 148.8 | 1266 |
| 720 min Summer | 10.016 | 0.0 | 294.0 | 1306 |
| 960 min Summer | 8.080 | 0.0 | 518.8 | 1432 |
| 1440 min Summer | 5.860 | 0.0 | 680.2 | 1794 |
| 2160 min Summer | 4.154 | 0.0 | 1606.9 | 2428 |
| 2880 min Summer | 3.224 | 0.0 | 1574.3 | 3080 |
| 4320 min Summer | 2.228 | 0.0 | 1269.9 | 4412 |
| 5760 min Summer | 1.712 | 0.0 | 2420.9 | 5776 |
| 7200 min Summer | -0.012 | 0.0 | 0.0 | 0 |
| 8640 min Summer | -0.010 | 0.0 | 0.0 | 0 |
| 10080 min Summer | -0.008 | 0.0 | 0.0 | 0 |
| 15 min Winter | 122.248 | 0.0 | 0.0 | 0 |
| 30 min Winter | 82.572 | 0.0 | 0.0 | 0 |
| 60 min Winter | 52.458 | 0.0 | 0.0 | 0 |
| 120 min Winter | 33.215 | 0.0 | 0.0 | 0 |
| 180 min Winter | 25.480 | 0.0 | 0.0 | 0 |

Cascade Summary of Results for Proj Subs - Hybrid - FEH 2YR - (FEH13 100 YR + 40% CC) - Detention Only - New.SRCX

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 240 min Winter | 14.597 | 0.000 | 0.0 | 0.0 | O K |
| 360 min Winter | 14.622 | 0.025 | 0.5 | 376.9 | O K |
| 480 min Winter | 14.664 | 0.067 | 2.6 | 1015.6 | O K |
| 600 min Winter | 14.696 | 0.099 | 4.8 | 1509.8 | O K |
| 720 min Winter | 14.722 | 0.125 | 6.4 | 1911.8 | O K |
| 960 min Winter | 14.762 | 0.165 | 7.6 | 2522.6 | O K |
| 1440 min Winter | 14.810 | 0.213 | 7.8 | 3269.2 | O K |
| 2160 min Winter | 14.841 | 0.244 | 7.9 | 3748.5 | O K |
| 2880 min Winter | 14.852 | 0.255 | 7.9 | 3917.6 | O K |
| 4320 min Winter | 14.849 | 0.252 | 7.9 | 3867.6 | O K |
| 5760 min Winter | 14.836 | 0.239 | 7.9 | 3663.7 | O K |
| 7200 min Winter | 14.597 | 0.000 | 0.0 | 0.0 | O K |
| 8640 min Winter | 14.597 | 0.000 | 0.0 | 0.0 | O K |
| 10080 min Winter | 14.597 | 0.000 | 0.0 | 0.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 240 min Winter | 21.109 | 0.0 | 0.0 | 0 |
| 360 min Winter | 16.158 | 0.0 | 58.8 | 1048 |
| 480 min Winter | 13.321 | 0.0 | 310.3 | 1100 |
| 600 min Winter | 11.410 | 0.0 | 559.1 | 1138 |
| 720 min Winter | 10.016 | 0.0 | 744.5 | 1198 |
| 960 min Winter | 8.080 | 0.0 | 910.3 | 1384 |
| 1440 min Winter | 5.860 | 0.0 | 847.1 | 1794 |
| 2160 min Winter | 4.154 | 0.0 | 1996.4 | 2424 |
| 2880 min Winter | 3.223 | 0.0 | 1818.2 | 3064 |
| 4320 min Winter | 2.228 | 0.0 | 1423.1 | 4380 |
| 5760 min Winter | 1.712 | 0.0 | 3384.7 | 5704 |
| 7200 min Winter | -0.012 | 0.0 | 0.0 | 0 |
| 8640 min Winter | -0.010 | 0.0 | 0.0 | 0 |
| 10080 min Winter | -0.008 | 0.0 | 0.0 | 0 |

Cascade Rainfall Details for Proj Subs - Hybrid - FEH 2YR - (FEH13 100 YR + 40% CC) - Detention Only - New.SRCX

| | | | |
|---|---|---|---|
| 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 641300 260300 TM 41300 60300 | Shortest Storm (mins) | 15 |
| Data Type | Catchment | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +40 |

Time Area Diagram

Total Area (ha) 0.000

| Time (mins) From: | To: | Area (ha) |
|---|---|---|
| 0 | 4 | 0.000 |

## Cascade Model Details for Proj Subs - Hybrid - FEH 2YR - (FEH13 100 YR + 40% CC) - Detention Only - New.SRCX

Storage is Online Cover Level (m) 16.000

## Tank or Pond Structure

Invert Level (m) 14.597

| Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) |
|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 15124.0 | 0.903 | 16799.0 | 1.203 | 17374.0 | 1.303 | 19104.0 | 1.403 | 19306.0 |

## Hydro-Brake® Optimum Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0132-7900-0905-7900 |
| Design Head (m) | 0.905 |
| Design Flow (l/s) | 7.9 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Application | Surface |
| Sump Available | Yes |
| Diameter (mm) | 132 |
| Invert Level (m) | 14.595 |
| Minimum Outlet Pipe Diameter (mm) | 150 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) | Control Points | Head (m) | Flow (l/s) |
|---|---|---|---|---|---|
| Design Point (Calculated) | 0.905 | 7.9 | Kick-Flo® | 0.613 | 6.6 |
| Flush-Flo™ | 0.275 | 7.9 | Mean Flow over Head Range | - | 6.8 |

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 | 4.8 | 0.800 | 7.5 | 2.000 | 11.5 | 4.000 | 16.0 | 7.000 | 20.9 |
| 0.200 | 7.8 | 1.000 | 8.3 | 2.200 | 12.0 | 4.500 | 16.9 | 7.500 | 21.6 |
| 0.300 | 7.9 | 1.200 | 9.0 | 2.400 | 12.5 | 5.000 | 17.8 | 8.000 | 22.2 |
| 0.400 | 7.7 | 1.400 | 9.7 | 2.600 | 13.0 | 5.500 | 18.6 | 8.500 | 22.9 |
| 0.500 | 7.5 | 1.600 | 10.3 | 3.000 | 13.9 | 6.000 | 19.4 | 9.000 | 23.5 |
| 0.600 | 6.8 | 1.800 | 10.9 | 3.500 | 15.0 | 6.500 | 20.1 | 9.500 | 24.1 |

## 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 | 14.684 | 0.087 | 2.4 | 1324.6 | O K |
| 30 min Summer | 14.711 | 0.114 | 3.5 | 1743.3 | O K |
| 60 min Summer | 14.741 | 0.144 | 4.1 | 2195.6 | O K |
| 120 min Summer | 14.785 | 0.188 | 4.9 | 2881.0 | O K |
| 180 min Summer | 14.813 | 0.216 | 5.3 | 3306.4 | O K |
| 240 min Summer | 14.832 | 0.235 | 5.6 | 3609.3 | O K |
| 360 min Summer | 14.859 | 0.262 | 6.0 | 4018.4 | O K |
| 480 min Summer | 14.876 | 0.279 | 6.2 | 4283.4 | O K |
| 600 min Summer | 14.888 | 0.291 | 6.4 | 4476.0 | O K |
| 720 min Summer | 14.897 | 0.300 | 6.5 | 4624.1 | O K |
| 960 min Summer | 14.911 | 0.314 | 6.7 | 4842.5 | O K |
| 1440 min Summer | 14.928 | 0.331 | 6.9 | 5109.8 | O K |
| 2160 min Summer | 14.942 | 0.345 | 7.0 | 5331.6 | O K |
| 2880 min Summer | 14.951 | 0.354 | 7.1 | 5471.8 | O K |
| 4320 min Summer | 14.963 | 0.366 | 7.3 | 5654.7 | O K |
| 5760 min Summer | 14.970 | 0.373 | 7.3 | 5766.2 | O K |
| 7200 min Summer | 14.597 | 0.000 | 0.0 | 0.0 | O K |
| 8640 min Summer | 14.597 | 0.000 | 0.0 | 0.0 | O K |
| 10080 min Summer | 14.597 | 0.000 | 0.0 | 0.0 | O K |
| 15 min Winter | 14.695 | 0.098 | 2.8 | 1483.4 | O K |
| 30 min Winter | 14.725 | 0.128 | 3.8 | 1952.5 | O K |
| 60 min Winter | 14.758 | 0.161 | 4.4 | 2459.2 | O K |
| 120 min Winter | 14.808 | 0.211 | 5.3 | 3227.2 | O K |
| 180 min Winter | 14.838 | 0.241 | 5.7 | 3704.1 | O K |
| 240 min Winter | 14.860 | 0.263 | 6.0 | 4043.9 | O K |
| 360 min Winter | 14.890 | 0.293 | 6.4 | 4502.9 | O K |
| 480 min Winter | 14.909 | 0.312 | 6.6 | 4800.8 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 15 min Summer | 72.520 | 0.0 | 183.3 | 19 |
| 30 min Summer | 47.768 | 0.0 | 270.0 | 34 |
| 60 min Summer | 30.128 | 0.0 | 625.3 | 64 |
| 120 min Summer | 19.824 | 0.0 | 758.6 | 124 |
| 180 min Summer | 15.209 | 0.0 | 825.9 | 184 |
| 240 min Summer | 12.485 | 0.0 | 867.6 | 244 |
| 360 min Summer | 9.315 | 0.0 | 914.1 | 364 |
| 480 min Summer | 7.485 | 0.0 | 935.7 | 484 |
| 600 min Summer | 6.289 | 0.0 | 945.3 | 604 |
| 720 min Summer | 5.441 | 0.0 | 947.6 | 724 |
| 960 min Summer | 4.316 | 0.0 | 939.9 | 964 |
| 1440 min Summer | 3.096 | 0.0 | 897.3 | 1442 |
| 2160 min Summer | 2.217 | 0.0 | 1902.5 | 2164 |
| 2880 min Summer | 1.756 | 0.0 | 1845.2 | 2880 |
| 4320 min Summer | 1.278 | 0.0 | 1683.5 | 4320 |
| 5760 min Summer | 1.031 | 0.0 | 3703.3 | 5368 |
| 7200 min Summer | -0.012 | 0.0 | -102.4 | 0 |
| 8640 min Summer | -0.010 | 0.0 | -102.4 | 0 |
| 10080 min Summer | -0.008 | 0.0 | -102.4 | 0 |
| 15 min Winter | 72.520 | 0.0 | 216.6 | 19 |
| 30 min Winter | 47.768 | 0.0 | 304.5 | 34 |
| 60 min Winter | 30.128 | 0.0 | 683.3 | 64 |
| 120 min Winter | 19.824 | 0.0 | 819.2 | 124 |
| 180 min Winter | 15.209 | 0.0 | 889.4 | 182 |
| 240 min Winter | 12.485 | 0.0 | 933.0 | 242 |
| 360 min Winter | 9.315 | 0.0 | 981.7 | 360 |
| 480 min Winter | 7.485 | 0.0 | 1004.4 | 480 |

## 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 |
|---|---|---|---|---|---|
| 600 min Winter | 14.922 | 0.325 | 6.8 | 5017.7 | O K |
| 720 min Winter | 14.933 | 0.336 | 6.9 | 5184.9 | O K |
| 960 min Winter | 14.949 | 0.352 | 7.1 | 5432.2 | O K |
| 1440 min Winter | 14.968 | 0.371 | 7.3 | 5737.2 | O K |
| 2160 min Winter | 14.984 | 0.387 | 7.5 | 5996.2 | O K |
| 2880 min Winter | 14.995 | 0.398 | 7.6 | 6165.2 | O K |
| 4320 min Winter | 15.010 | 0.413 | 7.8 | 6400.0 | O K |
| 5760 min Winter | 15.020 | 0.423 | 7.9 | 6556.0 | O K |
| 7200 min Winter | 14.597 | 0.000 | 0.0 | 0.0 | O K |
| 8640 min Winter | 14.597 | 0.000 | 0.0 | 0.0 | O K |
| 10080 min Winter | 14.597 | 0.000 | 0.0 | 0.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 600 min Winter | 6.289 | 0.0 | 1014.5 | 598 |
| 720 min Winter | 5.441 | 0.0 | 1017.2 | 716 |
| 960 min Winter | 4.316 | 0.0 | 1009.4 | 952 |
| 1440 min Winter | 3.096 | 0.0 | 965.6 | 1426 |
| 2160 min Winter | 2.217 | 0.0 | 2047.9 | 2120 |
| 2880 min Winter | 1.756 | 0.0 | 1988.3 | 2824 |
| 4320 min Winter | 1.278 | 0.0 | 1820.4 | 4188 |
| 5760 min Winter | 1.031 | 0.0 | 4005.5 | 5480 |
| 7200 min Winter | -0.012 | 0.0 | -114.7 | 0 |
| 8640 min Winter | -0.010 | 0.0 | -114.7 | 0 |
| 10080 min Winter | -0.008 | 0.0 | -114.7 | 0 |

## 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 641300 260300 TM 41300 60300 | Shortest Storm (mins) | 15 |
| Data Type | Catchment | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +40 |

## Time Area Diagram

Total Area (ha) 9.750

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 9.750 |

## Model Details

Storage is Online Cover Level (m) 16.000

## Tank or Pond Structure

Invert Level (m) 14.597

| Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) |
|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 15124.0 | 0.903 | 16799.0 | 1.203 | 17374.0 | 1.303 | 19103.0 | 1.403 | 19306.0 |

## Orifice Outflow Control

Diameter (m) 0.078 Discharge Coefficient 0.600 Invert Level (m) 14.597

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

Half Drain Time exceeds 7 days.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 15 min Summer | 14.842 | 0.192 | 2.4 | 0.0 | 2.4 | 1582.4 | O K |
| 30 min Summer | 14.908 | 0.258 | 2.5 | 0.0 | 2.5 | 2136.6 | O K |
| 60 min Summer | 14.975 | 0.325 | 2.5 | 0.0 | 2.5 | 2712.1 | O K |
| 120 min Summer | 15.058 | 0.408 | 2.6 | 0.0 | 2.6 | 3428.6 | O K |
| 180 min Summer | 15.117 | 0.467 | 2.6 | 0.0 | 2.6 | 3939.4 | O K |
| 240 min Summer | 15.163 | 0.513 | 2.7 | 5.9 | 8.5 | 4342.1 | O K |
| 360 min Summer | 15.207 | 0.557 | 2.7 | 55.3 | 58.0 | 4735.7 | O K |
| 480 min Summer | 15.217 | 0.567 | 2.7 | 71.3 | 74.0 | 4826.1 | O K |
| 600 min Summer | 15.225 | 0.575 | 2.7 | 84.4 | 87.1 | 4896.4 | O K |
| 720 min Summer | 15.232 | 0.582 | 2.7 | 96.5 | 99.2 | 4959.3 | O K |
| 960 min Summer | 15.241 | 0.591 | 2.7 | 111.8 | 114.5 | 5034.8 | O K |
| 1440 min Summer | 15.244 | 0.594 | 2.7 | 117.4 | 120.1 | 5064.4 | O K |
| 2160 min Summer | 15.238 | 0.588 | 2.7 | 106.3 | 109.0 | 5010.5 | O K |
| 2880 min Summer | 15.230 | 0.580 | 2.7 | 93.0 | 95.7 | 4945.0 | O K |
| 4320 min Summer | 15.218 | 0.568 | 2.7 | 72.9 | 75.6 | 4835.4 | O K |
| 5760 min Summer | 15.210 | 0.560 | 2.7 | 59.7 | 62.4 | 4758.2 | O K |
| 7200 min Summer | 14.650 | 0.000 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 8640 min Summer | 14.650 | 0.000 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 10080 min Summer | 14.650 | 0.000 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 15 min Winter | 14.865 | 0.215 | 2.4 | 0.0 | 2.4 | 1772.5 | O K |
| 30 min Winter | 14.938 | 0.288 | 2.5 | 0.0 | 2.5 | 2393.3 | O K |
| 60 min Winter | 15.013 | 0.363 | 2.5 | 0.0 | 2.5 | 3038.2 | O K |
| 120 min Winter | 15.106 | 0.456 | 2.6 | 0.0 | 2.6 | 3841.5 | O K |
| 180 min Winter | 15.170 | 0.520 | 2.7 | 11.3 | 14.0 | 4405.8 | O K |
| 240 min Winter | 15.208 | 0.558 | 2.7 | 56.8 | 59.4 | 4741.3 | O K |
| 360 min Winter | 15.235 | 0.585 | 2.7 | 101.8 | 104.5 | 4986.5 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 15 min Summer | 122.248 | 0.0 | 0.0 | 19 |
| 30 min Summer | 82.572 | 0.0 | 0.0 | 34 |
| 60 min Summer | 52.458 | 0.0 | 0.0 | 64 |
| 120 min Summer | 33.215 | 0.0 | 0.0 | 124 |
| 180 min Summer | 25.480 | 0.0 | 0.0 | 184 |
| 240 min Summer | 21.109 | 0.0 | 47.2 | 244 |
| 360 min Summer | 16.158 | 0.0 | 633.7 | 360 |
| 480 min Summer | 13.321 | 0.0 | 1112.4 | 420 |
| 600 min Summer | 11.410 | 0.0 | 1486.5 | 452 |
| 720 min Summer | 10.016 | 0.0 | 1787.0 | 500 |
| 960 min Summer | 8.080 | 0.0 | 2227.9 | 624 |
| 1440 min Summer | 5.860 | 0.0 | 2755.7 | 880 |
| 2160 min Summer | 4.154 | 0.0 | 3125.5 | 1276 |
| 2880 min Summer | 3.224 | 0.0 | 3298.7 | 1668 |
| 4320 min Summer | 2.228 | 0.0 | 3402.2 | 2424 |
| 5760 min Summer | 1.712 | 0.0 | 3413.3 | 3176 |
| 7200 min Summer | -0.012 | 0.0 | 0.0 | 0 |
| 8640 min Summer | -0.010 | 0.0 | 0.0 | 0 |
| 10080 min Summer | -0.008 | 0.0 | 0.0 | 0 |
| 15 min Winter | 122.248 | 0.0 | 0.0 | 19 |
| 30 min Winter | 82.572 | 0.0 | 0.0 | 34 |
| 60 min Winter | 52.458 | 0.0 | 0.0 | 64 |
| 120 min Winter | 33.215 | 0.0 | 0.0 | 124 |
| 180 min Winter | 25.480 | 0.0 | 100.9 | 182 |
| 240 min Winter | 21.109 | 0.0 | 526.7 | 236 |
| 360 min Winter | 16.158 | 0.0 | 1229.2 | 338 |

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

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 480 min Winter | 15.249 | 0.599 | 2.7 | 127.9 | 130.6 | 5114.7 | O K |
| 600 min Winter | 15.259 | 0.609 | 2.7 | 147.7 | 150.4 | 5204.6 | O K |
| 720 min Winter | 15.264 | 0.614 | 2.7 | 157.9 | 160.7 | 5249.4 | O K |
| 960 min Winter | 15.267 | 0.617 | 2.7 | 163.1 | 165.9 | 5267.8 | O K |
| 1440 min Winter | 15.260 | 0.610 | 2.7 | 148.7 | 151.4 | 5209.0 | O K |
| 2160 min Winter | 15.247 | 0.597 | 2.7 | 123.1 | 125.8 | 5088.4 | O K |
| 2880 min Winter | 15.235 | 0.585 | 2.7 | 101.8 | 104.5 | 4988.9 | O K |
| 4320 min Winter | 15.220 | 0.570 | 2.7 | 75.3 | 78.0 | 4847.5 | O K |
| 5760 min Winter | 15.209 | 0.559 | 2.7 | 59.0 | 61.7 | 4757.6 | O K |
| 7200 min Winter | 14.650 | 0.000 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 8640 min Winter | 14.650 | 0.000 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 10080 min Winter | 14.650 | 0.000 | 0.0 | 0.0 | 0.0 | 0.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 480 min Winter | 13.321 | 0.0 | 1771.1 | 364 |
| 600 min Winter | 11.410 | 0.0 | 2193.4 | 430 |
| 720 min Winter | 10.016 | 0.0 | 2532.4 | 498 |
| 960 min Winter | 8.080 | 0.0 | 3030.6 | 634 |
| 1440 min Winter | 5.860 | 0.0 | 3630.3 | 896 |
| 2160 min Winter | 4.154 | 0.0 | 4057.7 | 1296 |
| 2880 min Winter | 3.223 | 0.0 | 4264.7 | 1672 |
| 4320 min Winter | 2.228 | 0.0 | 4407.1 | 2424 |
| 5760 min Winter | 1.712 | 0.0 | 4446.2 | 3224 |
| 7200 min Winter | -0.012 | 0.0 | 0.0 | 0 |
| 8640 min Winter | -0.010 | 0.0 | 0.0 | 0 |
| 10080 min Winter | -0.008 | 0.0 | 0.0 | 0 |

## 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 641300 260300 TM 41300 60300 | Shortest Storm (mins) | 15 |
| Data Type | Catchment | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +40 |

## Time Area Diagram

Total Area (ha) 6.912

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 6.912 |

## Model Details

Storage is Online Cover Level (m) 16.650

## Infiltration Basin Structure

Invert Level (m) 14.650 Safety Factor 10.0
Infiltration Coefficient Base (m/hr) 0.01000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.01000

| Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 8114.0 | 1.500 | 10292.0 | 1.900 | 12157.0 |
| 0.500 | 8815.0 | 1.800 | 10755.0 | 2.000 | 12322.0 |

## Weir Overflow Control

Discharge Coef 0.544 Width (m) 2.400 Invert Level (m) 15.150

Cascade Summary of Results for Nat Grid Subs - Basin - FEH 2YR - (FEH13 100 YR + 40% CC) - Detention Only.SRCX

| Upstream Structures | Outflow To | Overflow To |
|---|---|---|
| Nat Grid Subs - Basin - FEH 2YR - (FEH13 100 YR + 40% CC) - Infiltration Only.SRCX | (None) | (None) |

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 15 min Summer | 15.267 | 0.000 | 0.0 | 0.0 | O K |
| 30 min Summer | 15.267 | 0.000 | 0.0 | 0.0 | O K |
| 60 min Summer | 15.267 | 0.000 | 0.0 | 0.0 | O K |
| 120 min Summer | 15.267 | 0.000 | 0.0 | 0.0 | O K |
| 180 min Summer | 15.267 | 0.000 | 0.0 | 0.0 | O K |
| 240 min Summer | 15.272 | 0.005 | 0.0 | 47.0 | O K |
| 360 min Summer | 15.331 | 0.064 | 2.0 | 579.1 | O K |
| 480 min Summer | 15.376 | 0.109 | 4.3 | 992.2 | O K |
| 600 min Summer | 15.413 | 0.146 | 5.2 | 1325.3 | O K |
| 720 min Summer | 15.443 | 0.176 | 5.3 | 1601.3 | O K |
| 960 min Summer | 15.486 | 0.219 | 5.5 | 2003.9 | O K |
| 1440 min Summer | 15.536 | 0.269 | 5.5 | 2465.8 | O K |
| 2160 min Summer | 15.565 | 0.298 | 5.5 | 2740.7 | O K |
| 2880 min Summer | 15.573 | 0.306 | 5.5 | 2818.0 | O K |
| 4320 min Summer | 15.563 | 0.296 | 5.5 | 2726.5 | O K |
| 5760 min Summer | 15.544 | 0.277 | 5.5 | 2539.4 | O K |
| 7200 min Summer | 15.267 | 0.000 | 0.0 | 0.0 | O K |
| 8640 min Summer | 15.267 | 0.000 | 0.0 | 0.0 | O K |
| 10080 min Summer | 15.267 | 0.000 | 0.0 | 0.0 | O K |
| 15 min Winter | 15.267 | 0.000 | 0.0 | 0.0 | O K |
| 30 min Winter | 15.267 | 0.000 | 0.0 | 0.0 | O K |
| 60 min Winter | 15.267 | 0.000 | 0.0 | 0.0 | O K |
| 120 min Winter | 15.267 | 0.000 | 0.0 | 0.0 | O K |
| 180 min Winter | 15.278 | 0.011 | 0.1 | 99.4 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 15 min Summer | 122.248 | 0.0 | 0.0 | 0 |
| 30 min Summer | 82.572 | 0.0 | 0.0 | 0 |
| 60 min Summer | 52.458 | 0.0 | 0.0 | 0 |
| 120 min Summer | 33.215 | 0.0 | 0.0 | 0 |
| 180 min Summer | 25.480 | 0.0 | 0.0 | 0 |
| 240 min Summer | 21.109 | 0.0 | 2.5 | 640 |
| 360 min Summer | 16.158 | 0.0 | 231.3 | 790 |
| 480 min Summer | 13.321 | 0.0 | 493.6 | 826 |
| 600 min Summer | 11.410 | 0.0 | 658.3 | 920 |
| 720 min Summer | 10.016 | 0.0 | 720.9 | 1020 |
| 960 min Summer | 8.080 | 0.0 | 717.6 | 1234 |
| 1440 min Summer | 5.860 | 0.0 | 648.8 | 1668 |
| 2160 min Summer | 4.154 | 0.0 | 1468.4 | 2336 |
| 2880 min Summer | 3.224 | 0.0 | 1344.9 | 3012 |
| 4320 min Summer | 2.228 | 0.0 | 1088.7 | 4384 |
| 5760 min Summer | 1.712 | 0.0 | 2596.0 | 5768 |
| 7200 min Summer | -0.012 | 0.0 | 0.0 | 0 |
| 8640 min Summer | -0.010 | 0.0 | 0.0 | 0 |
| 10080 min Summer | -0.008 | 0.0 | 0.0 | 0 |
| 15 min Winter | 122.248 | 0.0 | 0.0 | 0 |
| 30 min Winter | 82.572 | 0.0 | 0.0 | 0 |
| 60 min Winter | 52.458 | 0.0 | 0.0 | 0 |
| 120 min Winter | 33.215 | 0.0 | 0.0 | 0 |
| 180 min Winter | 25.480 | 0.0 | 10.4 | 674 |

Cascade Summary of Results for Nat Grid Subs - Basin - FEH 2YR - (FEH13 100 YR + 40% CC) - Detention Only.SRCX

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 240 min Winter | 15.321 | 0.054 | 1.5 | 486.6 | O K |
| 360 min Winter | 15.388 | 0.121 | 4.7 | 1096.9 | O K |
| 480 min Winter | 15.443 | 0.176 | 5.3 | 1598.9 | O K |
| 600 min Winter | 15.486 | 0.219 | 5.5 | 1999.6 | O K |
| 720 min Winter | 15.520 | 0.253 | 5.5 | 2321.4 | O K |
| 960 min Winter | 15.570 | 0.303 | 5.5 | 2789.5 | O K |
| 1440 min Winter | 15.627 | 0.360 | 5.5 | 3331.1 | O K |
| 2160 min Winter | 15.663 | 0.396 | 5.5 | 3668.8 | O K |
| 2880 min Winter | 15.675 | 0.408 | 5.5 | 3782.6 | O K |
| 4320 min Winter | 15.670 | 0.403 | 5.5 | 3734.1 | O K |
| 5760 min Winter | 15.653 | 0.386 | 5.5 | 3577.6 | O K |
| 7200 min Winter | 15.267 | 0.000 | 0.0 | 0.0 | O K |
| 8640 min Winter | 15.267 | 0.000 | 0.0 | 0.0 | O K |
| 10080 min Winter | 15.267 | 0.000 | 0.0 | 0.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 240 min Winter | 21.109 | 0.0 | 179.2 | 716 |
| 360 min Winter | 16.158 | 0.0 | 570.7 | 720 |
| 480 min Winter | 13.321 | 0.0 | 761.5 | 820 |
| 600 min Winter | 11.410 | 0.0 | 785.0 | 924 |
| 720 min Winter | 10.016 | 0.0 | 777.6 | 1030 |
| 960 min Winter | 8.080 | 0.0 | 741.1 | 1240 |
| 1440 min Winter | 5.860 | 0.0 | 654.4 | 1666 |
| 2160 min Winter | 4.154 | 0.0 | 1469.2 | 2324 |
| 2880 min Winter | 3.223 | 0.0 | 1340.2 | 2992 |
| 4320 min Winter | 2.228 | 0.0 | 1092.1 | 4340 |
| 5760 min Winter | 1.712 | 0.0 | 2733.7 | 5688 |
| 7200 min Winter | -0.012 | 0.0 | 0.0 | 0 |
| 8640 min Winter | -0.010 | 0.0 | 0.0 | 0 |
| 10080 min Winter | -0.008 | 0.0 | 0.0 | 0 |

Cascade Rainfall Details for Nat Grid Subs - Basin - FEH 2YR - (FEH13 100 YR + 40% CC) - Detention Only.SRCX

| | | | |
|---|---|---|---|
| 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 641300 260300 TM 41300 60300 | Shortest Storm (mins) | 15 |
| Data Type | Catchment | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +40 |

Time Area Diagram

Total Area (ha) 0.000

| Time (mins) From: | To: | Area (ha) |
|---|---|---|
| 0 | 4 | 0.000 |

Cascade Model Details for Nat Grid Subs - Basin - FEH 2YR - (FEH13 100 YR + 40% CC) - Detention Only.SRCX

Storage is Online Cover Level (m) 16.650

Tank or Pond Structure

Invert Level (m) 15.267

| Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) |
|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 8983.0 | 0.883 | 10292.0 | 1.183 | 10755.0 | 1.283 | 12157.0 | 1.383 | 13322.0 |

Hydro-Brake® Optimum Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0112-5500-0883-5500 |
| Design Head (m) | 0.883 |
| Design Flow (l/s) | 5.5 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Application | Surface |
| Sump Available | Yes |
| Diameter (mm) | 112 |
| Invert Level (m) | 15.267 |
| Minimum Outlet Pipe Diameter (mm) | 150 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) | Control Points | Head (m) | Flow (l/s) |
|---|---|---|---|---|---|
| Design Point (Calculated) | 0.883 | 5.5 | Kick-Flo® | 0.581 | 4.5 |
| Flush-Flo™ | 0.262 | 5.5 | Mean Flow over Head Range | - | 4.7 |

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 | 3.9 | 0.800 | 5.3 | 2.000 | 8.1 | 4.000 | 11.2 | 7.000 | 14.6 |
| 0.200 | 5.4 | 1.000 | 5.8 | 2.200 | 8.4 | 4.500 | 11.8 | 7.500 | 15.1 |
| 0.300 | 5.5 | 1.200 | 6.3 | 2.400 | 8.8 | 5.000 | 12.4 | 8.000 | 15.6 |
| 0.400 | 5.3 | 1.400 | 6.8 | 2.600 | 9.1 | 5.500 | 13.0 | 8.500 | 16.0 |
| 0.500 | 5.1 | 1.600 | 7.3 | 3.000 | 9.8 | 6.000 | 13.6 | 9.000 | 16.4 |
| 0.600 | 4.6 | 1.800 | 7.7 | 3.500 | 10.5 | 6.500 | 14.1 | 9.500 | 16.9 |

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 | 15.371 | 0.104 | 2.2 | 938.7 | O K |
| 30 min Summer | 15.403 | 0.136 | 2.6 | 1235.5 | O K |
| 60 min Summer | 15.438 | 0.171 | 3.0 | 1556.0 | O K |
| 120 min Summer | 15.490 | 0.223 | 3.5 | 2041.6 | O K |
| 180 min Summer | 15.523 | 0.256 | 3.8 | 2342.8 | O K |
| 240 min Summer | 15.545 | 0.278 | 4.0 | 2557.2 | O K |
| 360 min Summer | 15.576 | 0.309 | 4.2 | 2846.7 | O K |
| 480 min Summer | 15.596 | 0.329 | 4.4 | 3033.9 | O K |
| 600 min Summer | 15.610 | 0.343 | 4.5 | 3169.9 | O K |
| 720 min Summer | 15.621 | 0.354 | 4.6 | 3274.3 | O K |
| 960 min Summer | 15.638 | 0.371 | 4.7 | 3428.1 | O K |
| 1440 min Summer | 15.657 | 0.390 | 4.8 | 3615.5 | O K |
| 2160 min Summer | 15.673 | 0.406 | 4.9 | 3770.0 | O K |
| 2880 min Summer | 15.683 | 0.416 | 5.0 | 3866.9 | O K |
| 4320 min Summer | 15.697 | 0.430 | 5.1 | 3992.5 | O K |
| 5760 min Summer | 15.704 | 0.437 | 5.1 | 4067.0 | O K |
| 7200 min Summer | 15.267 | 0.000 | 0.0 | 0.0 | O K |
| 8640 min Summer | 15.267 | 0.000 | 0.0 | 0.0 | O K |
| 10080 min Summer | 15.267 | 0.000 | 0.0 | 0.0 | O K |
| 15 min Winter | 15.383 | 0.116 | 2.3 | 1051.4 | O K |
| 30 min Winter | 15.419 | 0.152 | 2.8 | 1383.9 | O K |
| 60 min Winter | 15.458 | 0.191 | 3.2 | 1742.8 | O K |
| 120 min Winter | 15.517 | 0.250 | 3.8 | 2287.0 | O K |
| 180 min Winter | 15.553 | 0.286 | 4.0 | 2624.8 | O K |
| 240 min Winter | 15.578 | 0.311 | 4.2 | 2865.4 | O K |
| 360 min Winter | 15.613 | 0.346 | 4.5 | 3190.3 | O K |
| 480 min Winter | 15.635 | 0.368 | 4.7 | 3400.9 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 15 min Summer | 72.520 | 0.0 | 172.3 | 19 |
| 30 min Summer | 47.768 | 0.0 | 209.6 | 34 |
| 60 min Summer | 30.128 | 0.0 | 463.1 | 64 |
| 120 min Summer | 19.824 | 0.0 | 548.3 | 124 |
| 180 min Summer | 15.209 | 0.0 | 592.5 | 184 |
| 240 min Summer | 12.485 | 0.0 | 620.0 | 244 |
| 360 min Summer | 9.315 | 0.0 | 650.7 | 364 |
| 480 min Summer | 7.485 | 0.0 | 664.9 | 484 |
| 600 min Summer | 6.289 | 0.0 | 671.1 | 604 |
| 720 min Summer | 5.441 | 0.0 | 672.7 | 724 |
| 960 min Summer | 4.316 | 0.0 | 667.5 | 964 |
| 1440 min Summer | 3.096 | 0.0 | 639.0 | 1442 |
| 2160 min Summer | 2.217 | 0.0 | 1350.1 | 2164 |
| 2880 min Summer | 1.756 | 0.0 | 1311.6 | 2880 |
| 4320 min Summer | 1.278 | 0.0 | 1203.6 | 4320 |
| 5760 min Summer | 1.031 | 0.0 | 2630.4 | 5480 |
| 7200 min Summer | -0.012 | 0.0 | -72.6 | 0 |
| 8640 min Summer | -0.010 | 0.0 | -72.6 | 0 |
| 10080 min Summer | -0.008 | 0.0 | -72.6 | 0 |
| 15 min Winter | 72.520 | 0.0 | 187.9 | 19 |
| 30 min Winter | 47.768 | 0.0 | 226.1 | 34 |
| 60 min Winter | 30.128 | 0.0 | 499.2 | 64 |
| 120 min Winter | 19.824 | 0.0 | 588.3 | 124 |
| 180 min Winter | 15.209 | 0.0 | 634.6 | 182 |
| 240 min Winter | 12.485 | 0.0 | 663.5 | 242 |
| 360 min Winter | 9.315 | 0.0 | 695.7 | 360 |
| 480 min Winter | 7.485 | 0.0 | 710.7 | 480 |

## 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 |
|---|---|---|---|---|---|
| 600 min Winter | 15.651 | 0.384 | 4.8 | 3554.2 | O K |
| 720 min Winter | 15.663 | 0.396 | 4.8 | 3672.3 | O K |
| 960 min Winter | 15.681 | 0.414 | 5.0 | 3846.8 | O K |
| 1440 min Winter | 15.704 | 0.437 | 5.1 | 4061.4 | O K |
| 2160 min Winter | 15.723 | 0.456 | 5.2 | 4242.9 | O K |
| 2880 min Winter | 15.735 | 0.468 | 5.3 | 4360.9 | O K |
| 4320 min Winter | 15.752 | 0.485 | 5.4 | 4524.6 | O K |
| 5760 min Winter | 15.763 | 0.496 | 5.5 | 4632.8 | O K |
| 7200 min Winter | 15.267 | 0.000 | 0.0 | 0.0 | O K |
| 8640 min Winter | 15.267 | 0.000 | 0.0 | 0.0 | O K |
| 10080 min Winter | 15.267 | 0.000 | 0.0 | 0.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 600 min Winter | 6.289 | 0.0 | 717.4 | 598 |
| 720 min Winter | 5.441 | 0.0 | 719.1 | 716 |
| 960 min Winter | 4.316 | 0.0 | 713.9 | 952 |
| 1440 min Winter | 3.096 | 0.0 | 684.6 | 1426 |
| 2160 min Winter | 2.217 | 0.0 | 1447.3 | 2120 |
| 2880 min Winter | 1.756 | 0.0 | 1407.2 | 2824 |
| 4320 min Winter | 1.278 | 0.0 | 1294.7 | 4188 |
| 5760 min Winter | 1.031 | 0.0 | 2833.1 | 5480 |
| 7200 min Winter | -0.012 | 0.0 | -81.3 | 0 |
| 8640 min Winter | -0.010 | 0.0 | -81.3 | 0 |
| 10080 min Winter | -0.008 | 0.0 | -81.3 | 0 |

## 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 641300 260300 TM 41300 60300 | Shortest Storm (mins) | 15 |
| Data Type | Catchment | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +40 |

## Time Area Diagram

Total Area (ha) 6.912

| Time From: | (mins) To: | Area (ha) |
| --- | --- | --- |
| 0 | 4 | 6.912 |

## Model Details

Storage is Online Cover Level (m) 16.650

## Tank or Pond Structure

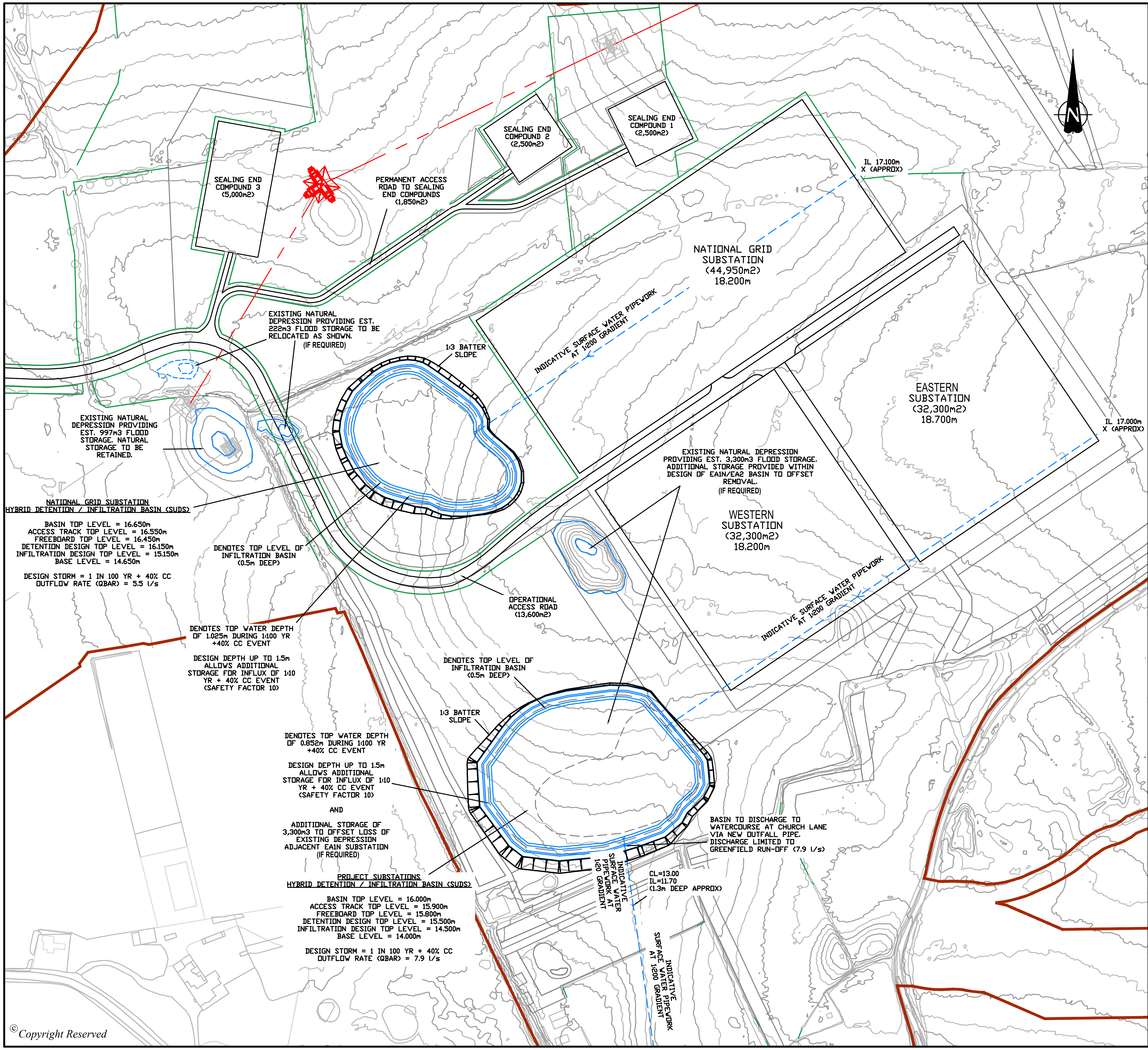
Invert Level (m) 15.267

| Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) |
|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 8983.0 | 0.883 | 10292.0 | 1.183 | 10755.0 | 1.283 | 12157.0 | 1.383 | 12322.0 |

## Orifice Outflow Control

Diameter (m) 0.062 Discharge Coefficient 0.600 Invert Level (m) 15.267

# Appendix 6: Hybrid Scheme Figures




DO NOT SCALE FROM THIS DRAWING

NOTES:

HYBRID DETENTION / INFILTRATION BASINS ARE SHOWN INDICATIVELY FOR ILLUSTRATION PURPOSES ONLY. DETAILED DESIGN OF BASINS WOULD BE REQUIRED TO CONFIRM EXACT ELEVATIONS, SHAPES AND LOCATIONS AS APPROPRIATE AND AS PART OF THE MASTERPLANNING PROCESS.

DENOTES DCO ORDER LIMITS

DENOTES INDICATIVE SURFACE WATER PIPEWORK

DENOTES INDICATIVE SUDS FEATURE (SEE ANNOTATION)

| REVISION | DETAILS | DATE | DRN | CHK'D | APP'D |
|---|---|---|---|---|---|
| A | FIRST ISSUE | 23.03.21 | CS | CS | SH |

CLIENT
Haskoning DHV UK Limited

PROJECT
EAST ANGLIA OFFSHORE WIND
EA1N & EA2

SKETCH

DRAWING TITLE
DETENTION / INFILTRATION BASIN HYBRID
1 IN 100 YR + 40% CC DESIGN

| DRG No. | | REV |
|---|---|---|
| ED11892-C-SK14 | | A |
| DRG SIZE: A3 | SCALE: NTS | DATE: MAR'21 |
| DRAWN BY: CS | CHECKED BY: CS | APPROVED BY: SH |

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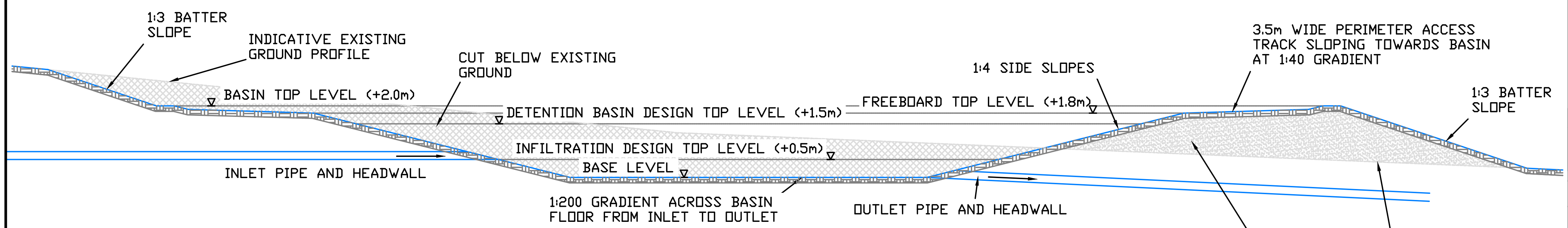
N:\ED\ED11892 - EAST ANGLIA OFFSHORE WIND EA 1\03 - DESIGN\AUTOCAD\ED11892-C-SK14-A SK15-A - DETENTION & INFILTRATION HYBRID BASIN.DWG

DO NOT SCALE FROM THIS DRAWING

NOTES:

HYBRID DETENTION / INFILTRATION BASINS ARE SHOWN INDICATIVELY FOR ILLUSTRATION PURPOSES ONLY. DETAILED DESIGN OF BASINS WOULD BE REQUIRED TO CONFIRM EXACT ELEVATIONS, SHAPES AND LOCATIONS AS APPROPRIATE AND AS PART OF THE MASTERPLANNING PROCESS.




NOTE:
OUTLET PIPEWORK CONNECTS TO FLOW CONTROL MANHOLE COMPLETE WITH INTERNAL WEIR WALL AND VORTEX FLOW CONTROL LIMITING DISCHARGE TO GREENFIELD RUN-OFF RATE

INTERNAL WEIR WALL TO BE 0.5m HIGH TO ALLOW FLOOD WATER TO INFILTRATE BEFORE OVERFLOWING TO OUTFALL AT GREENFIELD RUN-OFF RATE

## TYPICAL HYBRID DETENTION / INFILTRATION BASIN CROSS SECTION

| REVISION | DETAILS | DATE | DR'N | CHK'D | APP'D |
|---|---|---|---|---|---|
| A | FIRST ISSUE | 23.03.21 | CS | CS | SH |

CLIENT
Haskoning DHV UK Limited

PROJECT
EAST ANGLIA OFFSHORE WIND
EA1N & EA2

SKETCH

DRAWING TITLE
DETENTION / INFILTRATION BASIN HYBRID
1 IN 100 YR + 40% CC DESIGN
TYPICAL BASIN CROSS SECTION

| DRG No. | | REV |
|---|---|---|
| ED11892-C-SK15 | | A |
| DRG SIZE: A3 | SCALE: NTS | DATE: MAR'21 |
| DRAWN BY: CS | CHECKED BY: CS | APPROVED BY: SH |

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☐ GLASGOW ☐ STOKE ON TRENT



N:\ED\ED11892 - EAST ANGLIA OFFSHORE WIND EA 1\03 - DESIGN\AUTOCAD\ED11892-C-SK14-A SK15-A - DETENTION & INFILTRATION HYBRID BASIN.DWG

# Appendix 7: Attenuation Only Scheme Model Outputs

**SUDS Design Summary**

**Notes:**

1. SUDS design proposal to attenuate surface water flows from hardstanding areas associated with EA2 / EA1N and National Grid substations (including access roads and cable sealing compounds).

2. Separate SUDS required for EA2/EA1N project substations and National Grid infrastructure.

3. EA2/EA1N project substations and access roads discharge to SUDS Basin with outfall to existing ditch in Church Lane at pre-development run-off rate. To mimic existing drainage regime and achieve no net increase in flows to receiving watercourse.

4. NG substation and sealing end compounds discharge to SUDS Basin with outfall to existing ditch in field at 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 set out in The SUDS Manual (C753) & Suffolk County Council Sustainable Drainage Systems (SUDS) a Local Design Guide.

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 | EA2 | EA1N | National Grid | Change Notes |
|---|---|---|---|---|
| **Hardstanding (all footprints assumed 100% impermeable)** | | | | 01.12.20<br>Updated with areas of SUDS basin footprint (including perimeter access tracks)<br><br>05.01.21<br>Reduced project substation footprints from 36,100$m^2$ to 32,300$m^2$ for each substation (previous total 96,510$m^2$).<br><br>02.02.21<br>Amended design to store 1:100 YR + 40% exceedence within 1m design depth.<br><br>10.02.21<br>Added note on additional volume allowed for existing depression adjacent EA1N substation. |
| Substation operational footprint | 32,300 $m^2$ | 32,300 $m^2$ | 44,950 $m^2$ | |
| Operational access road | 13,600 $m^2$ | | - | |
| Cable sealing end compound operational footprint | - | | 10,000 $m^2$ | |
| Permanent access road to sealing end compound | - | | 1,850 $m^2$ | |
| SUDS Basin Footprint (including perimeter access track) | 18,300 $m^2$ | | 10,602 $m^2$ | |
| Total | **96,500 $m^2$** | | **67,402 $m^2$** | |
| **Additional Volumes** | | | | |
| Existing depression adjacent EA1N substation. Estimated volume to be allowed for in SUDS design (see additional design requirements below). | **3,300 $m^3$** | | - | |
| | | | | |
| **Pre-Development Run-Off Rates (calculated from HR Wallingford Greenfield Runoff Rate Estimation Online Tool)** | | | | 01.12.20<br>Updated to suit increased contribution areas as above<br><br>05.01.21<br>Updated to suit reduced project subsation contribution areas as above<br><br>02.02.21<br>Amended design to store 1:100 YR + 40% exceedence within 1m design depth. |
| 2 l/s/ha | 19.30 l/s | | 13.48 l/s | |
| | **FEH** | | **FEH** | |
| 1 Year Return | 6.88 l/s | | 4.81 l/s | |
| **2 Year Return ($Q_{BAR}$)** | **7.91 l/s** | | **5.52 l/s** | |
| 30 Year Return | 19.38 l/s | | 13.53 l/s | |
| 100 Year Return | 28.15 l/s | | 19.66 l/s | |
| 200 Year Return | 33.30 l/s | | 23.25 l/s | |
| | | | | |
| **Unttenuated Flow Discharging to SUDS from Harstanding (calculated from FEH13 Rainfall using Micro Drainage design software)** | | | | 01.12.20<br>Updated to suit increased contribution areas as above<br><br>05.01.21<br>Updated to suit reduced project subsation contribution areas as above<br><br>02.02.21<br>Amended design to store 1:100 YR + 40% exceedence within 1m design depth. |
| | **FEH13** | | **FEH13** | |
| 1 Year Return + 40% CC | N/A | | N/A | |
| 2 Year Return + 40% CC | 68.0 l/s | | 79.2 l/s | |
| 30 Year Return + 40% CC | 173.0 l/s | | 204.8 l/s | |
| 100 Year Return + 40% CC | 285.5 l/s | | 310.2 l/s | |
| 200 Year Return + 40% CC | 362.3 l/s | | 389.5 l/s | |
| | | | | |
| **Attenuated Post Development Run-Off Rates** | **Limited to pre-development (2-year FEH) run-off rate. Provides betterment over 2 l/s/ha rate and IH124 rate.** | | | No change |
| | | | | |
| **Pre / Post Development Reduction In Run-Off Rates (pre development rates minus attenuated post development rates)** | | | | 01.12.20<br>Updated to suit increased contribution areas as above<br><br>05.01.21<br>Updated to suit reduced project subsation contribution areas as above<br><br>02.02.21<br>Amended design to store 1:100 YR + 40% exceedence within 1m design depth. |
| 1 Year Return | N/A | | N/A | |
| 2 Year Return | 60.09 l/s | | 73.68 l/s | |
| 30 Year Return | 165.09 l/s | | 199.28 l/s | |
| 100 Year Return | 277.59 l/s | | 304.68 l/s | |
| 200 Year Return | 354.39 l/s | | 383.6 l/s | |
| | | | | |
| **Design Storm Event** | **1 in 100 year + 40% climate change as per SCC guidance.** | | | 02.02.21<br>Updated to 1:100 year + 40% CC |
| | | | | |
| **Attenuation Storage Required (calculated from FEH13 Rainfall using Micro Drainage design software)** | | | | 01.12.20<br>Updated to suit increased contribution areas as above<br><br>05.01.21<br>Updated to suit reduced project subsation contribution areas as above<br><br>02.02.21<br>Amended design to store 1:100 YR + 40% exceedence within 1m design depth. |
| | **FEH13** | | **FEH13** | |
| All Hardstanding Areas | **11,593.4 $m^3$** | | **8,024.5 $m^3$** | |
| | | | | |
| **Attenuation Dimensions** | | | | 01.12.20<br>Added areas for perimeter access track. Access track falls towards top of basin providing an additional 0.1m depth of storage.<br><br>02.02.21<br>Amended design to store 1:100 YR + 40% exceedence within 1m design depth. |
| **Detention Basins** | | | | |
| Design Top area (1.0m Deep) | 15,861 $m^2$ | | 8,721 $m^2$ | |
| Freeboard Top area (1.3m Deep) | 16,421 $m^2$ | | 9,149 $m^2$ | |
| Perimeter access track top area (1.4m Deep) | 18,106 $m^2$ | | 10,449 $m^2$ | |
| Basin Top area (1.5m Deep) | 18,303 $m^2$ | | 10,602 $m^2$ | |
| Base area | 14,062 $m^2$ | | 7,360 $m^2$ | |
| Design storage depth | 1.0 m | | 1.0 m | |
| Design freeboard + 0.3m (1.3m Deep) | 0.3 m | | 0.3 m | |
| Overall depth | 1.5 m | | 1.5 m | |
| Side slopes | 1 in 4 | | 1 in 4 | |
| | | | | |
| **Attenuation Storage Provided** | | | | 01.12.20<br>Added additional storage volume from perimter access track. Access track falls towards top of basin providing an additional 0.1m depth of storage.<br><br>02.02.21<br>Amended design to store 1:100 YR + 40% exceedence within 1m design depth. |
| **Detention Basins** | | | | |
| Design | 14,961.5 $m^3$ | | 8,040.5 $m^3$ | |
| Freeboard | 4,842.3 $m^3$ | | 2,680.5 $m^3$ | |
| Perimeter access track | 1,726.35 $m^3$ | | 979.90 $m^3$ | |
| Additional storage between track and basin top | 1,820.45 $m^3$ | | 1,052.55 $m^3$ | |
| Total (design) | **14,961.5 $m^3$** | | **8,040.5 $m^3$** | |
| Total (inc. freeboard, access track etc) | 23,350.6 $m^3$ | | 12,753.45 $m^3$ | |
| **Design storage required < attenuation storage provided?** | **YES = OK** | | **YES = OK** | |
| | | | | |
| **Additional Design Requirements** | | | | 02.02.21<br>Added to show allowance for existing depression included in basin design. |
| Offset removal of depression adjacent EA1N substation by allowing additional storage in basin design depth. Additional storage required: | **3,300 $m^3$** | | N/A | |
| Surplus storage available within basin design depth (1.0m) | **3,368.1 $m^3$** | | N/A | |
| **Design storage required < attenuation storage provided?** | **YES = OK** | | N/A | |
| | | | | |
| **Discharge Location** | **Existing watercourse in Church Lane via new outfall pipe as per existing drainage regime. Provides additional betterment over existing arrangment by reducing flood flows down existing farm track.** | | **Existing ditch in field. Provides betterment over existing by attenuating flows from greater return period storms.** | **Design flows up to 1:100 year + 40% CC are attenuated within the basin design depth (1m).**<br><br>**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).** |
| | | | | |

# Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

| | |
|---|---|
| Calculated by: | Christopher Sneddon |
| Site name: | East Anglia EA1N / EA2 |
| Site location: | Project Substations FEH13 |

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: | 52.19357° N |
| Longitude: | 1.52746° E |
| Reference: | 829599236 |
| Date: | Feb 02 2021 10:25 |

**Runoff estimation approach**: FEH Statistical

## Site characteristics

| | |
|---|---|
| Total site area (ha): | 9.65 |

## Methodology

| | |
|---|---|
| $Q_{MED}$ estimation method: | Calculate from BFI and SAAR |
| BFI and SPR method: | Specify BFI manually |
| HOST class: | N/A |
| BFI / BFIHOST: | 0.729 |
| $Q_{MED}$ (l/s): | |
| $Q_{BAR}$ / $Q_{MED}$ factor: | 1.12 |

## Hydrological characteristics

| | Default | Edited |
|---|---|---|
| SAAR (mm): | 585 | 585 |
| Hydrological region: | 5 | 5 |
| Growth curve factor 1 year: | 0.87 | 0.87 |
| Growth curve factor 30 years: | 2.45 | 2.45 |
| Growth curve factor 100 years: | 3.56 | 3.56 |
| Growth curve factor 200 years: | 4.21 | 4.21 |

## 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): | | 7.91 |
| 1 in 1 year (l/s): | | 6.88 |
| 1 in 30 years (l/s): | | 19.38 |
| 1 in 100 year (l/s): | | 28.15 |
| 1 in 200 years (l/s): | | 33.3 |

# Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

| | |
|---|---|
| Calculated by: | Christopher Sneddon |
| Site name: | East Anglia EA1N / EA2 |
| Site location: | National Grid FEH13 |

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: | 52.19357° N |
| Longitude: | 1.52746° E |
| Reference: | 2369002495 |
| Date: | Feb 02 2021 12:08 |

**Runoff estimation approach** FEH Statistical

**Site characteristics**

Total site area (ha): 6.74

**Methodology**

| | |
|---|---|
| $Q_{MED}$ estimation method: | Calculate from BFI and SAAR |
| BFI and SPR method: | Specify BFI manually |
| HOST class: | N/A |
| BFI / BFIHOST: | 0.729 |
| $Q_{MED}$ (l/s): | |
| $Q_{BAR}$ / $Q_{MED}$ factor: | 1.12 |

**Hydrological characteristics**

| | Default | Edited |
|---|---|---|
| SAAR (mm): | 585 | 585 |
| Hydrological region: | 5 | 5 |
| Growth curve factor 1 year: | 0.87 | 0.87 |
| Growth curve factor 30 years: | 2.45 | 2.45 |
| Growth curve factor 100 years: | 3.56 | 3.56 |
| Growth curve factor 200 years: | 4.21 | 4.21 |

**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): | | 5.52 |
| 1 in 1 year (l/s): | | 4.81 |
| 1 in 30 years (l/s): | | 13.53 |
| 1 in 100 year (l/s): | | 19.66 |
| 1 in 200 years (l/s): | | 23.25 |

## 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 | 14.656 | 0.156 | 7.4 | 2207.9 | O K |
| 30 min Summer | 14.709 | 0.209 | 7.7 | 2979.7 | O K |
| 60 min Summer | 14.764 | 0.264 | 7.9 | 3779.5 | O K |
| 120 min Summer | 14.832 | 0.332 | 7.9 | 4772.5 | O K |
| 180 min Summer | 14.881 | 0.381 | 7.9 | 5478.1 | O K |
| 240 min Summer | 14.918 | 0.418 | 7.9 | 6037.5 | O K |
| 360 min Summer | 14.977 | 0.477 | 7.9 | 6904.4 | O K |
| 480 min Summer | 15.021 | 0.521 | 7.9 | 7561.3 | O K |
| 600 min Summer | 15.054 | 0.554 | 7.9 | 8067.1 | O K |
| 720 min Summer | 15.081 | 0.581 | 7.9 | 8468.9 | O K |
| 960 min Summer | 15.119 | 0.619 | 7.9 | 9049.5 | O K |
| 1440 min Summer | 15.164 | 0.664 | 7.9 | 9720.7 | O K |
| 2160 min Summer | 15.191 | 0.691 | 7.9 | 10139.6 | O K |
| 2880 min Summer | 15.200 | 0.700 | 7.9 | 10283.5 | O K |
| 4320 min Summer | 15.197 | 0.697 | 7.9 | 10236.3 | O K |
| 5760 min Summer | 15.186 | 0.686 | 7.9 | 10063.4 | O K |
| 7200 min Summer | 14.500 | 0.000 | 0.0 | 0.0 | O K |
| 8640 min Summer | 14.500 | 0.000 | 0.0 | 0.0 | O K |
| 10080 min Summer | 14.500 | 0.000 | 0.0 | 0.0 | O K |
| 15 min Winter | 14.674 | 0.174 | 7.5 | 2473.0 | O K |
| 30 min Winter | 14.734 | 0.234 | 7.8 | 3337.8 | O K |
| 60 min Winter | 14.796 | 0.296 | 7.9 | 4234.2 | O K |
| 120 min Winter | 14.872 | 0.372 | 7.9 | 5347.6 | O K |
| 180 min Winter | 14.925 | 0.425 | 7.9 | 6139.5 | O K |
| 240 min Winter | 14.968 | 0.468 | 7.9 | 6767.9 | O K |
| 360 min Winter | 15.033 | 0.533 | 7.9 | 7742.5 | O K |
| 480 min Winter | 15.082 | 0.582 | 7.9 | 8482.3 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 15 min Summer | 122.248 | 0.0 | 570.5 | 19 |
| 30 min Summer | 82.572 | 0.0 | 649.4 | 34 |
| 60 min Summer | 52.458 | 0.0 | 1325.0 | 64 |
| 120 min Summer | 33.215 | 0.0 | 1338.4 | 124 |
| 180 min Summer | 25.480 | 0.0 | 1327.0 | 184 |
| 240 min Summer | 21.109 | 0.0 | 1310.8 | 244 |
| 360 min Summer | 16.158 | 0.0 | 1277.5 | 364 |
| 480 min Summer | 13.321 | 0.0 | 1245.8 | 484 |
| 600 min Summer | 11.410 | 0.0 | 1215.4 | 604 |
| 720 min Summer | 10.016 | 0.0 | 1185.5 | 724 |
| 960 min Summer | 8.080 | 0.0 | 1128.9 | 964 |
| 1440 min Summer | 5.860 | 0.0 | 1035.1 | 1444 |
| 2160 min Summer | 4.154 | 0.0 | 2145.4 | 2164 |
| 2880 min Summer | 3.224 | 0.0 | 2064.3 | 2884 |
| 4320 min Summer | 2.228 | 0.0 | 1942.5 | 4324 |
| 5760 min Summer | 1.712 | 0.0 | 4249.0 | 5760 |
| 7200 min Summer | -0.012 | 0.0 | -101.3 | 0 |
| 8640 min Summer | -0.010 | 0.0 | -101.3 | 0 |
| 10080 min Summer | -0.008 | 0.0 | -101.3 | 0 |
| 15 min Winter | 122.248 | 0.0 | 618.5 | 19 |
| 30 min Winter | 82.572 | 0.0 | 660.7 | 34 |
| 60 min Winter | 52.458 | 0.0 | 1341.4 | 64 |
| 120 min Winter | 33.215 | 0.0 | 1339.4 | 124 |
| 180 min Winter | 25.480 | 0.0 | 1321.0 | 182 |
| 240 min Winter | 21.109 | 0.0 | 1300.9 | 242 |
| 360 min Winter | 16.158 | 0.0 | 1261.5 | 362 |
| 480 min Winter | 13.321 | 0.0 | 1220.1 | 482 |

## 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 |
|---|---|---|---|---|---|
| 600 min Winter | 15.120 | 0.620 | 7.9 | 9053.9 | O K |
| 720 min Winter | 15.150 | 0.650 | 7.9 | 9509.5 | O K |
| 960 min Winter | 15.193 | 0.693 | 7.9 | 10169.9 | O K |
| 1440 min Winter | 15.243 | 0.743 | 7.9 | 10931.8 | O K |
| 2160 min Winter | 15.274 | 0.774 | 7.9 | 11415.0 | O K |
| 2880 min Winter | 15.286 | 0.786 | 7.9 | 11593.4 | O K |
| 4320 min Winter | 15.285 | 0.785 | 7.9 | 11579.2 | O K |
| 5760 min Winter | 15.275 | 0.775 | 7.9 | 11430.3 | O K |
| 7200 min Winter | 14.500 | 0.000 | 0.0 | 0.0 | O K |
| 8640 min Winter | 14.500 | 0.000 | 0.0 | 0.0 | O K |
| 10080 min Winter | 14.500 | 0.000 | 0.0 | 0.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 600 min Winter | 11.410 | 0.0 | 1176.1 | 600 |
| 720 min Winter | 10.016 | 0.0 | 1130.5 | 720 |
| 960 min Winter | 8.080 | 0.0 | 1069.2 | 956 |
| 1440 min Winter | 5.860 | 0.0 | 1055.8 | 1428 |
| 2160 min Winter | 4.154 | 0.0 | 2181.7 | 2140 |
| 2880 min Winter | 3.223 | 0.0 | 2147.0 | 2852 |
| 4320 min Winter | 2.228 | 0.0 | 2041.2 | 4240 |
| 5760 min Winter | 1.712 | 0.0 | 4252.5 | 5648 |
| 7200 min Winter | -0.012 | 0.0 | -113.5 | 0 |
| 8640 min Winter | -0.010 | 0.0 | -113.5 | 0 |
| 10080 min Winter | -0.008 | 0.0 | -113.5 | 0 |

## 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 641300 260300 TM 41300 60300 | Shortest Storm (mins) | 15 |
| Data Type | Catchment | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +40 |

## Time Area Diagram

Total Area (ha) 9.650

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 9.650 |

## Model Details

Storage is Online Cover Level (m) 16.000

## Tank or Pond Structure

Invert Level (m) 14.500

| Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) |
|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 14062.0 | 1.000 | 15861.0 | 1.300 | 16421.0 | 1.400 | 18106.0 | 1.500 | 18303.0 |

## Hydro-Brake® Optimum Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0131-7900-1000-7900 |
| Design Head (m) | 1.000 |
| Design Flow (l/s) | 7.9 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Application | Surface |
| Sump Available | Yes |
| Diameter (mm) | 131 |
| Invert Level (m) | 14.500 |
| Minimum Outlet Pipe Diameter (mm) | 150 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) | Control Points | Head (m) | Flow (l/s) |
|---|---|---|---|---|---|
| Design Point (Calculated) | 1.000 | 7.9 | Kick-Flo® | 0.660 | 6.5 |
| Flush-Flo™ | 0.299 | 7.9 | Mean Flow over Head Range | - | 6.8 |

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 | 4.7 | 0.800 | 7.1 | 2.000 | 10.9 | 4.000 | 15.2 | 7.000 | 19.9 |
| 0.200 | 7.7 | 1.000 | 7.9 | 2.200 | 11.4 | 4.500 | 16.1 | 7.500 | 20.6 |
| 0.300 | 7.9 | 1.200 | 8.6 | 2.400 | 11.9 | 5.000 | 16.9 | 8.000 | 21.2 |
| 0.400 | 7.8 | 1.400 | 9.2 | 2.600 | 12.4 | 5.500 | 17.7 | 8.500 | 21.8 |
| 0.500 | 7.6 | 1.600 | 9.9 | 3.000 | 13.3 | 6.000 | 18.5 | 9.000 | 22.4 |
| 0.600 | 7.1 | 1.800 | 10.4 | 3.500 | 14.3 | 6.500 | 19.2 | 9.500 | 23.0 |

## 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 | 15.356 | 0.206 | 5.4 | 1541.5 | O K |
| 30 min Summer | 15.426 | 0.276 | 5.5 | 2080.4 | O K |
| 60 min Summer | 15.498 | 0.348 | 5.5 | 2638.6 | O K |
| 120 min Summer | 15.586 | 0.436 | 5.5 | 3331.1 | O K |
| 180 min Summer | 15.647 | 0.497 | 5.5 | 3823.1 | O K |
| 240 min Summer | 15.696 | 0.546 | 5.5 | 4213.2 | O K |
| 360 min Summer | 15.770 | 0.620 | 5.5 | 4818.6 | O K |
| 480 min Summer | 15.826 | 0.676 | 5.5 | 5278.3 | O K |
| 600 min Summer | 15.868 | 0.718 | 5.5 | 5630.9 | O K |
| 720 min Summer | 15.902 | 0.752 | 5.5 | 5909.3 | O K |
| 960 min Summer | 15.949 | 0.799 | 5.5 | 6308.5 | O K |
| 1440 min Summer | 16.003 | 0.853 | 5.5 | 6760.3 | O K |
| 2160 min Summer | 16.034 | 0.884 | 5.5 | 7028.8 | O K |
| 2880 min Summer | 16.043 | 0.893 | 5.5 | 7108.4 | O K |
| 4320 min Summer | 16.035 | 0.885 | 5.5 | 7039.1 | O K |
| 5760 min Summer | 16.017 | 0.867 | 5.5 | 6887.7 | O K |
| 7200 min Summer | 15.150 | 0.000 | 0.0 | 0.0 | O K |
| 8640 min Summer | 15.150 | 0.000 | 0.0 | 0.0 | O K |
| 10080 min Summer | 15.150 | 0.000 | 0.0 | 0.0 | O K |
| 15 min Winter | 15.380 | 0.230 | 5.4 | 1726.8 | O K |
| 30 min Winter | 15.458 | 0.308 | 5.5 | 2330.5 | O K |
| 60 min Winter | 15.538 | 0.388 | 5.5 | 2956.2 | O K |
| 120 min Winter | 15.636 | 0.486 | 5.5 | 3733.1 | O K |
| 180 min Winter | 15.705 | 0.555 | 5.5 | 4285.7 | O K |
| 240 min Winter | 15.759 | 0.609 | 5.5 | 4724.6 | O K |
| 360 min Winter | 15.841 | 0.691 | 5.5 | 5406.2 | O K |
| 480 min Winter | 15.903 | 0.753 | 5.5 | 5921.3 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 15 min Summer | 122.248 | 0.0 | 451.4 | 19 |
| 30 min Summer | 82.572 | 0.0 | 468.2 | 34 |
| 60 min Summer | 52.458 | 0.0 | 941.7 | 64 |
| 120 min Summer | 33.215 | 0.0 | 928.6 | 124 |
| 180 min Summer | 25.480 | 0.0 | 908.6 | 184 |
| 240 min Summer | 21.109 | 0.0 | 886.6 | 244 |
| 360 min Summer | 16.158 | 0.0 | 831.7 | 364 |
| 480 min Summer | 13.321 | 0.0 | 775.6 | 484 |
| 600 min Summer | 11.410 | 0.0 | 767.8 | 604 |
| 720 min Summer | 10.016 | 0.0 | 777.8 | 724 |
| 960 min Summer | 8.080 | 0.0 | 787.4 | 964 |
| 1440 min Summer | 5.860 | 0.0 | 784.3 | 1444 |
| 2160 min Summer | 4.154 | 0.0 | 1617.8 | 2164 |
| 2880 min Summer | 3.224 | 0.0 | 1592.7 | 2884 |
| 4320 min Summer | 2.228 | 0.0 | 1513.7 | 4320 |
| 5760 min Summer | 1.712 | 0.0 | 3104.0 | 5760 |
| 7200 min Summer | -0.012 | 0.0 | -70.8 | 0 |
| 8640 min Summer | -0.010 | 0.0 | -70.8 | 0 |
| 10080 min Summer | -0.008 | 0.0 | -70.8 | 0 |
| 15 min Winter | 122.248 | 0.0 | 460.4 | 19 |
| 30 min Winter | 82.572 | 0.0 | 471.1 | 34 |
| 60 min Winter | 52.458 | 0.0 | 941.7 | 64 |
| 120 min Winter | 33.215 | 0.0 | 918.4 | 124 |
| 180 min Winter | 25.480 | 0.0 | 889.2 | 182 |
| 240 min Winter | 21.109 | 0.0 | 852.0 | 242 |
| 360 min Winter | 16.158 | 0.0 | 779.2 | 362 |
| 480 min Winter | 13.321 | 0.0 | 790.8 | 482 |

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 |
|---|---|---|---|---|---|
| 600 min Winter | 15.950 | 0.800 | 5.5 | 6317.4 | O K |
| 720 min Winter | 15.987 | 0.837 | 5.5 | 6631.2 | O K |
| 960 min Winter | 16.040 | 0.890 | 5.5 | 7083.0 | O K |
| 1440 min Winter | 16.100 | 0.950 | 5.5 | 7599.9 | O K |
| 2160 min Winter | 16.137 | 0.987 | 5.5 | 7917.0 | O K |
| 2880 min Winter | 16.149 | 0.999 | 5.5 | 8022.2 | O K |
| 4320 min Winter | 16.144 | 0.994 | 5.5 | 7977.2 | O K |
| 5760 min Winter | 16.128 | 0.978 | 5.5 | 7839.9 | O K |
| 7200 min Winter | 15.150 | 0.000 | 0.0 | 0.0 | O K |
| 8640 min Winter | 15.150 | 0.000 | 0.0 | 0.0 | O K |
| 10080 min Winter | 15.150 | 0.000 | 0.0 | 0.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 600 min Winter | 11.410 | 0.0 | 807.2 | 600 |
| 720 min Winter | 10.016 | 0.0 | 817.9 | 720 |
| 960 min Winter | 8.080 | 0.0 | 827.6 | 954 |
| 1440 min Winter | 5.860 | 0.0 | 823.1 | 1428 |
| 2160 min Winter | 4.154 | 0.0 | 1701.0 | 2140 |
| 2880 min Winter | 3.223 | 0.0 | 1673.0 | 2852 |
| 4320 min Winter | 2.228 | 0.0 | 1587.5 | 4236 |
| 5760 min Winter | 1.712 | 0.0 | 3274.2 | 5640 |
| 7200 min Winter | -0.012 | 0.0 | -79.3 | 0 |
| 8640 min Winter | -0.010 | 0.0 | -79.3 | 0 |
| 10080 min Winter | -0.008 | 0.0 | -79.3 | 0 |

## 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 641300 260300 TM 41300 60300 | Shortest Storm (mins) | 15 |
| Data Type | Catchment | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +40 |

## Time Area Diagram

Total Area (ha) 6.740

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 6.740 |

## Model Details

Storage is Online Cover Level (m) 16.650

## Tank or Pond Structure

Invert Level (m) 15.150

| Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) |
|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 7360.0 | 1.000 | 8721.0 | 1.300 | 9149.0 | 1.400 | 10449.0 | 1.500 | 10602.0 |

## Hydro-Brake® Optimum Outflow Control

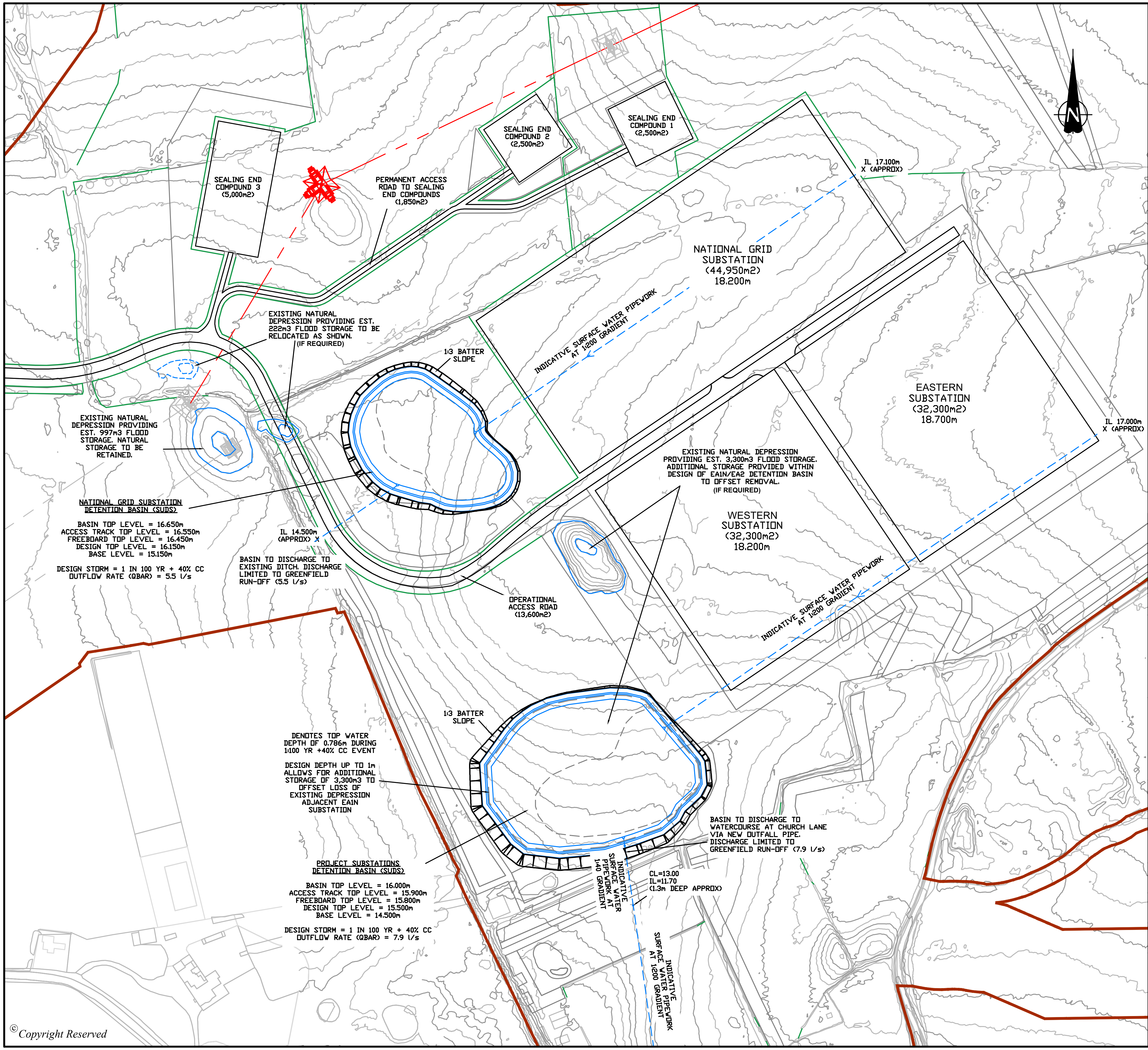
| | |
|---|---|
| Unit Reference | MD-SHE-0111-5520-1000-5520 |
| Design Head (m) | 1.000 |
| Design Flow (l/s) | 5.5 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Application | Surface |
| Sump Available | Yes |
| Diameter (mm) | 111 |
| Invert Level (m) | 15.150 |
| Minimum Outlet Pipe Diameter (mm) | 150 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) | Control Points | Head (m) | Flow (l/s) |
|---|---|---|---|---|---|
| Design Point (Calculated) | 1.000 | 5.5 | Kick-Flo® | 0.644 | 4.5 |
| Flush-Flo™ | 0.298 | 5.5 | Mean Flow over Head Range | - | 4.8 |

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 | 3.8 | 0.800 | 5.0 | 2.000 | 7.6 | 4.000 | 10.5 | 7.000 | 13.8 |
| 0.200 | 5.4 | 1.000 | 5.5 | 2.200 | 7.9 | 4.500 | 11.2 | 7.500 | 14.2 |
| 0.300 | 5.5 | 1.200 | 6.0 | 2.400 | 8.3 | 5.000 | 11.7 | 8.000 | 14.7 |
| 0.400 | 5.4 | 1.400 | 6.4 | 2.600 | 8.6 | 5.500 | 12.3 | 8.500 | 15.1 |
| 0.500 | 5.2 | 1.600 | 6.8 | 3.000 | 9.2 | 6.000 | 12.8 | 9.000 | 15.5 |
| 0.600 | 4.8 | 1.800 | 7.2 | 3.500 | 9.9 | 6.500 | 13.3 | 9.500 | 15.9 |

# Appendix 8: Indicative Attenuation Only Scheme Figures




DO NOT SCALE FROM THIS DRAWING

NOTES:

DETENTION BASINS ARE SHOWN INDICATIVELY FOR ILLUSTRATION PURPOSES ONLY. DETAILED DESIGN OF BASINS WOULD BE REQUIRED TO CONFIRM EXACT ELEVATIONS, SHAPES AND LOCATIONS AS APPROPRIATE AND AS PART OF THE MASTERPLANNING PROCESS.

DENOTES DCO ORDER LIMITS

DENOTES INDICATIVE SURFACE WATER PIPEWORK

DENOTES INDICATIVE SUDS FEATURE (SEE ANNOTATION)

| REVISION | DETAILS | DATE | DRN | CHK'D | APP'D |
|---|---|---|---|---|---|
| B | UPDATED TO SUIT RHDHV COMMENTS | 10.02.21 | CS | CS | SH |
| A | FIRST ISSUE | 29.01.21 | CS | CS | SH |

CLIENT
Haskoning DHV UK Limited

PROJECT
EAST ANGLIA OFFSHORE WIND
EA1N & EA2

SKETCH

DRAWING TITLE
DETENTION BASIN
1 IN 100 YR + 40% CC DESIGN

| DRG No. ED11892-C-SK11 | | REV B |
|---|---|---|
| DRG SIZE A3 | SCALE NTS | DATE JAN'21 |
| DRAWN BY CS | CHECKED BY CS | APPROVED BY SH |

wardell armstrong

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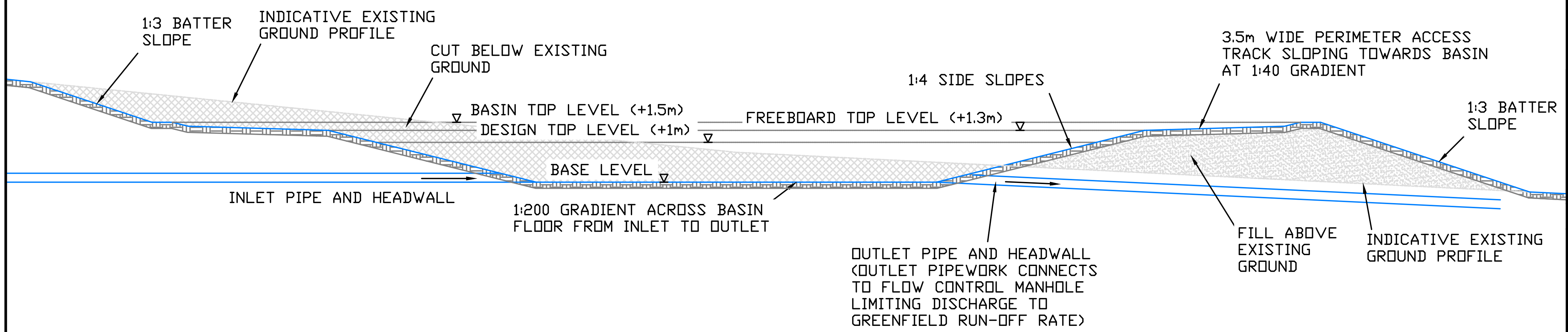
N:\ED\ED11892 - EAST ANGLIA OFFSHORE WIND EA 1\03 - DESIGN\AUTOCAD\ED11892-C-SK11-B SK12-A - DETENTION BASINS.DWG




## TYPICAL DETENTION BASIN CROSS SECTION

DO NOT SCALE FROM THIS DRAWING

NOTES:

DETENTION BASINS ARE SHOWN INDICATIVELY FOR ILLUSTRATION PURPOSES ONLY. DETAILED DESIGN OF BASINS WOULD BE REQUIRED TO CONFIRM EXACT ELEVATIONS, SHAPES AND LOCATIONS AS APPROPRIATE AND AS PART OF THE MASTERPLANNING PROCESS.

| REVISION | DETAILS | DATE | DR'N | CHK'D | APP'D |
|---|---|---|---|---|---|
| B | UPDATED TO SHOW INDICATIVE EXISTING GROUND PROFILE AND BATTER SLOPES. | 24.02.21 | CS | CS | SH |
| A | FIRST ISSUE | 10.02.21 | CS | CS | SH |

CLIENT
Haskoning DHV UK Limited

PROJECT
EAST ANGLIA OFFSHORE WIND
EA1N & EA2

SKETCH

DRAWING TITLE
DETENTION BASIN
1 IN 100 YR + 40% CC DESIGN
TYPICAL BASIN CROSS SECTION

| DRG No. | REV |
|---|---|
| ED11892-C-SK12 | B |

| DRG SIZE | SCALE | DATE |
|---|---|---|
| A3 | NTS | FEB'21 |

| DRAWN BY | CHECKED BY | APPROVED BY |
|---|---|---|
| CS | CS | SH |

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