UK Onshore Scheme

Proposed Converter Station

Outline Drainage Strategy

VKL-08-39-G500-015

August 2017

Contents

List of Tables

Appendices

Glossary & Abbreviations

Glossary of Terms	
Term	**Meaning**
Viking Link	Also referred to as the Project (from Revsing to Bicker Fen)
UK Onshore Scheme	Also referred to as the Scheme (from MLWS to Connection Point)
Bicker Fen Substation	Also referred to as the connection point
Temporary construction area	Working area (AC and DC cable) in addition to working width
Temporary construction compound	Compound for site offices, storage, welfare facilities etc.
Converter station	Specialist facility to convert electricity AC to DC or vice versa
Proposed converter station site	The complete site including temporary working areas. (approx. 28 ha)
Proposed converter station zone	The proposed zone containing the converter station, buildings and outdoor electrical equipment and associated hardstandings within a security fence
Proposed permanent access road	The permanent access to the converter station from the A52
Proposed AC cable route	Also referred to as the AC route (from converter station to Bicker Fen)
Proposed AC cable working width	Typical 60m wide works corridor in which AC cable installation will occur
Junction box	Kiosk-like infrastructure marking joint between adjacent AC cable sections
Rochdale Envelope	The maximum parameters in which the converter station will be designed.
Limits of Deviation	The maximum corridor in which DC and AC cables will be installed
Base Scheme design	The base design of the UK Onshore Scheme (combines the RE and LoD)
The Contractor	Party or parties responsible for the detailed design and construction

List of Abbreviation	
Abbreviation	**Meaning**
AC	Alternating Current
BGS	British Geological Survey
CFMP	Catchment Flood Management Plan
CIRIA	Construction Industry Research and Information Association
DC	Direct Current

List of Abbreviation	
Abbreviation	**Meaning**
DK	Danish Onshore Scheme
DTM	Digital Terrain Model
EA	Environment Agency
FRA	Flood Risk Assessment
HA (ha)	Hectare
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IDB	Internal Drainage Board
LA	Local Authority
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
l.s-1	Litres per Second (unit volume over time)
l.s-1.ha-1	Litres per Second per Hectare (unit volume, time and area)
m AOD	Metres Above Ordnance Datum (unit height)
mg.l-1	Milligrams per Litre (unit concentration)
MLWS	Mean Low Water Springs
MW	Megawatt
NGVL	National Grid Viking Link
NPPF	National Planning Policy Framework
PPG	Planning Practice Guidance
SAAR	Standard Average Annual Rainfall
SFRA	Strategic Flood Risk Assessment
SHDC	South Holland District Council
SPZ	Source Protection Zone
SuDS	Sustainable Drainage Systems
WFD	Water Framework Directive
ZoI	Zone of Influence

1 Introduction

1.1 Introduction

1.1.1 This Surface Water Drainage Strategy has been prepared by RPS on behalf of National Grid as part of the planning application for the UK Onshore Scheme. The Drainage Strategy is focused on the proposed converter station which is to be located on agricultural land located off North Ing Drove, South Holland. The location and extent of the proposed development boundary is illustrated in Appendix A.

1.2 Scope of this Report

1.2.1 In terms of scope, the focus of this report is to outline a strategy for the disposal of surface water from the site once developed for its intended purposes.

1.2.2 Existing baseline conditions, including the existing drainage arrangements and ground conditions are reviewed along with national and local drainage policies and guidance. This report is not intended to provide a formal surface water drainage detailed design, but to provide information to demonstrate that the proposals can be provided with an acceptable means of surface water disposal.

1.2.3 The level and type of flood risk within the site has been examined within a site-specific Flood Risk Assessment (FRA) undertaken by RPS (Ref VKL-08-39-G500-010). The FRA is also to be included within the pre-application submission documents.

2 Sources of Information

2.1 Introduction

2.1.1 Table 1 below lists the information sources consulted during preparation of this report. The assessment has been undertaken in accordance to the guidance detailed within the National Planning Policy Framework (NPPF) and the accompanying Planning Practice Guidance (PPG). This Drainage Strategy has been prepared with reference to documents and information sources provided and / or published by the following bodies:

Table 1 Information sources consulted during preparation of the report.

Data	Source	Notes
Site setting and hydrology.	OS Mapping 1: 50 000 Sheet 130: Grantham. (Ref: 21.1).	Area information, rivers and other watercourses, general environs, built environment, catchment information.
Geology.	British Geological Society (BGS) (online) Geology of Britain Viewer. (Ref: 21.2) Available at: http://mapapps.bgs.ac.uk/geologyofbritain/home.html.	Area geology.
Hydrological setting.	Environment Agency (EA) data holdings, customer service, engagement team and online mapping. (Ref: 21.3).	Current flood risk, local flood defences, flood levels, supplementary geology and groundwater information.
	Local Planning Authority (LPA) - South Holland District Council (SHDC).	Flood Zoning Local development framework.
Water Utility Assets.	Anglian Water.	Water and sewerage assets in the vicinity of the proposed converter station site.
Planning documentation.	NPPF (Ref: 21.4). PPG (Ref: 21.5). Construction Industry Research and Information Association (CIRIA).	Flood zoning for the proposed converter station site.

Table 1 Information sources consulted during preparation of the report.		
Data	**Source**	**Notes**
	SHDC Local Plan, 2006. (Ref: 21.6).	Planning polices relevant to hydrology, flood risk and drainage.

3 Planning Policy, Legislation and Guidance

3.1 Key National Planning Policy

National Planning Policy Framework, March 2012

3.1.1 The NPPF sets out Government planning policies for England and how these are expected to be applied. The framework acts as guidance for local planning authorities and decision-takers, both in drawing up plans and making decisions about planning applications.

3.1.2 Paragraphs 99-104 set out the need for an appropriate assessment of flood risk. Guidance on the minimum requirements for such as assessment is contained in PPG ID7.

3.2 Key Local Planning Policy

South Holland Local Plan 2006

3.2.1 The SHDC Local Plan sets out the planning policies which will guide and control new development in the District until 2021.

3.2.2 Following the direction by the Secretary of State, as of 18th July 2009, the policy regarding Development and Flood Risk is no longer valid.

3.2.3 The policies relevant to Sustainable Urban Drainage Systems (SuDS) and pollution and contamination have been outlined below.

Policy SG11: Sustainable Urban Drainage System

3.2.4 Development generating surface water run-off, likely to result in increased flood risk, will be permitted provided that:

- *The development's surface water management system accords with sustainable development principles and has been designed as part of the development layout; and*
- *The system will effectively control and adequately mitigate or attenuate any adverse effects from surface water run-off on people, habitats of acknowledged importance and property; and*
- *Developers can ensure long term maintenance of the drainage systems, where necessary through planning obligations.*

3.2.5 Where this is not possible the developer will be required to implement an alternative method of surface water disposal that is to the Council's satisfaction.

Policy SG13: Pollution and Contamination

3.2.6 Planning permission will only be permitted for development proposals which:

- *do not cause unacceptable levels of pollution of the surrounding area by noise, light, toxic or offensive odour, airborne pollutants or by the release of waste products;*
- *provide, as necessary, appropriate treatment of land to clean up pollution and contamination.*

South East Lincolnshire Local Plan 2006

3.2.7 A new local plan is currently being produced jointly between SHDC, Boston Borough Council and Lincolnshire Country Council. The Draft Plan sets out the vision, strategic priorities and policies for the future development of South East Lincolnshire. It also identifies site options for housing and employment to deliver the growth planned for the Plan Area to 2036.

3.2.8 The plan is currently in the publication (Pre-Submission) Consultation phase of development, seeking the views of local residents, key stakeholders and other interested parties as to whether they consider the Plan meets all obligations.

Black Sluice IDB Land Drainage Byelaws and Developer Guidance (Ref: 21.7)

3.2.9 The BSIDB powers and authority outlined by section 34 of the Land Drainage Act 1976 proposed a number of Byelaws for securing the efficient working of drainage systems in their district. As of the 6th April 2015, the Board acts as a sub-consultee to the Lead Local Flood Authority (Lincolnshire County Council) for all matters regarding flood risk and surface water discharge. An outline of the Byelaws relevant to the proposed converter station and permanent access road in relation to water resources and hydrology are as follows:

- *Byelaw 3: Control of Introduction of Water and Increase in Flow or Volume of Water*
- *Byelaw 6: Diversion or Stopping Up of Watercourses*
- *Byelaw 7: Detrimental Substances Not to be put into Watercourses*
- *Byelaw 10: No Obstructions within 9 Metres of the Edge of the Watercourse*

Guidance for Property Owners & Developers

3.2.10 The BSIDB considers a number of factors when appraising proposed properties or developments. The factors relevant to flood risk and hydrology on the proposed converter station site are presented below:

Section 1: Rainfall Run-off and Development Contributions

3.2.11 The Board's consent is required to increase the rate of rainfall run-off from a property or development. Where possible, sustainable methods of disposal (SuDS) should be used which do not adversely affect existing surface water management, nor adversely expose people or property to an increased risk of flooding.

3.2.12 A development contribution shall be payable to the Board for any discharge from the site above the Greenfield rate. For regulated or attenuated flow, BSIDB present the Green field rate as follows:

- Green field rate: 1.4 litres per second per Hectare.

Section 3: Discharge Outfalls

3.2.13 The Board's consent is required before any structure is placed in a Board watercourse. All outfalls shall have a suitable headwall to protect the banks from erosion. No part of the headwall unit shall protrude beyond the profile of the bank in order that flails and weed cutting machinery is not obstructed. Suitable scour protection shall be placed below and/or in front of the headwall if necessary.

Section 4 - Access to Watercourses and Byelaws

3.2.14 No obstructions shall be placed within 9m of the edge of a Board watercourse. Access to and maintenance of all other watercourses or piped systems (not vested with any authority) is the responsibility of the riparian owners (i.e. the land or property owners on either bank).

3.2.15 Developers should take into account the future maintenance of riparian or private watercourses and piped systems when designing the site layout; access may be required for weed cutting excavators or for jetting equipment for piped systems.

3.2.16 Developers shall inform purchasers of the presence of a Board Watercourse and/or their responsibilities relating to a riparian watercourse.

Section 7 – Site Ground Levels

3.2.17 The Board recommends that the ground level of the site should not be raised above the level of neighbouring land unless it can be shown that it will not:

- Obstruct overland surface water flow from neighbouring land;
- Cause surface water to flow overland off the site onto neighbouring land; and
- Raise the sub-surface water table causing water logging of neighbouring land.

3.2.18 In general if ground levels are raised above surrounding land then interceptor infiltration drains (French Drains) will need to be installed around the site boundary.

3.3 Key Legislation

Flood and Water Management Act

3.3.1 The Flood and Water Management Act 2010 (Ref: 21.8) placed new duties on upper tier Councils, by designating them as Lead Local Flood Authorities (LLFAs) for the coordination of local flood risk management in their respective administrative areas.

3.3.2 From April 6 2015, the responsibility for drainage and surface water management design approval resides with the local planning authority and the design of the drainage and surface water management should be submitted as part of the planning process.

3.3.3 Local planning authorities have responsibility for the approval of proposed drainage systems in new developments and redevelopments. Approval must be given before any developer can commence construction. In order to be approved, the proposed drainage system has to meet national standards for sustainable drainage.

3.3.4 The national standards set out the criteria by which the form of drainage appropriate to any particular site or development can be determined, as well as requirements for the design, construction, operation and maintenance of SuDS.

3.3.5 Additional guidance for the use of SuDS is provided via CIRIA and BRE in the following:

- C753 – The SuDS Manual, 2015 (Ref: 21.9);
- C522 Sustainable Drainage Systems- Design Manual for England and Wales (Ref: 21.10);
- C523 Sustainable Drainage Systems- Best practice (Ref: 21.11);
- C156 Infiltration Drainage – Manual of Good practice (Ref: 21.12); and
- BRE365 Soakaway design (Ref: 21.13).

3.4 Key Guidance

Planning Practice Guidance, online

3.4.1 PPG ID7 Flood Risk and Coastal Change provides guidance to ensure the effective implementation of the NPPF planning policy for development in areas at risk of flooding.

3.4.2 PPG ID7 states that for major developments, as defined in the Town and Country Planning (Development Management Procedure, England) Order 2015 (updated April 2015), SuDS should be provided unless demonstrated to be inappropriate.

3.4.3 The PPG (paragraph 51) recommends that priority should be given to the use of sustainable drainage systems as they are designed to control surface water runoff where it falls and to mimic natural drainage as closely as possible. SuDS also provide opportunities for the following:

- Reduce the causes and impacts of flooding;
- Remove pollutants from urban runoff at source; and
- Combine water management with green space with benefits for amenity, recreation and wildlife.

3.4.4 Approved Document H of the Building Regulations and the PPG (paragraph 80) agree on the hierarchy of surface water drainage disposal and is set out as below:

1 Into the ground (infiltration);
2 To surface water body;
3 To a surface water sewer, highway drain or another drainage system; and
4 To a combined sewer.

3.4.5 SuDS can be incorporated into any development, but the choice of system used is dependent upon ground conditions and on the availability of suitable areas within a development layout.

3.4.6 Infiltration based techniques are high up in the hierarchy of techniques available due to the ability for close to source dispersion of surface water. This technique is considered the closest solution to mimic the natural drainage of undeveloped sites.

3.4.7 SuDS encompass a wide range of drainage techniques intended to minimise the rate of discharge, volume and environmental impact of runoff and include:

- Permeable pavements;
- Swales and basins;
- Green roofs and rainwater reuse;
- Infiltration trenches and filter drains; and
- Ponds and wetlands.

3.4.8 Sustainable infiltration techniques include the use of permeable paving, gravel filled trench soakaways, concrete ring soakaways, infiltration trenches, infiltration blankets and swales. When used across a site these techniques control the rate of discharge, attenuate flow, provide storage and recharge groundwater. Storage capacity within infiltration and attenuation schemes can be increased with the use of cellular storage crates.

3.4.9 As well as allowing infiltration and attenuation, permeable paving also degrades pollutants such as hydrocarbons, which thereby improves the quality of surface water to ground.

Sustainable Drainage Systems Non-Technical Standard for SuDS (March 2015), DEFRA

3.4.10 The sustainable Drainage Systems Non-Technical Standard for SuDS (Ref: 21.14) document sets out non-statutory technical standards for SuDS and should be used in conjunction with the NPPF and PPG. The standards state the following with regards to peak flow and volume control for greenfield sites:

> ***"S2: For greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should never exceed the peak greenfield runoff rate for the same event; and***
>
> ***S4: Where reasonably practicable, for greenfield development, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event should never exceed the greenfield runoff volume for the same event."***

Climate Change

3.4.11 The NPPF and supporting PPG ID7 requires applicant to demonstrate how surface water run-off will be managed now and over the development's lifetime, taking climate change into account.

3.4.12 In February 2016, the EA updated advice on climate change allowances (Ref: 21.15/21.16) to support the NPPF. New guidance requires that surface water run-off assessments take due consideration of both the central and upper end allowances climate change allowances for peak rainfall intensity (Table 2) to understand the potential range of impacts.

Table 2 Peak rainfall intensity allowance in small and urban catchments (use 1961 to 1990 baseline)

Applies across all of England	Total potential change anticipated for 2010 to 2039	Total potential change anticipated for 2040 to 2059	Total potential change anticipated for 2060 to 2115
Upper End	10%	20%	40%
Central	5%	10%	20%

4 Site Setting & Existing Development

4.1 Site Location

4.1.1 The proposed converter station site comprises an irregular shaped parcel of agricultural land situated between North Ing Drove road and Middle Fen Drove road, centred on NG 518705, 337377, c.2 km west of Northorpe Village centre, Lincolnshire. The site location plan is included in Appendix A for reference.

4.2 Hydrological Catchment

4.2.1 The proposed converter station site is situated within the South Holland District which covers approximately 750 km^2, encapsulating the South Forty Foot Drain which is fed by a complex network of ordinary watercourses, drainage ditches and channels.

4.2.2 The area surrounding the proposed converter station is rural where much of the land is drained for agriculture. The South Forty Foot Drain flows in a general northerly direction towards Boston and discharges into the Haven via London Road pumping station.

4.3 Existing Development

4.3.1 The proposed converter station site covers 30.00 hectares (ha) and is currently used for agricultural purposes with enclosed fields separated by hedging. The proposed converter station site is defined by North Ing Drive road to the south, Middle Fen Drove road to the north and field drainage to the east and west. The proposed converter station site is open with a gentle slope from north to south, with a number of agricultural buildings located on the southern boundary.

5 Proposed Development

5.1 Overview

5.1.1 The surface water drainage assessment presents drainage arrangements for the proposed converter station in order to reduce any potential impact of the base scheme design on the surrounding receptors. For the purposes of the application for planning permission a base scheme has been established with which the Contractor's detailed design will comply. The base design establishes parameters including details of the maximum size and layout and appearance of the proposed converter station. This approach strikes a balance, ensuring sufficient information to inform the drainage strategy based on a realistic worst case whilst also providing some flexibility to the Contractor in finalising the detailed design of the proposed converter station.

5.1.2 A detailed description of the proposed converter station is contained in chapter 17 of the ES. The proposed converter station zone layout plan can be found in Drawing 4. It is located within a 30 ha site and comprises a number of distinct zones based on design parameters. The zones include:

- Building and outdoor electrical equipment zone: This comprises two areas which have been defined based on the maximum heights of the building(s) and/or outdoor electrical equipment which could be constructed within them.
    - Sub-zone A to the north of the converter station zone containing buildings up to 16 m tall and/or outdoor electrical equipment up to 24m tall. This would include components such as the transformers and AC switchyard.
    - Sub-zone B to the south of the converter station zone containing buildings and/or outdoor electrical equipment up to 24 m tall. This would include components such as the DC switch hall, valve halls and AC reactor.
- Perimeter road zone: This comprises a permanent perimeter road which would form a continuous circuit around the converter station to facilitate access. It has been defined taking into account the largest vehicles which will require access to the site as well as appropriate clearances.
- Security zone: This comprises an 8 m wide 'buffer' zone within which security fencing would be erected. This provides clearance between the perimeter road and landscape zones. It would include security fencing up to 3.5 m tall and incorporate security gates for pedestrian and vehicle access/egress to/from the site. CCTV cameras will also be installed at regular intervals.
- Additional hardstanding zone: This comprises an area for permanent car parking for up to twenty vehicles as well as an area of hardstanding to provide a permanent laydown area for the storage of equipment and plant as well as providing an area to be used for siting of temporary offices and welfare facilities in the event of future maintenance activities. Part of the hardstanding will be within the security zone and the remainder will be situated outside of the security fence.

- Reinstated zone: This comprises all areas within the site which are not required for permanent development. The reinstated zone lies to the east of the converter station and could potentially be returned to agricultural use. The reinstated areas to the north and south of the converter station would be seeded but would not be returned to agricultural use.
- Attenuation zone: This comprises an area of the site which would be used to establish an attenuation pond as part of the permanent drainage scheme. The pond(s) have been sized based on estimated runoff rates from the developed areas to establish the maximum area required.
- Landscape planting zone: This comprises a variable 30-40 m wide 'buffer' zone which follows the perimeter of the converter station site. Within this zone a combination of earthworks and landscape planting will provide permanent landscape screening.

5.1.3 The base scheme design for the proposed converter station zone has been developed in order to provide sufficient information upon which a realistic worst case scenario can be assessed. Table 3 sets out the engineering assumptions which have informed the strategy.

Table 3 Proposed Converter Station engineering design assumptions

Flood Zone	Flood Zone Definition
Proposed converter station footprint.	Approximately 4.8 ha.
Additional Hardstanding.	Approximately 1.4 ha.
2 Poles each including 3 transformers (plus one spare transformer)	15 m x 15m. Total area 1,575 m^2.
Routine maintenance of the proposed converter station.	May involve the use of oils, greases and other substances with associated potential for accidental spillages. Oils / chemical spills to ground are worst case condition.
Construction.	Undertaken over a 2-3 year programme steered to observe seasonal restrictions where practicable and avoid soil handling activities in winter months.
Ground Profiling.	Establish 2.90 m AOD converter station zone platform level.
Operation.	Potential risk of oil spillage.
Decommissioning (Proposed converter station).	May include the dismantling and removal of all components for recycling or disposal.

6 Baseline Conditions

6.1 Hydrological Overview

6.1.1 The closest watercourses to the proposed converter station are the Mill Drain located along the northern boundary of the site and North Ing Drive Drain, which originates along the northern boundary then arcs along the western boundary connecting with Mill Drain in the northwest corner of the proposed site. These drains are managed by the Black Sluice Internal Drainage Board (IDB).

6.1.2 The closest EA designated Main River to the proposed converter station is the South Forty Foot Drain which flows northwards in an open embanked channel approximately 820 m to the west of the proposed converter station.

6.2 Flood Risk

6.2.1 The EA undefended flood mapping for Planners (Figure 1) indicates that the central and southern areas of the proposed converter station are situated within undefended Flood Zone 2 and 3, defined as at medium to high risk of fluvial/tidal flooding. The north, east and western extents are shown to be located in Flood Zone 1 indicative of a low risk of tidal/fluvial flooding.

6.2.2 The FRA (Ref VKL-08-39-G500-010) confirms the proposed converter station site is at low risk of flooding from all sources.

6.3 Geology

6.3.1 Geological maps published by the British Geological Survey (BGS 1:50,000) indicate the proposed converter station is underlain by superficial Barrow Drove Beds (Soft to firm, dark brown or orange-brown, mottled grey, sandy clay with loose and very loose orange-brown, medium sand) and Till (Boulder Clay). The bedrock underlying the superficial deposits is composed of the Oxford Clay Formation which comprises silicate-mudstone, grey, generally smooth to slightly silty, with sporadic beds of argillaceous limestone nodules.

6.3.2 Groundwater monitoring undertaken by AECOM (October 2016) during the preliminary ground investigation on the proposed converter station site within the three boreholes (BH 01, BH02, BH03) indicates that the depth to groundwater ranged between 0.58 metres below ground level (m bgl) and 2.53 mbgl within the Barroway Drove Beds.

6.3.3 The investigations observed no evidence of contamination within the subsoils, nor significant contamination levels within the groundwater beneath the proposed converter station site.

6.3.4 No infiltration / soakaway testing was undertaken as part of the investigations. Table 25.1 of the SuDS manual, CIRIA (C753) shows that soils consisting of mudstone, clay and silt are a poor infiltration media with a typical infiltration coefficient of 1.0 x 10-8 m/s. The minimum infiltration rate

value deemed acceptable within the manual is 1.0 x 10-6 m/s. It is reasonable to consider that the sub soils across the site will have limited infiltration potential.

6.4 Hydrogeology

6.4.1 The EA provides publically available mapping which indicates the groundwater vulnerability of geological deposits of England. The available mapping shows the site is not located within a groundwater vulnerability or source protection zone.

6.5 Existing Drainage Infrastructure

6.5.1 The site is agricultural, undeveloped land, it is therefore considered unlikely that there will be any formal sewer drainage systems present in the vicinity of the site.

7 Surface Water Drainage Strategy

7.1 Introduction

7.1.1 This section of the report sets out the hydraulic calculations pre and post development and proposes a viable preliminary surface water strategy for the site.

7.2 Surface Water Runoff Hydraulic Calculations

7.2.1 The FRA (Ref VKL-08-39-G500-010) presents current and proposed run off rates for the site for the following return periods: 1 in 1 year, 1 in 30 year and 1 in 100 year. The calculations were undertaken in MicroDrainage. An extract of the results are included within Table 4 below.

Table 4 Runoff Characteristics

Annual Probability (Return Period, years)	Current (Greenfield) Runoff		Proposed (Unmitigated) Runoff (l/s)		Increase in Runoff (l\s)	
	(l/s)	(l/s/ha)	(l/s)	(l/s/ha)	(l/s)	(l/s/ha)
100% (1)	9.70	1.22	39.00	4.91	29.30	3.69
QBAR urban	11.10	1.40	44.90	5.65	33.80	4.25
3.33% (30)	26.70	3.36	80.20	10.09	53.50	6.73
1% (100)	39.60	4.98	94.50	11.89	54.90	6.91
1% + 20% climate change	47.52	5.98	113.40	14.26	65.88	8.28
1% + 40% climate change	55.44	6.97	132.30	16.64	76.86	9.67

7.3 Preliminary Surface Water Drainage Strategy

7.3.1 Using the initial onsite attenuation storage calculations and design assumptions within the FRA (Ref VKL-08-39-G500-010), it is proposed to convey and attenuated the converter station's surface water runoff to an onsite attenuation pond. It is proposed, subject to site levels and IDB

approval, for the attenuation to discharge as close as feasible to the BSIDB green field rate of 1.4 litres per second per Hectare (11.10 l/s) to either the adjacent Mill Drain or the North Ing Drive Drain.

7.3.2 Alternatively, if required, the attenuation pond could discharge directly to the ground, and disperse discharge by means of a perforated pipe.

7.3.3 Given the variable levels of the groundwater table, it is anticipated that the attenuation pond would require an impermeable geotextile membrane. However, this will be subject to further intrusive testing and detailed design.

7.3.4 Flow restriction will most likely be achieved by installing a control chamber manhole (hydrobrake or similar) or orifice plate upstream of the outfall to ensure the attenuation supplied is utilised and maximised.

7.3.5 Preliminary calculations for the ponds required attenuation storage was undertaken utilising a hydrobrake to provide the flow restriction. The pond structure was modelled assuming a 1/3 slope and a base storage area of 5,810 m².

7.3.6 A storage depth of 1.25 m, and a resultant top storage area of 7,009 m² is required for the 100 year return period plus 20% climate change. A storage depth of 1.5 m, and a resultant top storage area of 7,262 m² is required for the 100 year return period plus 40% climate change.

7.3.7 The preliminary calculations undertaken indicate there is sufficient space for an attenuation pond within the area designated for attenuation within the proposed converter station site.

7.3.8 It is important to note that the calculations undertaken only consider the storage area required and not the 'wet' pond area / depth or freeboard area / depth. It would be recommended that attenuation pond is a wet pond, rather than a dry basin to provide ecological benefits to the proposed converter station site and to improve water quality by planting. A minimum freeboard of 0.3 m from the maximum water level to the stations finished flood level is recommend.

7.3.9 All MicroDrainage storage calculations relating to the preliminary pond design are included within Appendix B for reference.

Adoption and Maintenance

7.3.10 All new surface water infrastructure constructed to serve the site will be designed in accordance with Building Regulations Part H, current best practice and manufacturers' guidance where appropriate. It is anticipated that all infrastructure proposed will remain private.

Future Maintenance of Proposed SuDS Assets

7.3.11 Maintenance and management of SuDS features is now regarded as an important element of design to be considered from planning. It is anticipated that the SuDS assets proposed within the strategy are likely to remain private and be maintained by a management company set up by the developer or private owners, as appropriate.

7.3.12 Typical ongoing maintenance activities for attenuation ponds are tabulated in Table 5 below. All maintenance operations should be undertaken in accordance with manufacturer's guidance and current best practice as appropriate.

Table 5 Typical Maintenance Schedule for Ponds

Maintenance Activity	Remedial Action	Inspection Frequency
Litter removal from swales and ponds	Remove all litter. Quantity to vary depending	1 per month or as required
Inspect control structures to and from swale/ponds	Surface control structure can be slot weirs, gabion baskets. Visual inspection required only	1 per month
Landscape maintenance	Grass cutting on slopes and around point and vegetation removal as required	As required
Pond maintenance	Remove planting and silt from the base of the pond	1 per 5 years
Water condition	Inspection for excessive algae blooms in water	As required

8 Summary and Conclusion

8.1 Summary

8.1.1 A surface water drainage strategy in accordance with the NPPF and Planning Practice Guidance has been produced for the proposed converter station zone on land off North Ing Drove, Northorpe, South Holland.

8.2 Surface Water Drainage Strategy Summary

8.2.1 The purpose of this report is to outline surface water drainage strategy to demonstrate that an acceptable means of surface water disposal can be provided to facilitate the proposals.

8.2.2 Opportunities to utilised infiltration SuDS techniques are likely to be limited due to the likely low infiltration potential of the sites sub soils.

8.2.3 It is proposed to convey and attenuated the converter station's surface water runoff to an onsite attenuation pond, and discharge to either the Mill Drain or the North Ing Drive Drain, located adjacent to the site northern boundary. This is subject to site levels and IDB approval. Alternatively, the attenuation would discharge directly to ground.

8.2.4 Preliminary calculations undertaken indicate there is sufficient space for an attenuation pond within the area designated for attenuation within the site proposals provided.

8.2.5 Calculations have included for a restricted outfall of the site to the BSID green field green field rate of 1.4 litres per second per Hectare.

8.2.6 Preliminary calculations undertaken have demonstrated that acceptable attenuation storage can be provided onsite for the 1 in 100 plus 20% and 40% climate change return period. The depth, and storage base and top areas have been calculated and provided for each climate change event.

8.3 Conclusion

8.3.1 This Surface Water Drainage Strategy and supporting documentation illustrates that the proposed development is at risk of flooding. However, following the incorporation of appropriate drainage and attenuation measures, there are no overriding or sustainable reasons why the development proposals should not be approved.

9 References

Ref: 21.1 Ordnance Survey Explorer (2012) 1:50,000 Map 130: Grantham/ Ordnance Survey 1:10,000 Scale Electronic Data Mapping for assessment area;

Ref: 21.2 BGS (Online), Geology of Britain Viewer. Available at:

http://mapapps.bgs.ac.uk/geologyofbritain/home;

Ref: 21.3 Environment Agency Website (www.environment-agency.gov.uk) [Accessed September 2015, November 2015, January 2016, February 2016 and March 2016];

Ref: 21.4 Communities and Local Government, March 2012. National Planning Policy Framework;

Ref: 21.5 Planning Practice Guidance (http://planningguidance.communities.gov.uk/) [Accessed September 2015, November 2015, January 2016, February 2016, March 2016, May 2016, July 2016 and September 2016];

Ref: 21.6 South Holland District Council (2006). South Holland District Council Local Plan.

Ref: 21.7 Black Sluice IDB Website (http://www.blacksluiceidb.gov.uk/) [Accessed July 2017].

Ref: 21.8 Flood and Water Management Act 2010. (c.29). London: The Stationery Office.

Ref: 21.9 CIRIA Report C753 (2015). The SuDS manual;

Ref: 21.10 CIRIA Report C522 (2000). Sustainable Drainage Systems- Design Manual for England and Wales

Ref: 21.11 CIRIA Report C523 (2001). Sustainable Drainage Systems- Best practice

Ref: 21.12 CIRIA Report (1996). C156 Infiltration Drainage - Manual of Good practice

Ref:.21.13 BRE Digest 365 (2016). Soakaway design

Ref: 21.14 Department for Environmental, Food & Rurual Affairs (March 2015). Non-statutory technical standards for the design, maintenance and operation of sustainable drainage systems to drain surface water [Online]. Accessed July 2017.

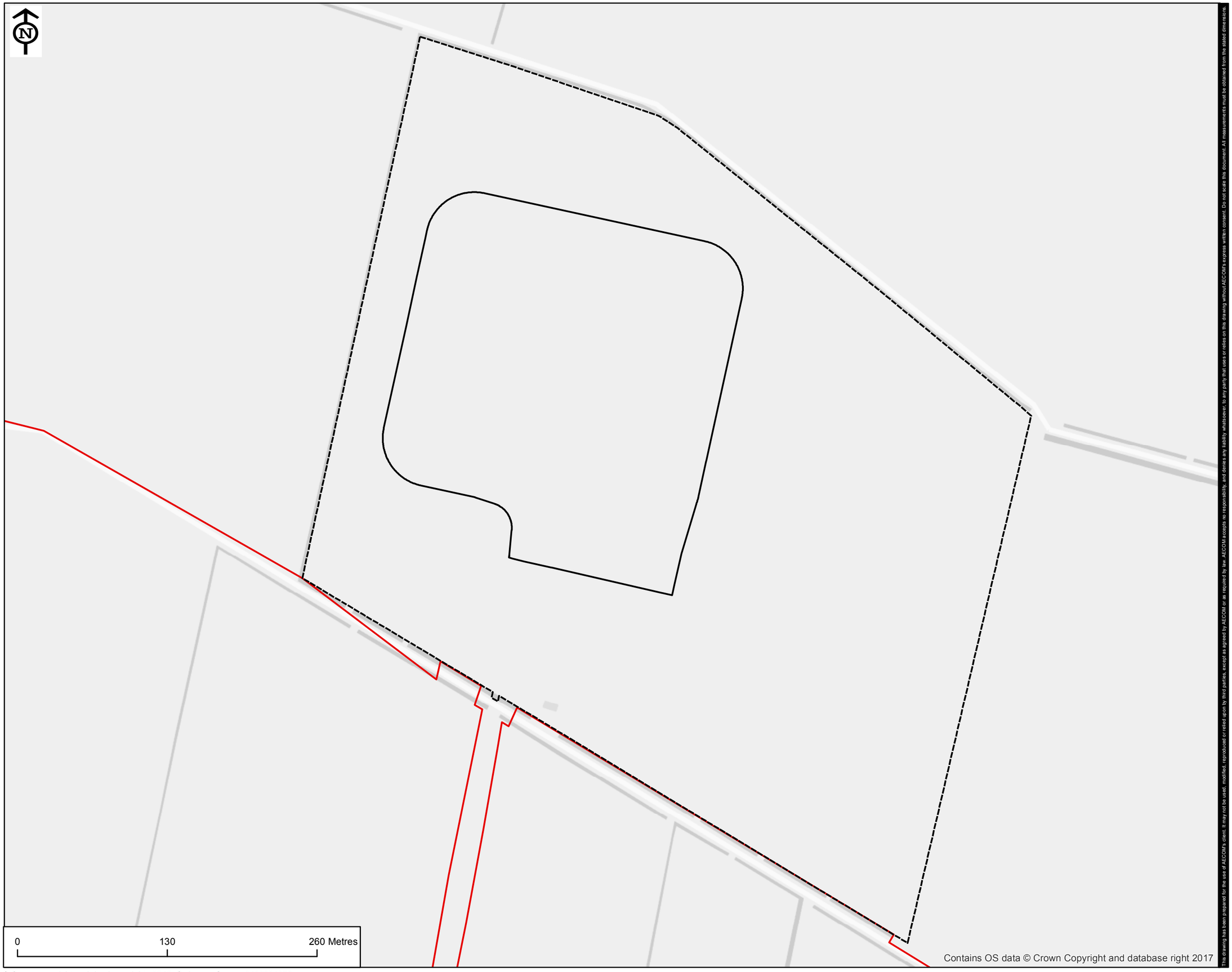
Ref: 21.15 UK Climate Projections science report: Climate change projections, Version 3, updated December 2010.

Ref: 21.16 Environment Agency Flood risk assessments: climate change allowances, online (https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances) [Accessed February 2016, April 2016, June 2016 and September 2016];

Appendices

Appendix A – Site Location Plan

CONSULTANT: RPS
PRODUCED: AK
CHECKED: JM
APPROVED: JM

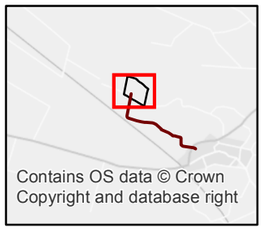


Filename: O:\JFR8501 - NG - Viking Interconnector Project\4. Drawings\1. RPS Drawings\MXD\JER8501_CS1 Site Location Plan.mxd

VikingLink

LEGEND

- Proposed Converter Station Zone
- Proposed Converter Station Site
- Application Boundary



REVISION:

REV.	DATE	DESCRIPTION
1	04/07/17	ORIGINAL ISSUE

FIGURE NO.

VL_170815_ES-4-C.03 CH19
SURFACE WATER DRAINAGE ASSESSMENT

FIGURE TITLE

APPENDIX A
SITE LOCATION PLAN

SHEET NUMBER

1 of 1

NOTES

Date:	Scale at A3:
15/08/17	1:3,000

Appendix B – Hydraulic Calculations

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	9.151	0.451	10.9	2714.2	O K
30 min Summer	9.215	0.515	10.9	3115.7	O K
60 min Summer	9.287	0.587	10.9	3570.2	O K
120 min Summer	9.366	0.666	10.9	4078.4	O K
180 min Summer	9.416	0.716	10.9	4398.5	O K
240 min Summer	9.452	0.752	10.9	4634.1	O K
360 min Summer	9.504	0.804	10.9	4974.9	O K
480 min Summer	9.541	0.841	10.9	5216.9	O K
600 min Summer	9.569	0.869	10.9	5401.6	O K
720 min Summer	9.591	0.891	10.9	5548.2	O K
960 min Summer	9.637	0.937	10.9	5853.6	O K
1440 min Summer	9.697	0.997	10.9	6256.9	O K
2160 min Summer	9.746	1.046	10.9	6593.1	Flood Risk
2880 min Summer	9.771	1.071	10.9	6761.1	Flood Risk
4320 min Summer	9.708	1.008	10.9	6332.1	Flood Risk
5760 min Summer	9.641	0.941	10.9	5881.2	O K
7200 min Summer	9.584	0.884	10.9	5502.6	O K
8640 min Summer	9.534	0.834	10.9	5171.1	O K
10080 min Summer	9.487	0.787	10.9	4864.3	O K
15 min Winter	9.204	0.504	10.9	3045.4	O K
30 min Winter	9.275	0.575	10.9	3496.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	185.200	0.0	936.2	78
30 min Summer	106.325	0.0	926.1	93
60 min Summer	61.042	0.0	1849.4	122
120 min Summer	35.045	0.0	1806.8	180
180 min Summer	25.331	0.0	1766.7	240
240 min Summer	20.120	0.0	1727.8	298
360 min Summer	14.543	0.0	1656.4	416
480 min Summer	11.551	0.0	1613.8	534
600 min Summer	9.661	0.0	1590.7	652
720 min Summer	8.349	0.0	1580.1	770
960 min Summer	6.724	0.0	1588.7	1006
1440 min Summer	4.955	0.0	1628.5	1480
2160 min Summer	3.652	0.0	3246.1	2192
2880 min Summer	2.941	0.0	3287.0	2904
4320 min Summer	2.038	0.0	3225.8	4328
5760 min Summer	1.571	0.0	6516.7	5264
7200 min Summer	1.284	0.0	6319.2	5920
8640 min Summer	1.089	0.0	6096.9	6672
10080 min Summer	0.947	0.0	5906.6	7408
15 min Winter	185.200	0.0	930.0	78
30 min Winter	106.325	0.0	914.8	92

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	9.355	0.655	10.9	4007.9	O K
120 min Winter	9.444	0.744	10.9	4582.9	O K
180 min Winter	9.500	0.800	10.9	4947.3	O K
240 min Winter	9.541	0.841	10.9	5215.3	O K
360 min Winter	9.599	0.899	10.9	5603.1	O K
480 min Winter	9.641	0.941	10.9	5881.1	O K
600 min Winter	9.673	0.973	10.9	6095.5	O K
720 min Winter	9.698	0.998	10.9	6267.4	O K
960 min Winter	9.751	1.051	10.9	6625.2	Flood Risk
1440 min Winter	9.822	1.122	10.9	7109.0	Flood Risk
2160 min Winter	9.883	1.183	10.9	7532.7	Flood Risk
2880 min Winter	9.917	1.217	10.9	7766.7	Flood Risk
4320 min Winter	9.859	1.159	10.9	7365.9	Flood Risk
5760 min Winter	9.793	1.093	10.9	6912.1	Flood Risk
7200 min Winter	9.726	1.026	10.9	6454.4	Flood Risk
8640 min Winter	9.666	0.966	10.9	6046.8	O K
10080 min Winter	9.612	0.912	10.9	5689.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	61.042	0.0	1819.8	120
120 min Winter	35.045	0.0	1746.3	178
180 min Winter	25.331	0.0	1674.5	236
240 min Winter	20.120	0.0	1628.3	294
360 min Winter	14.543	0.0	1587.6	410
480 min Winter	11.551	0.0	1582.9	526
600 min Winter	9.661	0.0	1597.7	642
720 min Winter	8.349	0.0	1616.0	756
960 min Winter	6.724	0.0	1649.3	990
1440 min Winter	4.955	0.0	1682.7	1454
2160 min Winter	3.652	0.0	3375.2	2152
2880 min Winter	2.941	0.0	3415.8	2844
4320 min Winter	2.038	0.0	3338.5	4196
5760 min Winter	1.571	0.0	6540.7	5496
7200 min Winter	1.284	0.0	6385.2	6680
8640 min Winter	1.089	0.0	6216.6	6952
10080 min Winter	0.947	0.0	6043.0	7824

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
Site Location	GB 518400 336750 TF 18400 36750
C (1km)	-0.021
D1 (1km)	0.296
D2 (1km)	0.344
D3 (1km)	0.192
E (1km)	0.307
F (1km)	2.517
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+20

Time Area Diagram

Total Area (ha) 7.950

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.500	16	20	0.500	32	36	0.500	48	52	0.500
4	8	0.500	20	24	0.500	36	40	0.500	52	56	0.500
8	12	0.500	24	28	0.500	40	44	0.500	56	60	0.500
12	16	0.500	28	32	0.500	44	48	0.500	60	64	0.450

Model Details

Storage is Online Cover Level (m) 10.000

Tank or Pond Structure

Invert Level (m) 8.700

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	5809.7	1.250	7009.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0146-1110-1400-1110
Design Head (m)	1.400
Design Flow (l/s)	11.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	146
Invert Level (m)	8.600
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.400	11.0
Flush-Flo™	0.410	10.9
Kick-Flo®	0.882	8.8
Mean Flow over Head Range	-	9.5

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)
0.100	5.3	1.200	10.2	3.000	15.7	7.000	23.6
0.200	10.1	1.400	11.0	3.500	17.0	7.500	24.4
0.300	10.8	1.600	11.7	4.000	18.1	8.000	25.2
0.400	10.9	1.800	12.4	4.500	19.1	8.500	25.9
0.500	10.9	2.000	13.0	5.000	20.1	9.000	26.7
0.600	10.7	2.200	13.6	5.500	21.0	9.500	27.4
0.800	9.7	2.400	14.2	6.000	21.9		
1.000	9.4	2.600	14.7	6.500	22.8		

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	8.926	0.526	10.0	3176.5	O K
30 min Summer	9.001	0.601	10.0	3646.8	O K
60 min Summer	9.084	0.684	10.0	4178.9	O K
120 min Summer	9.177	0.777	10.0	4775.4	O K
180 min Summer	9.234	0.834	10.0	5152.6	O K
240 min Summer	9.277	0.877	10.0	5431.0	O K
360 min Summer	9.338	0.938	10.0	5834.9	O K
480 min Summer	9.382	0.982	10.0	6125.2	O K
600 min Summer	9.415	1.015	10.0	6349.3	O K
720 min Summer	9.442	1.042	10.0	6529.5	O K
960 min Summer	9.497	1.097	10.0	6904.6	O K
1440 min Summer	9.572	1.172	10.0	7414.1	O K
2160 min Summer	9.637	1.237	10.2	7863.2	O K
2880 min Summer	9.673	1.273	10.3	8111.7	O K
4320 min Summer	9.609	1.209	10.1	7671.4	O K
5760 min Summer	9.532	1.132	10.0	7140.2	O K
7200 min Summer	9.463	1.063	10.0	6674.5	O K
8640 min Summer	9.410	1.010	10.0	6314.8	O K
10080 min Summer	9.365	0.965	10.0	6013.0	O K
15 min Winter	8.988	0.588	10.0	3563.8	O K
30 min Winter	9.070	0.670	10.0	4091.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	216.067	0.0	741.6	79
30 min Summer	124.046	0.0	706.6	93
60 min Summer	71.216	0.0	1431.2	122
120 min Summer	40.886	0.0	1465.2	182
180 min Summer	29.552	0.0	1499.6	240
240 min Summer	23.473	0.0	1524.5	300
360 min Summer	16.966	0.0	1560.1	418
480 min Summer	13.476	0.0	1584.9	536
600 min Summer	11.271	0.0	1603.7	654
720 min Summer	9.741	0.0	1618.3	772
960 min Summer	7.844	0.0	1645.2	1008
1440 min Summer	5.781	0.0	1675.4	1484
2160 min Summer	4.261	0.0	3354.8	2196
2880 min Summer	3.431	0.0	3395.4	2908
4320 min Summer	2.378	0.0	3371.2	4332
5760 min Summer	1.833	0.0	6494.6	5736
7200 min Summer	1.498	0.0	6437.6	6264
8640 min Summer	1.270	0.0	6306.6	6960
10080 min Summer	1.105	0.0	6127.7	7712
15 min Winter	216.067	0.0	708.4	78
30 min Winter	124.046	0.0	718.2	93

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
60 min Winter	9.163	0.763	10.0	4689.3	O K
120 min Winter	9.266	0.866	10.0	5361.8	O K
180 min Winter	9.331	0.931	10.0	5788.8	O K
240 min Winter	9.379	0.979	10.0	6105.5	O K
360 min Winter	9.447	1.047	10.0	6567.4	O K
480 min Winter	9.497	1.097	10.0	6902.1	O K
600 min Winter	9.535	1.135	10.0	7162.8	O K
720 min Winter	9.566	1.166	10.0	7374.2	O K
960 min Winter	9.630	1.230	10.1	7813.8	O K
1440 min Winter	9.718	1.318	10.4	8422.8	Flood Risk
2160 min Winter	9.797	1.397	10.6	8983.0	Flood Risk
2880 min Winter	9.845	1.445	10.7	9319.0	Flood Risk
4320 min Winter	9.792	1.392	10.6	8946.2	Flood Risk
5760 min Winter	9.726	1.326	10.4	8482.9	Flood Risk
7200 min Winter	9.655	1.255	10.2	7984.7	O K
8640 min Winter	9.582	1.182	10.0	7483.3	O K
10080 min Winter	9.524	1.124	10.0	7087.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	71.216	0.0	1453.4	122
120 min Winter	40.886	0.0	1511.8	180
180 min Winter	29.552	0.0	1547.3	236
240 min Winter	23.473	0.0	1572.7	294
360 min Winter	16.966	0.0	1607.8	410
480 min Winter	13.476	0.0	1631.6	526
600 min Winter	11.271	0.0	1648.7	642
720 min Winter	9.741	0.0	1661.5	758
960 min Winter	7.844	0.0	1684.6	992
1440 min Winter	5.781	0.0	1705.4	1458
2160 min Winter	4.261	0.0	3444.2	2156
2880 min Winter	3.431	0.0	3470.0	2852
4320 min Winter	2.378	0.0	3404.9	4220
5760 min Winter	1.833	0.0	6661.4	5552
7200 min Winter	1.498	0.0	6605.2	6824
8640 min Winter	1.270	0.0	4281.3	7968
10080 min Winter	1.105	0.0	5181.8	8096

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
Site Location	GB 518400 336750 TF 18400 36750
C (1km)	-0.021
D1 (1km)	0.296
D2 (1km)	0.344
D3 (1km)	0.192
E (1km)	0.307
F (1km)	2.517
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 7.950

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.500	16	20	0.500	32	36	0.500	48	52	0.500
4	8	0.500	20	24	0.500	36	40	0.500	52	56	0.500
8	12	0.500	24	28	0.500	40	44	0.500	56	60	0.500
12	16	0.500	28	32	0.500	44	48	0.500	60	64	0.450

Model Details

Storage is Online Cover Level (m) 10.000

Tank or Pond Structure

Invert Level (m) 8.400

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	5809.7	1.600	7262.6

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0136-1010-1700-1010
Design Head (m)	1.700
Design Flow (l/s)	10.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	136
Invert Level (m)	7.900
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.700	10.1
Flush-Flo™	0.497	10.0
Kick-Flo®	1.033	8.0
Mean Flow over Head Range	-	8.8

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)
0.100	4.9	1.200	8.5	3.000	13.2	7.000	19.7
0.200	8.7	1.400	9.2	3.500	14.2	7.500	20.4
0.300	9.6	1.600	9.8	4.000	15.1	8.000	21.0
0.400	9.9	1.800	10.3	4.500	16.0	8.500	21.6
0.500	10.0	2.000	10.9	5.000	16.8	9.000	22.3
0.600	9.9	2.200	11.4	5.500	17.6	9.500	22.8
0.800	9.5	2.400	11.8	6.000	18.3		
1.000	8.3	2.600	12.3	6.500	19.0		

CONTACT US

You can find out more information by:

calling our freephone number:
0800 731 0561

Sending an email to:
vikinglink@communityrelations.co.uk

Writing to our freepost address at:
FREEPOST VIKING LINK

Visiting our website at:
www.viking-link.com

If you, or someone you know, would like information in Braille, audio, large print or another language, please call us on the freephone number above.