336-007-RP02

Drainage Impact Assessment

Proposed BESS - Knocknagael, Inverness

DOCUMENT STATUS	DATE	BY	APPROVED
Revision P01	26 June 2024	Beverley Hunter	James Calvert

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Contents

1 Introduction

Haydn Evans Consulting Ltd (HEC) has been commissioned by Field (hereafter referred to as the Client) to carry out a Drainage Assessment to support a planning application for the construction and operation of a 200 MW Battery Energy Storage System (BESS) with associated infrastructure, access and ancillary works on land 500 m south-east of Essich Farm Cottages, Inverness.

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1.1 Site Proposal

The proposed development comprises a total development footprint of approximately 6 hectares (ha) across the 42.4 ha site. The application site is approximately 1.8 hectares (ha) of greenfield land.

The Proposed Development principally comprises a battery energy storage system (BESS) that will charge and discharge electricity from the adjacent, existing Knocknagael substation. It includes two battery compounds comprising battery storage units arranged into rows, medium-voltage (MV) skids and associated ancillary equipment, a substation compound which accommodates high-voltage grid transformers, switchgear and a control building, as well as site-wide supporting infrastructure including underground cabling, access tracks, fencing, attenuation basins, and landscaping measures. Whilst the exact specifications are subject to detailed design, the principal components described form the basis of the planning application to allow environmental assessments and mitigation to be appropriately scoped.

2 Location and Existing Conditions

2.1 Site Location

The Site is located approximately 5 kilometres (km) to the south of Inverness City Centre, centred on approximate Ordnance Survey (OS) grid reference 264876, 839233 (see red line on Figure 1).

Figure 1: Site location map

The Site is generally surrounded by greenfield land. Essich Road bounds the Site to the west, Biorraid Road to east with Knocknagael substation beyond. The junction of Essich Road and Biorraid Road is immediately to the north of the site; Essich Farm Cottage is located opposite.

Essich Burn lies to the west of Essich Road, flowing in a northerly direction.

2.2 Existing Topography

A topographical survey has been produced for the Site (see Appendix A). The survey shows ground levels to fall from south-east to north-west. Ground levels in the south-east are circa 195 metres Above Ordnance Datum (mAOD), falling to circa 155 metres (mAOD) in the north-west. Ground levels are variable across the site.

The survey shows vegetation around the perimeter of the Site.

2.3 Existing Sewer/Water Assets

Scottish Water (SW) sewer records for the site have been obtained (see Appendix B). The records show no foul or surface water sewers in the vicinity of the site.

The utilities search has confirmed no Private Water Supplies are present at the site.

2.4 Existing Drainage Regime

There is no formal drainage regime for this Site, surface water is likely to flow overland following the topography of the ground. Various ditches/depressions adjacent to the surrounding roads are shown on the topographical survey, which would intercept any overland flow from the Site and prevent it from flowing over the road; these would also collect surface water run-off from the roads themselves. The survey shows a pipe from the Essich Road ditch, under the road, with the outfall on the opposite side where surface water would convey towards Essich Burn.

2.5 Ground Conditions

British Geological Survey (BGS) mapping confirms the Site to have a bedrock geology of Inshes Flagstone Formation (Sandstone) (see Figure 2). Superficial deposits of Hummocky (moundy) Glacial Deposits are shown to be present across the most-part of the Site, with Till, Devensian (Diamicton) located along the western boundary (see Figure 3).

Online mapping shows the site to be in an area with a 'low' groundwater vulnerability.

The Phase 2 Ground Investigation Report conducted on behalf of Field states that: 'Details on the hydrogeological classification of the Hummock Glacial Deposits were not given by SEPA mapping tools. The Inshes Flagstone Formation was characterised as a moderately productive aquifer, locally yielding small amounts of groundwater.'

Figure 2: BGS Geology Map of Bedrock geology

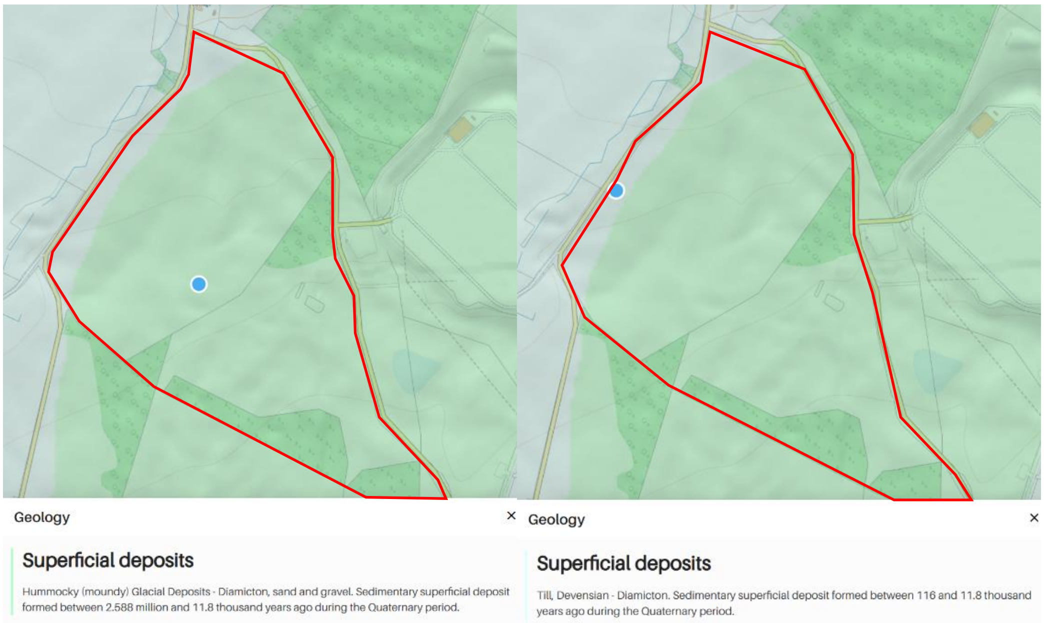

Figure 3: BGS Geology Map of Superficial Deposits

3 Planning Policy Context

3.1 National Planning Framework 4 (NPF4 Adopted 2023)

The National Planning Framework 4 (NPF4, 2023) includes government policy for developments and meeting the challenges of climate change and flood risk. Policy 22 states that development proposals should:

- Not increase the risk of surface water flooding to others, or itself be at risk;
- Manage all rain and surface water through sustainable urban drainage systems (SUDS), which should form part of and integrate with proposed and existing blue-green infrastructure. All proposals should presume no surface water connection to the combined sewer; and
- Seek to minimise the area of impermeable surface.

3.2 Highland-wide Local Development Plan (HwLDP, Adopted 2012)

On 5 April 2012 the Highland-wide Local Development Plan was adopted by the Council and was constituted as the local development plan in law. The Plan sets out a vision statement and spatial strategy for the area, taking on board the outcomes of consultation undertaken during preparation of the plan. Policy 66 is relevant to this assessment and reads as follows:

Policy 66 Surface Water Drainage
All proposed development must be drained by Sustainable Drainage Systems (SuDS) designed in accordance with The SuDS Manual (CIRIA C697) and, where appropriate, the Sewers for Scotland Manual 2nd Edition. Planning applications should be submitted with information in accordance with Planning Advice Note 69: Planning and Building Standards Advice on Flooding paragraphs 23 and 24. Each drainage scheme design must be accompanied by particulars of proposals for ensuring long-term maintenance of the scheme.

4 Surface Water Drainage

The surface water drainage strategy has been designed based on the requirements of CIRIA 753 (C753) dated March 2015 and the Water Assessment and Drainage Assessment Guide produced by the Sustainable Urban Drainage Scottish Working Party (SUDSWP).

4.1 SuDS Hierarchy

Surface water drainage should be managed in a way that replicates the natural drainage processes for the Site as closely as possible. The proposals should follow the hierarchy outlined in C753 and should be disposed of to a receptor in the order of preference described below:

1. Into the ground;
2. To a surface water body e.g. watercourse;
3. To a surface water, highway drain, or another drainage system;
4. To a combined sewer.

4.1.1 SuDS Selection

Into the ground

Infiltration testing was undertaken at the Site as part of the Phase 2 Ground Investigation undertaken by Curtins on behalf of Field (ref: 085444-CUR-XX-XX-T-GE-00001 dated 16 Apil 2024).

Infiltration testing in accordance with BRE365 was undertaken at one location (SA01) at the Site. The soakaway test was unsuccessful due to the 75% and 25% drop in water levels being unachieved. The poor infiltration is likely a result of the clayey nature of the Hummock Glacial Deposits and impermeable nature of the mudstone bedrock.

Infiltration drainage is therefore not feasible at this Site and is not discussed further in this report.

To a surface water body

It is proposed to discharge surface water run-off from the Site to the adjacent Essich Road ditch, which ultimately discharges to Essich Burn (see drawing in Appendix B). This mimics the existing drainage regime for the Site.

4.2 Greenfield run-off rates

The greenfield run-off discharge rates have been calculated using the HR Wallingford IH124 method and are based on the proposed impermeable area of the Proposed Development (3.59 ha). The greenfield rates for the site are summarised in Table 1 below (see Greenfield Calculations in Appendix B).

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Rainfall event	Greenfield discharge rate (l/s)
1:1 year	10.49
Qbar	12.34
1:30 year	24.06
1:200 year	35.04

Table 1: Greenfield run-off calculations

4.3 Surface water drainage strategy

The Proposed Development comprises three separate compounds where the infrastructure equipment is located (Southern BESS Compound, Western BESS Compound and Substation Compound) along with access roads. The surface water generated by each area is intercepted by filter drains positioned periodically across each area and at the low point for each. The filter drains direct the surface water through a network of pipes and basins provided to convey the surface water to the outfall. Surface water is discharged at a restricted rate to the existing ditch along the site's north-western boundary; from here, surface water would flow through the existing pipe under Essich Road, using the natural conveyance route to Essich Burn. Discharge to the ditch/Essich Burn is subject to Highland Council approval. The surface water drainage drawings and supporting calculations are provided in Appendix B.

Discharge rate

The discharge of surface water run-off from the Proposed Development will be restricted to the Qbar greenfield rate (12.3 l/s) in line with the guidance provided by SUDSWP. Discharge from the basins is restricted by a flow control device.

Attenuation

Attenuation has been sized using FEH data and Causeway Flow software to accommodate the temporary run-off for rainfall events up to and including the 1:200 year event. Two basins have been included in the design in order to mimic the existing drainage regime; the Southern BESS Compound discharges into Basin 1 which is located adjacent to the compound. Surface water is released from this basin at a restricted rate of 2.0 l/s into the lower part of the network. The Western BESS Compound and the Substation Compound discharge to Basin 2, along with the 2 l/s from Basin 1. Both basins have been designed to have a 300 mm of freeboard in the 200 year event and 1:3 side slopes. The volume of storage required for each basin in the 200 year event is:

- Basin 1 = 983 m^3.
- Basin 2 = 1,365 m^3.

The access areas are included in the calculations above.

4.4 Pollution Mitigation

The above proposal ensures that surface water is managed 'at source'. All surface water from the Proposed Development area will pass through a filter drain and the attenuation basin. This type of development has 'Low' pollution hazard level, as shown in table 26.2 of C753. The relevant land use is tabled below, with the SuDS pollution indices tabled (as per table 26.3 of C753).

Pollution Hazard indices for different land use classifications				
Land Use	**Pollution Hazard Level**	**Total suspended solids pollution index**	**Metals**	**Hydrocarbons (HC)**
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, home zones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie., 300 traffic movements/day	Low	0.5	0.4	0.4
Indicative SuDS mitigation indices for discharges to surface waters				
Filter Drain		0.4	0.4	0.4
Detention Basin (secondary indices halved)		0.5 (0.25)	0.5 (0.25)	0.6 (0.3)
Total		**0.65**	**0.65**	**0.7**

Table 2: SuDS Pollution Assessment

4.5 Management and Maintenance

The surface water drainage system should be maintained to ensure the system operates at its maximum capacity for the 30 year lifetime of development. A management and maintenance plan is provided in Appendix B.

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5 Summary and Conclusion

5.1 Summary

HEC has been commissioned by the Client to carry out a Drainage Impact Assessment to support a planning application for the construction and operation of a 200 MW Battery Energy Storage System (BESS) with associated infrastructure, access and ancillary works on land 500 m south-east of Essich Farm Cottages, Inverness.

Infiltration drainage is not feasible at the Site. It is therefore proposed to discharge surface water to Essich Burn via the existing ditch and outlet pipe, mimicking the existing drainage regime for the Site.

Attenuation has been provided for the 1 in 200-year event with a restricted discharge matching the Qbar greenfield run-off rate.

The use of filter drains and attenuation basins provide the appropriate mitigation for the pollutants likely for this type of development.

The surface water drainage system should be maintained to ensure the system operates at its maximum capacity for the lifetime of development. This is provided for through the management and maintenance plan submitted as part of the application.

5.2 Conclusion

The drainage strategy complies with guidance; surface water generated by the Proposed Development can be attenuated on site in the relevant extreme event and discharged to a watercourse. The proposals for the Site do not increase on or off-site flood risk and are therefore considered acceptable.

Appendix A – Existing & Proposed Site

Field drawing BTGBKNO01-002.1 – Site Location

Highland Surveyors Ltd drawing 24016-01 - Topographical Survey

Field drawing BTGBKNO01-001.1 Rev 02 – Indicative Site Layout Plan

1 Location Plan
Scale 1:1000 @ A0

Notes

1. All dimensions are shown in mm unless noted otherwise.
2. Do not scale from this drawing.
3. Planning boundary area = 42.375Ha

Legend

Planning boundary

REV	DATE	DESCRIPTION	BY	CHK'D
3	28.03.2024	Annotations added	JH	AP
2	18.01.2024	Planning boundary amended	JH	AP
1	25.10.2023	Drawing amended to show location plan	JH	RS
0	01.11.2022	Option Plan - For Information	WL	RS

FIELD

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186 Shoreditch High Street,
London,
E1 6HU

PROJECT
Knocknagael

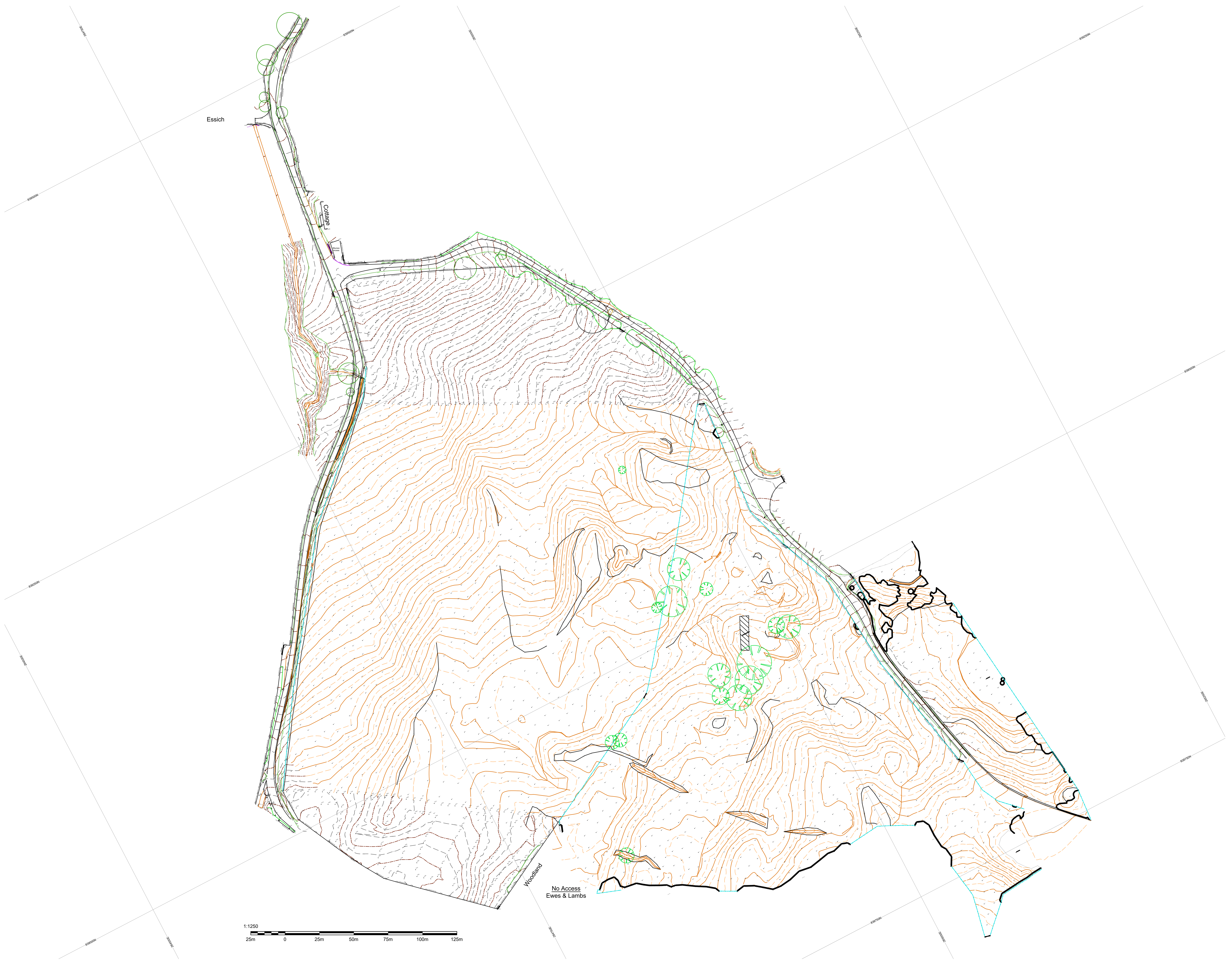
TITLE
Site Location Plan

DISCIPLINE
PLANNING

DRAWING STATUS
FOR PLANNING

SCALE	DATE	DRAWN BY	CHECKED BY	APPROVED BY
1:1000 @ A0	25.10.2023	JH	RS	RS

PROJECT NO.	DRAWING NO.	REV.
BTGBKNO01	002.1	3



FIGURED DIMENSIONS ONLY TO BE USED

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Notes

i) All survey levels are related to Ordnance Survey using GPS.

ii) Whilst every effort to locate all major service covers (ie.manhole positions) it should be noted that this may not be possible in all cases due to ground conditions or local obstructions.

Issue	Revision	Initial	Date
	First Issue		

Highland Surveyors Ltd

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Client:

Field

Project:

Proposed Development
Knocknagael
Essich

Drawing Title:

Topographic Survey

Status:

For Information

Scale: 1 : 1250 @ A1	Date: 01/06/2024
By: SCD	Checked: IKF
Approved: SCD	

Dwg. No.	Rev.
24016-01	-

1 Indicative Site Layout Plan
Scale 1:1000 @ A0

Notes

1. All dimensions are shown in metres unless noted otherwise.
2. Do not scale from this drawing.
3. This drawing is indicative only and the site layout is likely to change as more information becomes available.

Legend

- Planning Boundary
- Access Track - Unbound Finish
- Access Track - Asphalt Finish
- Attenuation Basin
- Palisade Fence
- 4m Acoustic Fence
- 3m Acoustic Fence
- Stock Proof Fence
- Indicative Underground Cable Route
- Site Landscaping and Planting
- Existing Trees to Remain

REV	DATE	DESCRIPTION	BY	CHK'D
3	27.06.2024	Landscaping and planting area amended	JH	AP
2	20.06.2024	Drainage and landscaping amended. Annotations added.	JH	AP
1	30.05.2024	Site layout amended	JH	JM
0	28.03.2024	Site Layout Plan - Original	JH	AP

Field
Fora Montacute Yards,
186 Shoreditch High Street,
London,
E1 6HU

PROJECT
Knocknagael

TITLE
Indicative Site Layout Plan

DISCIPLINE
PLANNING

DRAWING STATUS
FOR PLANNING

SCALE	DATE	DRAWN BY	CHECKED BY	APPROVED BY
1:1000 @ A0	28.03.2024	JH	AP	JM

PROJECT NO.	DRAWING NO.	REV.
BTGBKNO01	001.1	03

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Appendix B Surface Water Drainage

Greenfield Calculations

Haydn Evans drawing 336-007-D001 – Surface Water Drainage Strategy

Haydn Evans calculations 336-007-CA1 - Network Calculations

Haydn Evans document 336-007-RP3 – SuDS Management & Maintenance Plan hr wallingford

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Beverley Hunter
Site name:	Knocknagael
Site location:	Inverness

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:	57.42016° N
Longitude:	4.25188° W
Reference:	4148459472
Date:	Jun 26 2024 10:13

Runoff estimation approach

IH124

Site characteristics

Total site area (ha): 3.59

Methodology

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

Soil characteristics

	Default	Edited
SOIL type:	2	3
HOST class:	N/A	N/A
SPR/SPRHOST:	0.3	0.37

Hydrological characteristics

	Default	Edited
SAAR (mm):	816	816
Hydrological region:	1	1
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	1.95	1.95
Growth curve factor 100 years:	2.48	2.48
Growth curve factor 200 years:	2.84	2.84

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):	7.83	12.34
1 in 1 year (l/s):	6.65	10.49
1 in 30 years (l/s):	15.26	24.06
1 in 100 year (l/s):	19.41	30.6
1 in 200 years (l/s):	22.23	35.04

This report was produced using the greenfield runoff tool developed by HR Wallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement , which can both be found at www.uksuds.com/terms-and-conditions.htm. The outputs from this tool are estimates of greenfield runoff rates. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of this data in the design or operational characteristics of any drainage scheme.

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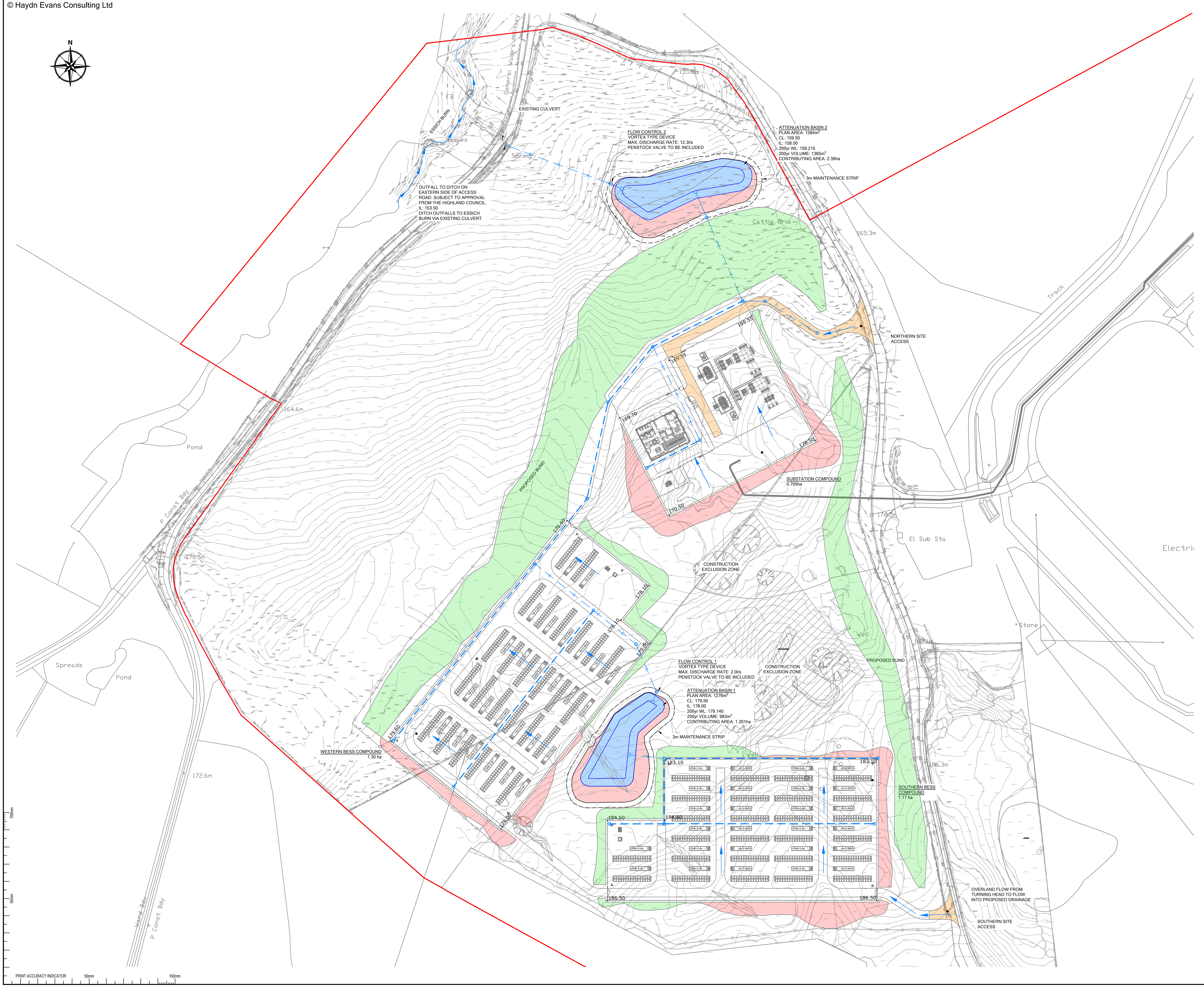

NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ENGINEERS, ARCHITECTS AND SPECIALISTS DRAWINGS AND THE SPECIFICATION.
2. DO NOT SCALE FROM THIS DRAWING MANUALLY OR ELECTRONICALLY. WRITTEN PERMISSION MUST BE OBTAINED FROM HAYDN EVANS PRIOR TO SCALING ELECTRONICALLY OR USING THIS ELECTRONIC FILE.
3. SITE LAYOUT BASED ON DRG. BTGBKNO01, PROVIDED BY FIELD ENERGY ON MAY 30TH 2024. TOPOGRAPHIC SURVEY BASED ON DRG. 220930, PROVIDED BY CASTLE SURVEYS 30TH SEPTEMBER 2022. ADDITIONAL TOPOGRAPHIC SURVEY BASED ON DRG. 24016-01, PROVIDED BY HIGHLAND SURVEYORS JUNE 12TH 2024
4. REFER TO SITE INVESTIGATION REPORT FOR EXISTING GROUND CONDITIONS AND ANY SPECIAL REQUIREMENTS FOR BURIED CONCRETE (SPECIAL REQUIREMENTS FOR BURIED CONCRETE SHALL INCLUDE ALL PRE-CAST AND IN-SITU CONCRETE AND MORTARS). WHERE APPROPRIATE REFER TO SITE INVESTIGATION / CONTAMINATION REPORTS FOR DETAILS OF CHEMICALS AFFECTING CHOICE OF MATERIALS AND OTHER ADDITIONAL REQUIREMENTS.

KEY

- XX.XXX+ PROPOSED LEVEL
- PROPOSED ATTENUATION BASIN
- CUT GRADING
- FILL GRADING
- SURFACE WATER MANHOLE
- SURFACE WATER DRAIN
- SURFACE WATER FILTER DRAIN
- PLANNING BOUNDARY
- ASPHALT SURFACE FINISH
- OVERLAND FLOW ARROWS

Rev'n	Date	Description	Drawn	Chk'd	App'd
P02	26.06.24	UPDATED TO SUIT LATEST LAYOUT	TE	BP	JRC
P01	08.05.24	PRELIMINARY ISSUE	BP	BH	

Status: PRELIMINARY

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Client: FIELD

Project: KNOCKNAGAEL

Drawing title: SURFACE WATER DRAINAGE STRATEGY

Scale	Drawn	Checked	Approved	Date
1:1000 @ A1	THW	BH	JRC	MAY 24

Drawing no.: 336-007-D001

Revision: P02

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	100	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	20.000	Minimum Backdrop Height (m)	0.000
Ratio-R	0.400	Preferred Cover Depth (m)	1.000
CV	0.750	Include Intermediate Ground	√
Time of Entry (mins)	3.00	Enforce best practice design rules	x

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
1	0.570	3.00	184.600	1350	265028.238	838877.104	1.375
2	0.156	3.00	184.600	1200	264874.076	838877.016	1.300
3	0.000		184.600	1350	264905.850	838877.050	1.875
4	0.475	3.00	183.100	1200	265030.252	838915.161	1.300
5	0.000		183.100	1350	264905.850	838915.162	1.875
BASIN 1	0.000		179.500	1350	264886.175	838917.195	1.500
FLOW CONTROL 1	0.000		179.500	1200	264901.504	838953.759	1.600
6	0.000		179.000	1200	264889.579	838981.611	1.500
7	0.544	3.00	177.500	1350	264783.264	838898.681	1.375
8	0.000		177.500	1350	264864.740	839001.328	1.875
9	0.630	3.00	175.600	1350	264748.336	838925.466	1.375
10	0.159	3.00	175.600	1350	264830.616	839028.432	1.950
11	0.029	3.00	175.600	1350	264860.967	839066.411	2.100
12	0.174	3.00	169.500	1500	264873.164	839122.466	2.075
13	0.122	3.00	170.100	1200	264895.854	839084.334	1.225
14	0.000		170.100	1200	264926.791	839100.392	1.575
15	0.473	3.00	169.500	1500	264899.322	839154.821	2.300
16	0.058	3.00	162.600	1500	264951.476	839181.314	2.729
17	0.000		162.500	1500	264928.825	839234.272	8.929
18	0.200	3.00	169.200	1500	264995.048	839162.814	4.200
BASIN 2	0.000		159.500	1500	264908.066	839258.216	1.500
FLOW CONTROL 2	0.000		159.500	1200	264899.136	839283.529	1.550
OUTFALL	0.000		154.000	1200	264811.960	839286.080	0.500

Links (Input)

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	1	3	122.388	0.600	183.225	182.725	0.500	244.8	375	4.77	50.0
2.000	2	3	31.774	0.600	183.300	182.800	0.500	63.5	300	3.27	50.0
1.001	3	5	38.112	0.600	182.725	181.225	1.500	25.4	375	4.94	50.0
3.000	4	5	124.402	0.600	181.800	181.300	0.500	248.8	300	5.09	50.0
1.002	5	BASIN 1	19.780	0.600	181.300	178.000	3.300	6.0	450	5.13	50.0
1.003	BASIN 1	FLOW CONTROL 1	5.000	0.600	178.000	177.900	0.100	50.0	300	5.17	50.0
1.004	FLOW CONTROL 1	6	30.298	0.600	177.900	177.500	0.400	75.7	300	5.45	50.0
1.005	6	8	31.713	0.600	177.500	175.700	1.800	17.6	300	5.59	50.0
4.000	7	8	131.052	0.600	176.125	175.625	0.500	262.1	375	4.96	50.0
1.006	8	10	43.578	0.600	175.625	173.725	1.900	22.9	375	5.78	50.0
5.000	9	10	131.803	0.600	174.225	173.725	0.500	263.6	375	4.98	50.0
1.007	10	11	48.617	0.600	173.650	173.500	0.150	324.1	450	6.50	50.0
1.008	11	12	57.367	0.600	173.500	167.500	6.000	9.6	450	6.64	50.0

Links (Input)

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.009	12	15	41.606	0.600	167.425	167.275	0.150	277.4	525	7.16	50.0
6.000	13	14	34.856	0.600	168.875	168.525	0.350	99.6	225	3.44	50.0
6.001	14	15	60.968	0.600	168.525	167.925	0.600	101.6	225	4.23	50.0
1.010	15	16	58.497	0.600	167.200	159.871	7.329	8.0	600	7.27	50.0
1.011	16	17	57.599	0.600	159.871	153.571	6.300	9.1	600	7.39	50.0
1.012	17	BASIN 2	31.690	0.600	160.850	158.000	2.850	11.1	600	7.47	50.0
1.013	BASIN 2	FLOW CONTROL 2	5.000	0.600	158.000	157.950	0.050	100.0	225	7.53	50.0
1.014	FLOW CONTROL 2	OUTFALL	87.213	0.600	157.950	153.500	4.450	19.6	225	8.02	50.0
7.000	18	16	47.337	0.600	165.000	160.246	4.754	10.0	225	3.19	50.0

Simulation Settings

Rainfall Methodology	FEH-13	Analysis Speed	Normal	Additional Storage (m³/ha)	20.0
Summer CV	0.750	Skip Steady State	x	Check Discharge Rate(s)	x
Winter CV	0.840	Drain Down Time (mins)	240	Check Discharge Volume	x

Storm Durations

60	180	360	600	960	2160	4320	7200	10080
120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
200	0	0	0

Node FLOW CONTROL 1 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	177.900	Product Number	CTL-SHE-0063-2000-1300-2000
Design Depth (m)	1.300	Min Outlet Diameter (m)	0.075
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node FLOW CONTROL 2 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	157.950	Product Number	CTL-SHE-0156-1230-1271-1230
Design Depth (m)	1.271	Min Outlet Diameter (m)	0.225
Design Flow (l/s)	12.3	Min Node Diameter (mm)	1200

Node BASIN 1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	5.0	Invert Level (m)	178.000
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	606.7	0.0	1.500	1276.0	0.0

Node BASIN 2 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	5.0	Invert Level (m)	158.000
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

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Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	809.0	0.0	1.500	1583.0	0.0

Node 1 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	183.225	Slope (1:X)	245.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	5	Depth (m)	
Safety Factor	2.0	Width (m)	0.750	Inf Depth (m)	
Porosity	0.30	Length (m)	122.000		

Node 2 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	183.300	Slope (1:X)	63.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	5	Depth (m)	
Safety Factor	2.0	Width (m)	0.600	Inf Depth (m)	
Porosity	0.30	Length (m)	31.500		

Node 4 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	181.800	Slope (1:X)	250.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	7	Depth (m)	
Safety Factor	2.0	Width (m)	0.600	Inf Depth (m)	
Porosity	0.30	Length (m)	124.000		

Node 7 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	176.125	Slope (1:X)	262.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	6	Depth (m)	
Safety Factor	2.0	Width (m)	0.750	Inf Depth (m)	
Porosity	0.30	Length (m)	131.000		

Node 9 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	174.225	Slope (1:X)	263.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	8	Depth (m)	
Safety Factor	2.0	Width (m)	1.000	Inf Depth (m)	
Porosity	0.30	Length (m)	131.000		

Node 10 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	173.650	Slope (1:X)	324.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	9	Depth (m)	
Safety Factor	2.0	Width (m)	1.000	Inf Depth (m)	
Porosity	0.30	Length (m)	48.600		

Node 11 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	173.500	Slope (1:X)	10.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	14	Depth (m)	
Safety Factor	2.0	Width (m)	1.000	Inf Depth (m)	
Porosity	0.30	Length (m)	57.000		

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Node 12 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	167.425	Slope (1:X)	277.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	13	Depth (m)	
Safety Factor	2.0	Width (m)	1.000	Inf Depth (m)	
Porosity	0.30	Length (m)	41.600		

Node 13 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	168.875	Slope (1:X)	100.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	4	Depth (m)	
Safety Factor	2.0	Width (m)	0.600	Inf Depth (m)	
Porosity	0.30	Length (m)	34.800		

Node 15 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	167.200	Slope (1:X)	292.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	13	Depth (m)	
Safety Factor	2.0	Width (m)	1.000	Inf Depth (m)	
Porosity	0.30	Length (m)	58.500		

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Results for 200 year Critical Storm Duration. Lowest mass balance: 96.34%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
60 minute summer	1	35	184.096	0.871	246.7	25.5734	0.0000	SURCHARGED
60 minute summer	2	32	183.455	0.155	67.5	0.6967	0.0000	OK
60 minute summer	3	33	182.943	0.218	235.4	0.3119	0.0000	OK
60 minute summer	4	36	183.040	1.240	205.6	32.6221	0.0000	FLOOD RISK
60 minute summer	5	34	181.456	0.231	353.6	0.3302	0.0000	OK
4320 minute winter	BASIN 1	4140	179.140	1.140	13.7	983.2049	0.0000	SURCHARGED
4320 minute winter	FLOW CONTROL 1	4140	179.140	1.240	8.4	1.4024	0.0000	SURCHARGED
4320 minute winter	6	4140	177.519	0.019	2.0	0.0210	0.0000	OK
60 minute summer	7	35	176.970	0.845	235.5	25.4477	0.0000	SURCHARGED
60 minute summer	8	36	175.789	0.164	165.1	0.2349	0.0000	OK
60 minute summer	9	36	175.502	1.277	272.7	53.9585	0.0000	FLOOD RISK
60 minute summer	10	36	174.662	1.012	365.1	16.7640	0.0000	SURCHARGED
60 minute summer	11	36	173.680	0.179	363.1	0.3725	0.0000	OK
60 minute summer	12	35	168.099	0.674	415.1	9.7987	0.0000	SURCHARGED
60 minute summer	13	32	169.075	0.200	52.8	0.9962	0.0000	OK
60 minute summer	14	33	168.715	0.190	52.1	0.2148	0.0000	OK
60 minute summer	15	33	167.405	0.205	641.3	3.0540	0.0000	OK
60 minute summer	16	33	161.964	2.093	747.9	4.5888	0.0000	SURCHARGED
60 minute winter	17	19	161.481	7.910	656.7	13.9765	0.0000	SURCHARGED
60 minute summer	18	32	165.115	0.115	86.6	0.3122	0.0000	OK
960 minute winter	BASIN 2	930	159.215	1.215	84.9	1365.4260	0.0000	FLOOD RISK
960 minute winter	FLOW CONTROL 2	930	159.209	1.259	12.3	1.4243	0.0000	FLOOD RISK
60 minute summer	OUTFALL	1	153.500	0.000	12.3	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
60 minute summer	1	1.000	3	175.5	1.791	1.378	10.8147	
60 minute summer	2	2.000	3	67.5	1.913	0.484	1.1215	
60 minute summer	3	1.001	5	235.3	3.425	0.591	2.6182	
60 minute summer	4	3.000	5	123.0	1.749	1.754	8.4930	
60 minute summer	5	1.002	BASIN 1	353.7	5.768	0.267	2.0082	
4320 minute winter	BASIN 1	1.003	FLOW CONTROL 1	8.4	0.327	0.053	0.3521	
4320 minute winter	FLOW CONTROL 1	Hydro-Brake®	6	2.0				
4320 minute winter	6	1.005	8	2.0	1.105	0.007	0.0563	
60 minute summer	7	4.000	8	163.5	1.799	1.328	10.2648	
60 minute summer	8	1.006	10	164.4	1.806	0.392	3.4133	
60 minute summer	9	5.000	10	153.2	1.389	1.249	14.5375	
60 minute summer	10	1.007	11	355.9	2.793	1.992	5.2843	
60 minute summer	11	1.008	12	363.2	3.208	0.346	6.2354	
60 minute summer	12	1.009	15	413.7	1.939	1.427	8.4580	
60 minute summer	13	6.000	14	52.1	1.458	1.000	1.2595	
60 minute summer	14	6.001	15	51.3	1.473	0.995	2.1719	
60 minute summer	15	1.010	16	641.7	4.296	0.262	10.7235	
60 minute summer	16	1.011	17	749.0	2.660	0.328	16.2243	
60 minute winter	17	1.012	BASIN 2	656.7	6.940	0.317	5.9149	
60 minute summer	18	7.000	16	86.5	2.522	0.522	1.4230	
960 minute winter	BASIN 2	1.013	FLOW CONTROL 2	12.3	0.470	0.237	0.1989	
960 minute winter	FLOW CONTROL 2	Hydro-Brake®	OUTFALL	12.3				702.1

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200 MW BESS, Knocknagael, Inverness
SuDS Management & Maintenance Plan

1 Introduction

Sustainable Drainage Systems (SuDS) features are utilised to manage rainfall and use landscape features to deal with surface water. SuDS control the flow rate and volume of water leaving the development area and reduce pollution by intercepting silt and cleaning run-off from hard surfaces.

Like all aspects of drainage systems, SuDS components should be regularly inspected and maintained. This ensures efficient operation and reduces the likelihood of failure. The level of inspection and maintenance will vary depending on the type of SuDS component. Further information on maintenance can be found in The SuDS Manual (CIRIA publication C753).

The SuDS and drainage features for the Proposed Development are to be maintained by the site owner/occupant.

This Plan should be updated following any changes to the proposed drainage design at detailed design stage.

2 Managing SuDS

The SuDS features have been designed for easy maintenance and comprise:

- Regular maintenance – litter collection and checking the inlets and outlets where water enters or leaves the SuDS feature.
- Occasional tasks – removing any silt that builds up, cutting back and clearing excessive vegetation growth, inspection of outlets, manholes and flow controls.
- Remedial work – repairing damage where necessary.

3 Contact

In the event of concern over any matter to do with the SuDS, please contact the site owner/occupant.

4 SuDS Maintenance

The surface water drainage system includes filter drains, attenuation basins, flow controls, pipes and manholes.

Surface water is collected by filter drains and directed to the attenuation basins via a piped network. Surface water is then directed to the outfall via a flow control.

Table 1 below provides a breakdown of general maintenance requirements to be undertaken, appropriate to the types of SuDS and surface water drainage systems proposed at this site.

Regular Maintenance		Frequency
1	**Litter Management** Check for and pick up litter around the entire site.	Monthly
2	**Inlets and Outlets** Remove silt and debris from inlets and outlets.	Quarterly
3	**Respond to reported blockages, etc.**	As required
Occasional Maintenance		**Frequency**
4	**Inspection of Control Chamber** Inspection of chambers for silt build up and visually check pipes appear clear and free flowing. Remove silt as required. Jetting as required.	Annually
5	**Inspection of Attenuation** Check for blockages within the connecting pipes.	Quarterly and following heavy storms
Remedial Work		**Frequency**
6	**Inspect SuDS systems to check for damage or failure** Undertake remedial work as required.	Annually
7	**Silt control and removal** Wash or replace filter medium when required.	As required

Table 1: SuDS General Maintenance Requirements

Tables 2 to 5 below provides a breakdown of typical maintenance requirements appropriate to the types of SuDS proposed at this site.

Operation and Maintenance Requirements for Attenuation Basins		
Responsible for Maintenance	**Site Owner/Occupier**	
Maintenance Schedule	**Required Action**	**Typical Frequency**
Regular maintenance	Remove litter and debris.	Monthly
	Cut grass - for spillways and access routes.	Monthly (during growing season)
	Cut grass - meadow grass in and around basins.	Half yearly (spring - before nesting season, and autumn)
	Manage other vegetation and remove nuisance plants.	Monthly (at start), then as required
	Inspect inlets, outlets and overflows for blockages, and clear if required.	Monthly
	Inspect banksides, structures, pipework etc for evidence of physical damage.	Monthly
	Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies.	Monthly (for first year), then annually
	Check any penstocks and other mechanical devices.	Annually
	Tidy all dead growth before start of growing season.	Annually
	Remove sediment from inlets, outlets and forebay.	Annually
	Manage wetland plants in outlet pool, where provided.	Annually
Occasional maintenance	Reseed areas of poor vegetation growth	To be reviewed every 2 years
	Prune and trim any trees and remove cuttings	Every 2 years
	Remove sediment from inlets, outlets, forebay and main basins when required	Every 5 years (likely to be minimal requirements where effective upstream source control is provided)
Remedial actions	Repair erosion or other damage by reseeding or re-turfing.	As required
	Realignment of rip-rap.	As required
	Repair/rehabilitation of inlets, outlets and overflows.	As required
	Relevel uneven surfaces and reinstate design levels.	As required

Table 2: Site specific maintenance requirements – Attenuation Basins

Operation and Maintenance Requirements for Pipes, Manholes and Gullies		
Responsible for Maintenance	**Site Owner/Occupier**	
Maintenance Schedule	**Required Action**	**Typical Frequency**
Regular inspections	Remove cover and inspect, ensuring that water is flowing freely and that the exit route for water is unobstructed. Remove debris and silt.	Annually and after leaf fall in autumn
Remedial action	Repair physical damage if necessary.	As required
Monitoring	Inspect for evidence of poor performance. CCTV survey to investigate poor performance.	As required

Table 3: Site specific maintenance requirements – Pipes, manholes and gullies

Operation and Maintenance Requirements for Flow Control		
Responsible for Maintenance	**Site Owner/Occupier**	
Maintenance Schedule	**Required Action**	**Typical Frequency**
Routine maintenance	Remove litter and debris and inspect for sediment, oil and grease accumulation	Six monthly
	Remove sediment, oil, grease and floatables	As necessary – indicated by system inspections or immediately following significant spill
Remedial actions	Replace malfunctioning parts or structures	As required
Monitoring	Inspect for evidence of poor operation	Six monthly
	Inspect sediment accumulation rates and establish appropriate removal frequencies	Monthly during first half year of operation, then every six months

Table 4: Site specific maintenance requirements – Flow control

Operation and Maintenance Requirements for Filter Drains		
Responsible for Maintenance	**Site Owner/Occupier**	
Maintenance Schedule	**Required Action**	**Typical Frequency**
Regular maintenance	Remove litter (including leaf litter) and debris from filter drain surface, access chambers and pre-treatment devices	Monthly, or as required
	Inspect filter drain surface, inlet/outlet pipework and control systems for blockages, clogging, standing water and structural damage	Monthly
	Inspect pre-treatment systems, inlets and perforated pipework for silt accumulation, and establish appropriate silt removal frequencies	Six monthly
	Remove sediment from pre-treatment	Six monthly, or as required
Occasional maintenance	Remove or control tree roots where they are encroaching the sides of the filter drain, using recommended methods (eg NJUG, 2007 or BS 3998:2010)	As required
	At locations with high pollution loads, remove surface geotextile and replace, and wash or replace overlying filter medium	Five yearly, or as required
	Clear perforated pipework of blockages	As required

Table 5: Site specific maintenance requirements – Filter drain

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