Limekiln BESS and Substation Extension

Flood Risk Assessment & Drainage Impact Assessment

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Basis of Report

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Acronyms and Abbreviations

AEP	Annual Exceedance Probability
AOD	Above Ordnance Datum
CC	Climate Change
CIRIA	Construction Industry Research and Information Association
DTM & DSM	Digital Terrain Model, Digital Surface Model
ENA	Energy Networks Association
FEH	Flood Estimation Handbook
FFL	Finished Floor Level
FOI	Freedom of Information
FRA	Flood Risk Assessment
LiDAR	Light Detection and Ranging
NFRA	National Flood Risk Assessment
NPF4, NPF3	National Planning Framework 4, 3
NGR	National Grid Reference
OS	Ordnance Survey
QA	Quality Assurance
ReFH	Revitalised Flood Hydrograph
RCP	Representative Concentration Pathway
SEPA	Scottish Environment Protection Agency
SPP	Scottish Planning Policy
SuDS	Sustainable Drainage Systems
THC	The Highland Council
UKCP18	United Kingdom Climate Projections – 2018 dataset

1.0 Introduction

SLR Consulting Ltd (SLR) has been appointed by Boralex Ltd to provide consulting services to support a proposed battery energy storage system (BESS) development and Substation Extension at Limekiln, located at National Grid Reference (NGR) NC 97681 62684 with a nearest corresponding postcode area of KW14 7RR.

This report addresses the flood risk and outline drainage aspects associated with the proposed development.

1.1 Policy and Guidance

This assessment has been completed in accordance with relevant guidance issued by The Highland Council (THC), The Scottish Government, and the Scottish Environment Protection Agency (SEPA). It takes cognisance of *National Planning Framework 4*[1] and the *Flood Risk Management (Scotland) Act 2009.* This assessment also references and takes due consideration (where appropriate) of the following principal guidance and policy documents:

- British Standards Institution (2017), Assessing and Managing Flood Risk in Development – Code of Practice, Report BS-8533:2017, October 2017;
- CIRIA (2004) Development and Flood Risk – Guidance for the construction Industry, Report C624;
- SEPA (2022) Technical Flood Risk Guidance for Stakeholders[2] (Reference SS-NFR-P-002), June 2022; and
- SEPA (2024) Flood Risk and Land Use Vulnerability Guidance[3], July 2024;
- SEPA (2025) Climate Change Allowances for Flood Risk Assessment in Land Use Planning[4], Version 6, February 2025;
- The Highland Council Supplementary Guidance on Flood Risk & Drainage Impact Assessment[5];
- Guidance for Pollution Prevention: Containing major spillages and firewater at industrial sites – GPP18[6]; and,
- Energy Network Association (2018), Engineering Technical Report 138[7].

[1] Scottish Government (2023), National Planning Framework 4, available at: https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2023/02/national-planning-framework-4/documents/national-planning-framework-4-revised-draft/national-planning-framework-4-revised-draft/govscot%3Adocument/national-planning-framework-4.pdf, last accessed June 2025

[2] Scottish Environment Protection Agency (2022), Technical Flood Risk Guidance for Stakeholders, available at: https://www.sepa.org.uk/environment/land/planning/guidance-and-advice-notes/, last accessed June 2025

[3] Scottish Environment Protection Agency (2024), Flood Risk and Land Use Vulnerability Guidance, available at: land-use-vulnerability-guidance.docx, last accessed June 2025

[4] Scottish Environment Protection Agency (2025), Climate Change Allowances for Flood Risk Assessment in Land Use Planning, available at: https://www.sepa.org.uk/media/jjwpxuso/climate-change-allowances-guidance_v6.pdf, last accessed June 2025

[5] The Highland Council (2013), Flood Risk & Drainage Impact Assessment: Supplementary Guidance, available at: https://www.highland.gov.uk/directory_record/712040/flood_risk_and_drainage, last accessed June 2025

[6] NIEA, SEPA (2024) Guidance for Pollution Prevention: Containing major spillages and firewater at industrial sites – GPP18, available at: https://www.netregs.org.uk/media/dgokst5q/gpp18-final.pdf, last accessed June 2025

[7] Energy Network Association (2018), Engineering Technical Report 138, available at: https://www.ena-eng.org/ena-docs/D0C3XTRACT/ENA_ET_138_Extract_180902050400.pdf, last accessed June 2025

1.2 Site Location

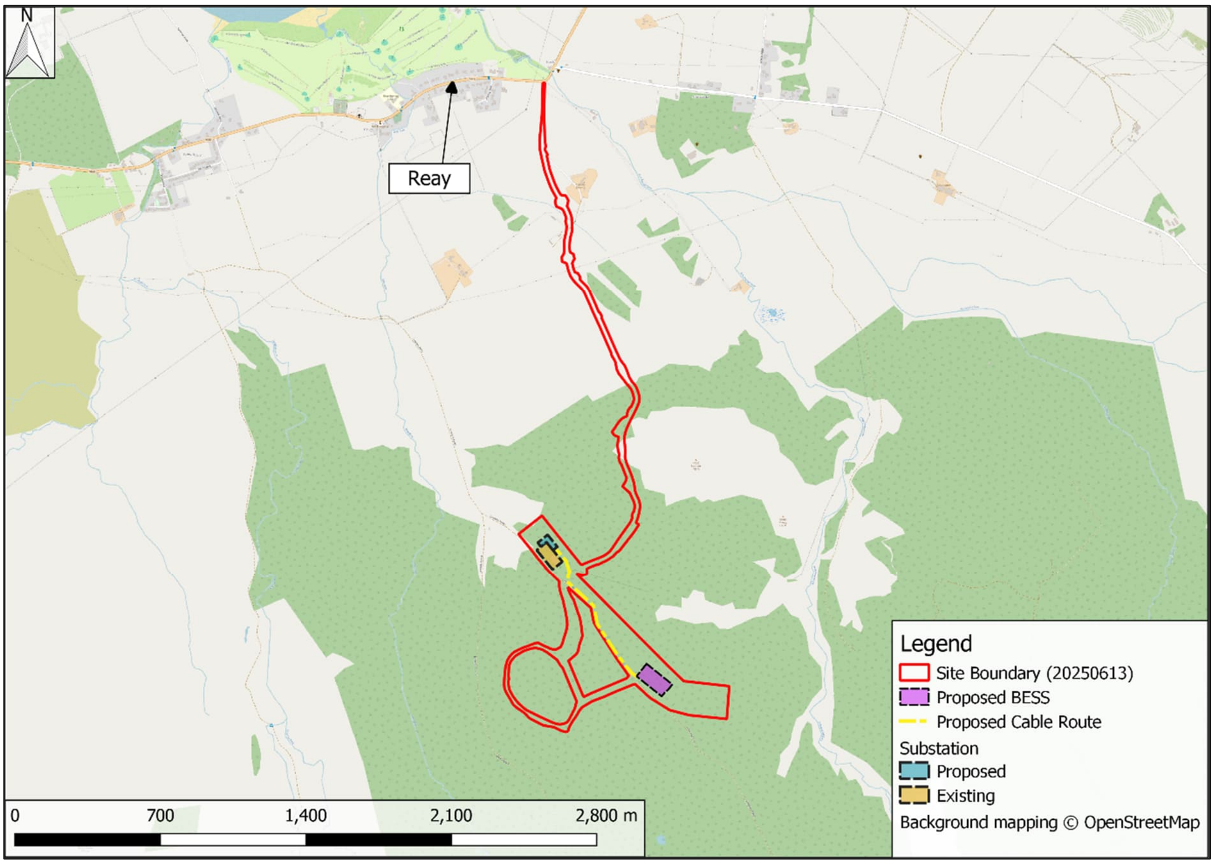
The site is located on an existing wind farm and forestry site, with the site entrance located some 200 m east of Reay. The proposed BESS site is presently comprised of felled forestry, and the proposed Substation Extension site is presently comprised of felled forestry land to the north of the existing Limekiln Substation.

The proposed development locations are both bounded on all sides by the existing forestry/windfarm site and associated tracks.

Access and egress to/from the site are afforded by the existing forestry/windfarm tracks from the A836.

A site location plan is provided in Figure 1.

Figure 1 : Site Location



1.3 Proposed Development

The proposed development is comprised of an extension to an existing substation site, a proposed battery energy storage system (BESS) site, and associated underground cable infrastructure (Figure 1). The proposed development is to be served entirely by existing windfarm tracks and the tracks do not require any upgrades.

The underground cable is not assumed to contribute to impermeable area and as such is not assessed from a flood risk and drainage perspective.

A site layout plan is included as Appendix A.

1.4 Topography

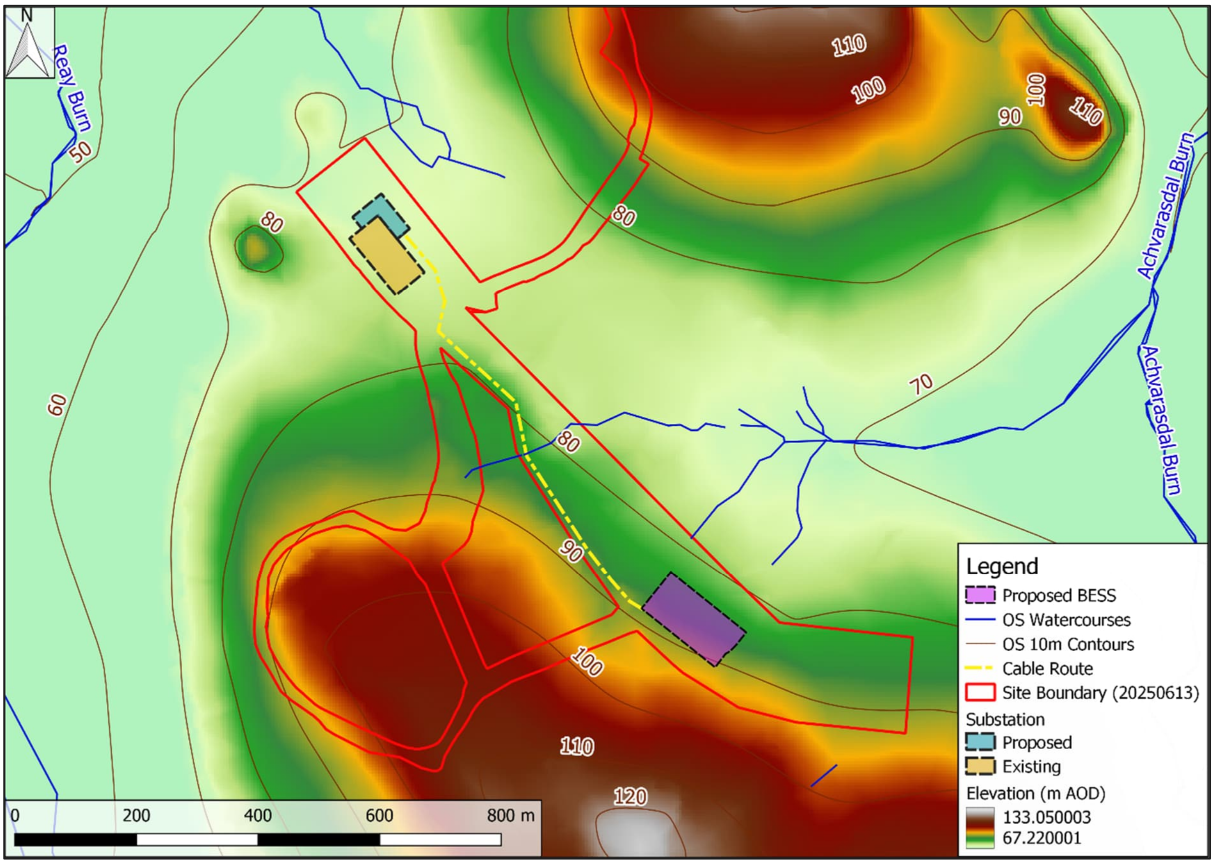
The site topography has been informed by a site-specific Digital Elevation Model (DEM) and Ordnance Survey (OS) 10m contours.

The site topography generally slopes from south to north, with a high point of approximately 105m above Ordnance Datum (AOD) in the southwestern corner of the site, and a low of approximately 25m AOD at the site access just east of Reay.

The proposed Substation Extension site ranges from 71.7m AOD in the southeastern corner to a low of 70.3m AOD in the western corner. The proposed BESS site ranges from 90m AOD in the southern corner to 81m AOD in the northern corner.

The site topography is indicated in Figure 2.

Figure 2 : Local Topography



It is understood that land raising is to be carried out in order to facilitate the development, with cut and fill diagrams to be provided at a later stage.

1.5 Geological Setting

The Soil Map of Scotland[8] indicates that the sites are underlain by peat and peaty podzols.

The proposed Substation Extension site is indicated on British Geological Survey (BGS) mapping[9] to be underlain by igneous bedrock of the Strath Halladale Granite Formation,

[8] Scotland's Soils, available at: https://map.environment.gov.scot/Soil_maps/?layer=2, last accessed June 2025

[9] BGS, GeoIndex Onshore, available at: https://mapapps2.bgs.ac.uk/geoindex/home.html?layers=BGSBedEngGeol,BGSSupEngGeol,BGSEGFSReports,BGSUSAReports, last accessed June 2025

comprised of granite and biotite. The bedrock is shown to be overlain by superficial peat deposits.

The proposed BESS location is underlain by bedrock of the Tobaireach Conglomerate Member, comprised of conglomerate sedimentary bedrock. The bedrock in this area is overlain by glacial till superficial deposits of the Thormaid Till Member.

The igneous bedrock is classed by the BGS as a low productivity aquifer whereby small amounts of groundwater may be present in the near surface weathered zone and secondary fractures. The sedimentary bedrock is classed by the BGS as a moderately productive, locally important, multi-layered aquifer. Glacial till and peat are not considered important aquifers.

1.6 Local Hydrology

The site lies in the catchment of the Reay Burn to the west and the Achvarasdal Burn to the east, which both flow in a northerly direction before discharging into the North Sea at Sandside Bay. The proposed Substation Extension location is approximately 80m east of a tributary of the Reay Burn at its closest extent, and the proposed BESS site is approximately 85m south of a tributary of the Achvarasdal Burn at its closest extent.

The local hydrological context is shown on Figure 9.1 of the Environmental Report.

1.7 Storm and Flood Risk Terminology

Flood risks are typically expressed by the probability of the occurrence of a flood event (maximum flood height or other such indicator) of stated magnitude or greater in any one year – termed the Annual Exceedance Probability (AEP). This may be expressed as a percentage (such as 1%, 0.5%, etc.) or by the equivalent chance of occurrence (1:100, 1:200, etc.).

Where flood events have a climate change factor included, the flood event is denoted in this report by “plus CC”. For example, the 1:200 AEP flood event with climate change included is denoted “0.5% AEP plus CC” or “1:200 AEP plus CC”.

2.0 Flood Risk Review – Sources of Information

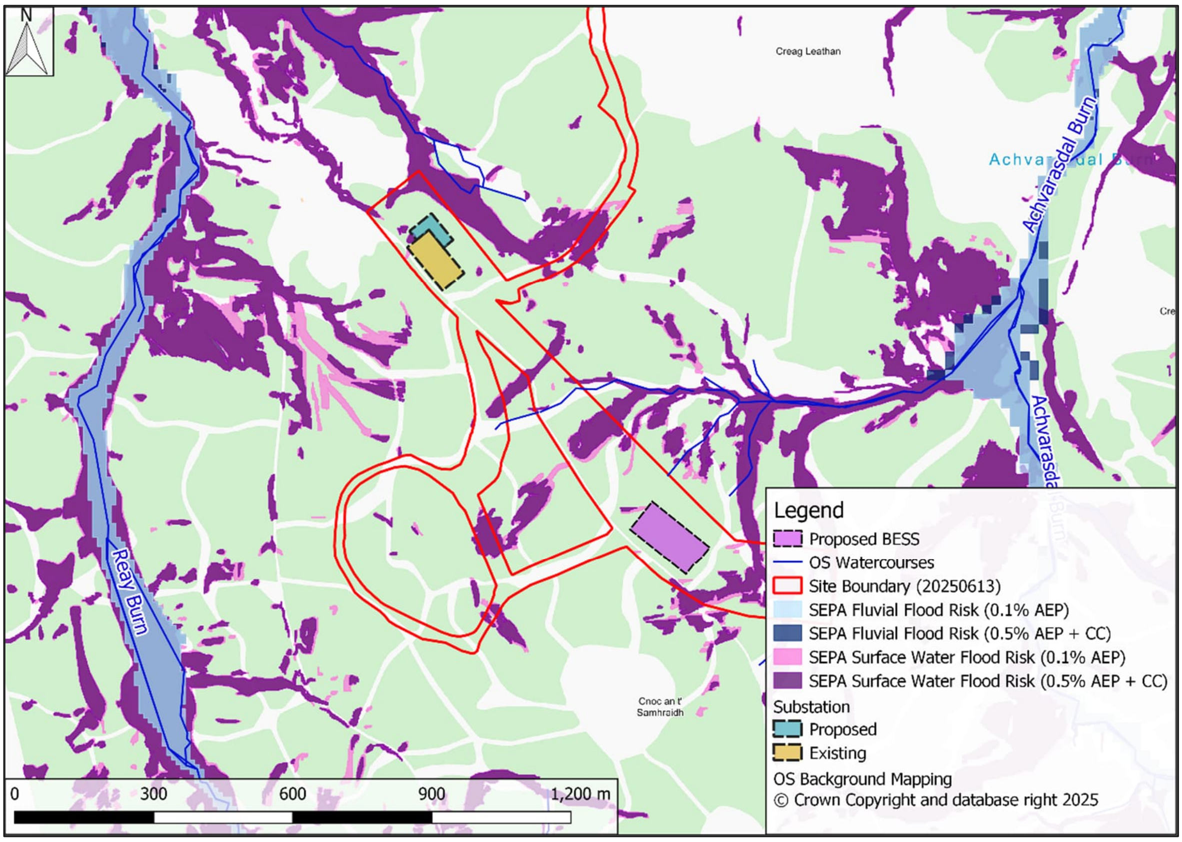
2.1 National Floodplain Mapping and Assessment

Strategic-level information regarding the tidal, fluvial and surface water flood risk at the site has been obtained from SEPA via the online SEPA Flood Maps[10]. Information on potential groundwater flood risk has been obtained from the SEPA Flood Risk Management Maps[11]. Information on flooding from reservoirs has been obtained from the SEPA Reservoirs Map[12].

The SEPA flood mapping for the site and surrounds is shown in Figure 3. The mapping shows that both the proposed Substation Extension and the proposed BESS is not at risk of fluvial flooding up to and including the 0.1% AEP event. Some areas of surface water flooding are indicated to lie in the vicinity of the proposed development locations, though are not indicated to cause flood risk to the proposed development areas themselves.

Figure 4 shows the surface water flood depths for the 0.1% AEP event. The surface water flooding in the vicinity of the development areas is indicated to be less than 300mm in depth.

Figure 3 : SEPA Flood Mapping

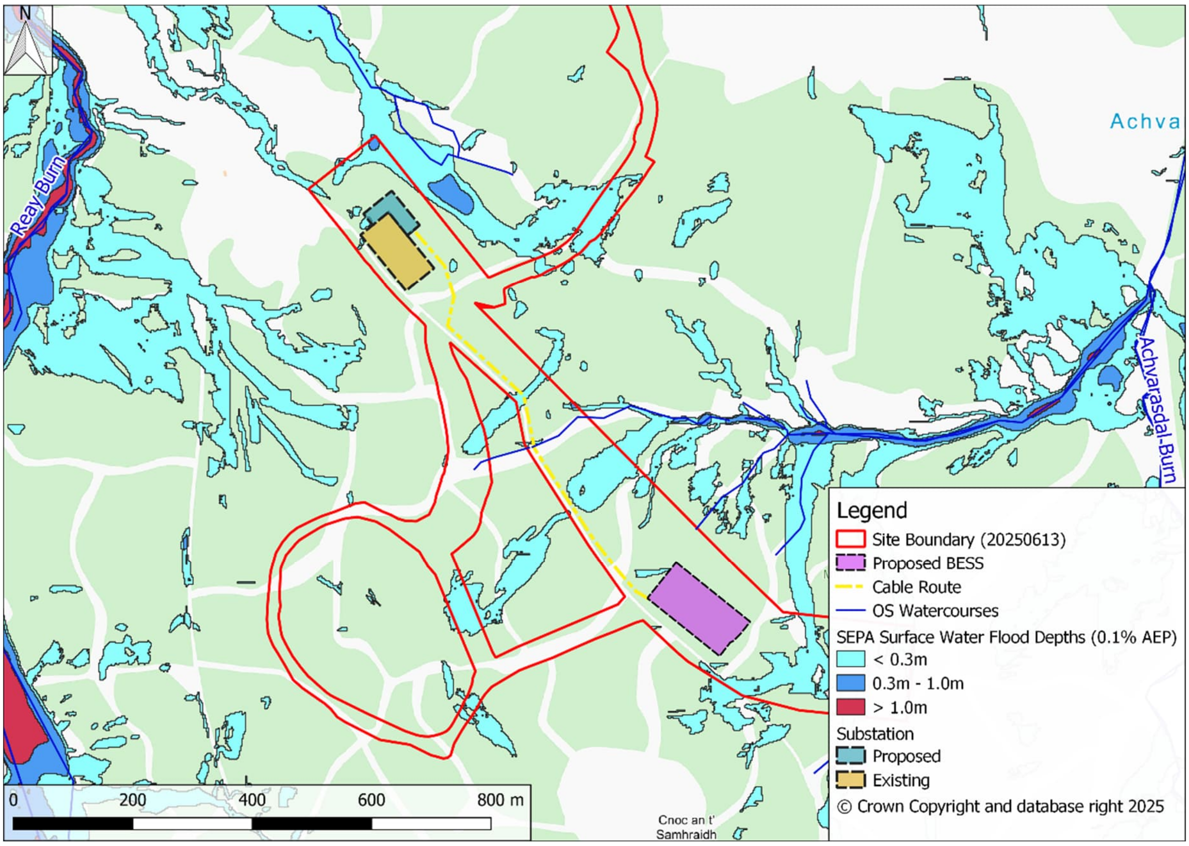


10 Scottish Environment Protection Agency (2025) SEPA Flood Maps, available at https://scottishepa.maps.arcgis.com/apps/webappviewer/index.html?id=3098bbef089c4dd79e5344a0e1e7c91c&showLayers=FloodMapsBasic_2743;FloodMapsBasic_2743_0;FloodMapsBasic_2743_1;FloodMapsBasic_2743_2;FloodMapsBasic_2743_3;FloodMapsBasic_2743_4;FloodMapsBasic_2743_5;FloodMapsBasic_2743_6;FloodMapsBasic_2743_7;FloodMapsBasic_2743_8;FloodMapsBasic_2743_9;FloodMapsBasic_2743_10;FloodMapsBasic_2743_11, last accessed June 2025

11 Scottish Environment Protection Agency (2016) Online Flood Risk Management Maps, available at: https://map.sepa.org.uk/floodmap/map.htm, last accessed June 2025

12 Scottish Environment Protection Agency (2022), Reservoirs Map, available at: https://map.sepa.org.uk/reservoirsfloodmap/Map.htm, last accessed June 2025

Figure 4 : SEPA Surface Water Flood Depths (0.1% AEP)



2.2 Mapping and Terrain Data

Aerial imagery, OS contour data (10m intervals), and the localised site topographic survey referred to in Section 1.4 have been used to assess the context of the site and its immediate surroundings.

2.3 Flood History and Records

The site is not designated as a Potentially Vulnerable Area (PVA) by the SEPA National Flood Risk Assessment (NFRA)[13] or the updated SEPA PVAs for 2028-2034[14]. There are no historical flood records for the area indicated on the SEPA NRFA website.

2.4 Consultation

2.4.1 The Highland Council

A data request with regard to historical flooding in the area or any relevant information on the nearby burns was submitted to The Highland Council's (THC) flooding team on 19th June 2025. At the time of writing no response had been received.

[13] Scottish Environment Protection Agency (2019) Flood Risk Management Strategies, available at: https://informatics.sepa.org.uk/NFRA2018/, last accessed June 2025

[14] Scottish Environment Protection Agency (2024), Potentially Vulnerable Areas 2028 – 2034, available at: https://storymaps.arcgis.com/stories/1ea8bc3b79b748d79a2fd0e9905d23de, last accessed June 2025

2.4.2 SEPA

A data request with regard to historical flooding in the area or any relevant information on the nearby burns was submitted to SEPA on 19th June 2025. At the time of writing no response had been received.

3.0 Planning Context

3.1 National Planning Framework 4

National Planning Framework 4 (NPF4)[1] was introduced in February 2023. Flood risk is addressed in Policy 22 of NPF4, which states the following:

a) Development proposals at risk of flooding or in a flood risk area will only be supported if they are for:

i. essential infrastructure where the location is required for operational reasons;

ii. water compatible uses;

iii. redevelopment of an existing building or site for an equal or less vulnerable use; or,

iv. redevelopment of previously used sites in built up areas where the LDP has identified a need to bring these into positive use and where proposals demonstrate that long term safety and resilience can be secured in accordance with relevant SEPA advice.

The protection offered by an existing formal flood protection scheme or one under construction can be taken into account when determining flood risk. In such cases, it will be demonstrated by the applicant that:

- all risks of flooding are understood and addressed;
- there is no reduction in floodplain capacity, increased risk for others, or a need for future flood protection schemes;
- the development remains safe and operational during floods;
- flood resistant and resilient materials and construction methods are used; and,
- future adaptations can be made to accommodate the effects of climate change.

Additionally, for development proposals meeting criteria part iv), where flood risk is managed at the site rather than avoided these will also require:

- the first occupied/utilised floor, and the underside of the development if relevant, to be above the flood risk level and have an additional allowance for freeboard; and,
- that the proposal does not create an island of development and that safe access/ egress can be achieved.

b) Small scale extensions and alterations to existing buildings will only be supported where they will not significantly increase flood risk.

c) Development proposals will:

i. not increase the risk of surface water flooding to others, or itself be at risk.

ii. 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,

iii. seek to minimise the area of impermeable surface.

d) Development proposals will be supported if they can be connected to the public water mains. If connection is not feasible, the applicant will need to demonstrate that water for drinking water purposes will be sourced from a sustainable water source that is resilient to periods of water scarcity.

e) Development proposals which create, expand or enhance opportunities for natural flood risk management, including blue and green infrastructure, will be supported.

NPF4 defines an area at risk of flooding as follows:

For planning purposes, at risk of flooding or in a flood risk area means land or built form with an annual probability of being flooded of greater than 0.5% (1:200 AEP) which must include an appropriate allowance for future climate change.

This risk of flooding is indicated on SEPA's future flood maps or may need to be assessed in a flood risk assessment. An appropriate allowance for climate change should be taken from the latest available guidance and evidence available for application in Scotland. The calculated risk of flooding can take account of any existing, formal flood protection schemes in determining the risk to the site.

Where the risk of flooding is less than this threshold, areas will not be considered 'at risk of flooding' for planning purposes, but this does not mean there is no risk at all, just that the risk is sufficiently low to be acceptable for the purpose of planning. This includes areas where the risk of flooding is reduced below this threshold due to a formal flood protection scheme.

3.2 Local Plan

The Highland-wide Local Development Plan[15] sets out guidance with regard to flood risk and drainage.

Policy 64 on Flooding states the following:

Development proposals should avoid areas susceptible to flooding and promote sustainable flood management.

Development proposals within or bordering medium to high flood risk areas, will need to demonstrate compliance with Scottish Planning Policy (SPP) through the submission of suitable information which may take the form of a Flood Risk Assessment.*

Development proposals outwith indicative medium to high flood risk areas may be acceptable.

However, where:

- *better local flood risk information is available and suggests a higher risk;*
- *a sensitive land use (as specified in the risk framework of Scottish Planning Policy) is proposed, and/or;*
- *the development borders the coast and therefore may be at risk from climate change;*

A Flood Risk Assessment or other suitable information which demonstrates compliance with SPP will be required.

Developments may also be possible where they are in accord with the flood prevention or management measures as specified within a local (development) plan allocation or a development brief. Any developments, particularly those on the flood plain, should not compromise the objectives of the EU Water Framework Directive.

Where flood management measures are required, natural methods such as restoration of floodplains, wetlands and water bodies should be incorporated, or adequate justification should be provided as to why they are impracticable.

[15] The Highland Council (2012), Highland-wide Local Development Plan, available at: https://www.highland.gov.uk/info/178/development_plans/199/highland-wide_local_development_plan, last accessed February 2025

*Superseded by NPF4.

Policy 66 on Surface Water Drainage states the following:

*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.*

** Superseded by Sewers for Scotland v4.0.

The Supplementary Guidance on Flood Risk & Drainage Impact[16] sets out the guidance in further detail. This document specifies that the SEPA Checklist and a Compliance Certificate (provided within the guidance document) are required to be submitted with the FRA document. These items are attached as Appendix E and F respectively.

3.3 SEPA Guidance

The SEPA Flood Risk and Land Use Vulnerability Guidance[17] outlines how SEPA assess vulnerability of flooding of different land use with the following Categories:

- Most Vulnerable Uses;
- Highly Vulnerable Uses;
- Least Vulnerable Uses;
- Essential Infrastructure; and,
- Water Compatible Uses.

With reference to Table 1 (SEPA Land Use Vulnerability Classification) of the guidance, the extension of the existing substation is considered to fall under the **Essential Infrastructure** category as *'All forms of renewable, low-carbon and zero emission technologies for electricity generation and distribution and transmission electricity grid networks and primary sub stations'*. The BESS would be connected to the substation via underground cabling and is considered to also fall under Essential Infrastructure.

3.4 ENA Guidance

The Energy Networks Association (ENA) guidance presented in Engineering Technical Report 138[5] recommends that flood risk to critical energy infrastructure in substations is assessed for the 0.1% AEP event plus climate change, with a minimum freeboard of 300mm. This recommendation is for substation resilience purposes, and is not a requirement for planning.

[16] The Highland Council (2013), Flood Risk and Drainage Impact Assessment Supplementary Guidance, available at: https://www.highland.gov.uk/directory_record/712040/flood_risk_and_drainage, last accessed June 2025

[17] SEPA (2024) Flood Risk and Land Use Vulnerability Guidance, July 2024, available at: https://www.sepa.org.uk/environment/land/planning/guidance-and-advice-notes/, last accessed June 2025

3.5 Climate Change & Design Event

The relevant SEPA climate change allowances[18] have been assessed for the site, which lies in the North Highland river basin. Based on the small size of the local surface water catchments, the recommended allowance for the assessment of flood risk to the site from these sources and for the outline drainage design would be a 42% applied to peak rainfall intensities.

[18] SEPA (2025) Climate change allowance for flood risk assessments in land use planning V6, February 2025, available at https://www.sepa.org.uk/media/jjwpxuso/climate-change-allowances-guidance_v6.pdf, last accessed May 2025

4.0 Potential Sources of Flooding

4.1 Methodology and Best Practice

This FRA report has been prepared in accordance with the advice and requirements prescribed in current best practice documents relating to management of flood risk in development outlined in NPF4, SEPA, ENA, and THC guidance.

A screening study has been completed to identify whether there are any potential sources of flooding at the site which may warrant further consideration. If required, any potential significant flooding issues identified in the screening study are then considered in subsequent sections of this assessment.

4.2 Screening Study

Potential sources of flooding include:

- Flooding from the sea or tidal flooding;
- flooding from rivers or fluvial flooding;
- flooding from surface water and overland flow;
- flooding from groundwater;
- flooding from sewers;
- flooding from reservoirs, canals, and other artificial sources; and,
- flooding from infrastructure failure.

Flood risk definitions within the screening assessment are based on qualitative technical assessment considering the information reviewed, risk to Site users and the development itself.

The flood risk from each of these potential sources is assessed in Table 1.

Table 1 : Flood Risk Screening

Source of Flood Risk	Description	Flood Risk Assessment
Tidal	The proposed Substation Extension is located approximately 3km south of the sea at Sandside Bay, and the proposed BESS site is located some 3.5km south of the sea. Both development locations are elevated above 80m AOD. It is therefore considered that the site is not at tidal flood risk.	No Flood Risk
Fluvial	The proposed Substation Extension location and the proposed BESS site are not indicated on the SEPA mapping to be at fluvial flood risk from the Reay Burn or Achvarasdal Burn up to and including the 0.5% AEP plus CC event. Flood risks from the minor tributaries of these watercourses is included in the SEPA surface water mapping as opposed to in the fluvial mapping. It is therefore considered that the proposed development is not at fluvial flood risk, and any flood risks from the minor tributaries will be assessed as surface water flood risk. Some fluvial flood risk is indicated to the existing access track from Reay for the 0.5% AEP event plus climate change. Given that the Substation Extension and BESS site will generally be unmanned, it is considered that a curtailment to the access track for the duration of a storm event is not considered to pose a significant flood risk to the development itself.	No Flood Risk
Pluvial (i.e., direct rainfall)	The proposed development is to be served by Sustainable Drainage Systems (SuDS) as outlined in Section 5.0 of this report. The proposed SuDS systems will be designed to attenuate up to and including the 0.5% AEP event + CC with no flooding. It is therefore considered that the site is not at pluvial flood risk.	Flood Risks Mitigated - Section 5.0

Source of Flood Risk	Description	Flood Risk Assessment
Surface Water Flows	SEPA mapping indicates several small areas of shallow surface water ponding (<300mm in depth) in the vicinity of the proposed development. Flooding is also noted along the tributaries of the Reay Burn and Achvarasdal Burn. The proposed development locations are situated significantly upslope of the tributaries and are therefore not expected to be at flood risk from these surface water sources. Any direct rainfall would be expected to be intercepted by the surface water drainage systems, and there are no surface water flow paths indicated through the proposed development areas. Surface water flooding is therefore not expected to present a flood risk to the proposed developments. Some surface water flood risk is indicated to the existing access track from Reay for the 0.5% AEP event plus climate change. Given that the Substation Extension and BESS site will generally be unmanned, it is considered that a curtailment to the access track for the duration of a storm event is not considered to pose a significant flood risk to the development itself.	Negligible Risk
Groundwater	SEPA flood mapping indicates that the site is not at risk from any wider area groundwater flood risk influences. It is expected that any groundwater in the local area would drain to the watercourse tributaries. The bedrock underlying the proposed Substation Extension site is noted to be low productivity aquifer, and it is not expected that this will pose a risk to the development. The bedrock underlying the proposed BESS site is indicated be a moderately productive aquifer. This is not expected to pose a risk to the site due to the	Negligible Risk

Source of Flood Risk	Description	Flood Risk Assessment
	positioning of the site upslope of the Achvarasdal Burn tributary, to which any rising groundwater flows would be expected to drain. Based on these considerations, there is a negligible risk of groundwater flooding from groundwater rise at the site.	
Sewers and Artificial Drainage Systems, and Water Supply	There are no known foul drainage systems at the proposed development locations. Any flooding from the existing substation surface water drainage systems would be expected to follow natural topographic gradients to the tributary of the Reay Burn. Based on these considerations, there is a negligible risk of flooding from drainage systems.	Negligible Risk
Infrastructure Failure (i.e., reservoirs, canals, culvert blockage, etc.)	The site is not indicated on the SEPA mapping to lie within the breach extents of any reservoirs. There are no bridges or culverts on the watercourses in the vicinity of the development locations that would be expected to present any flood risk to the development.	Negligible Risk

5.0 Drainage Impact Assessment

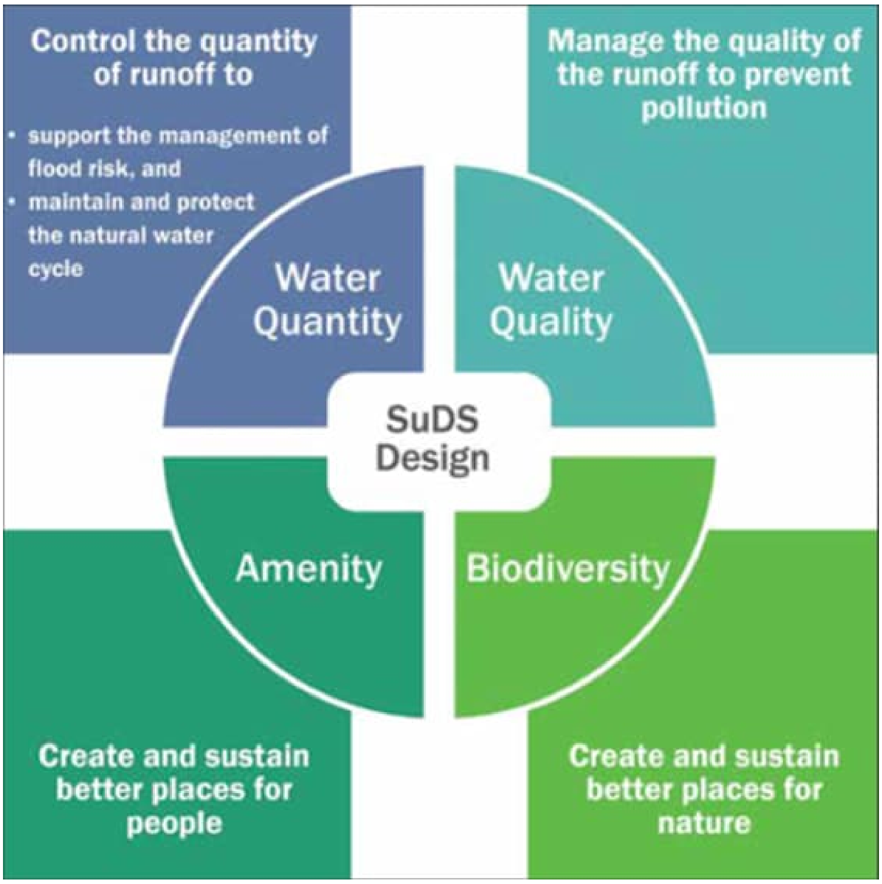
This Drainage Impact Assessment (DIA) sets out high-level principles for managing storm water for the proposed development in line with best practice and the requirements of The Highland Council.

This assessment is intended to demonstrate that, given the nature and quantum of development proposed, it will be feasible to drain the site in line with planning requirements.

5.1 Key Principles of Surface Water Management

Current best practice document; The Sustainable Drainage System (SuDS) Manual (CIRIA Report C753F)[19], promotes sustainable water management through the use of SuDS. There are four main categories of SuDS which are referred to as the 'four pillars of SuDS design' as depicted in **Figure 5**.

Figure 5 : Four Pillars of SuDS (extract from CIRIA Report C753)



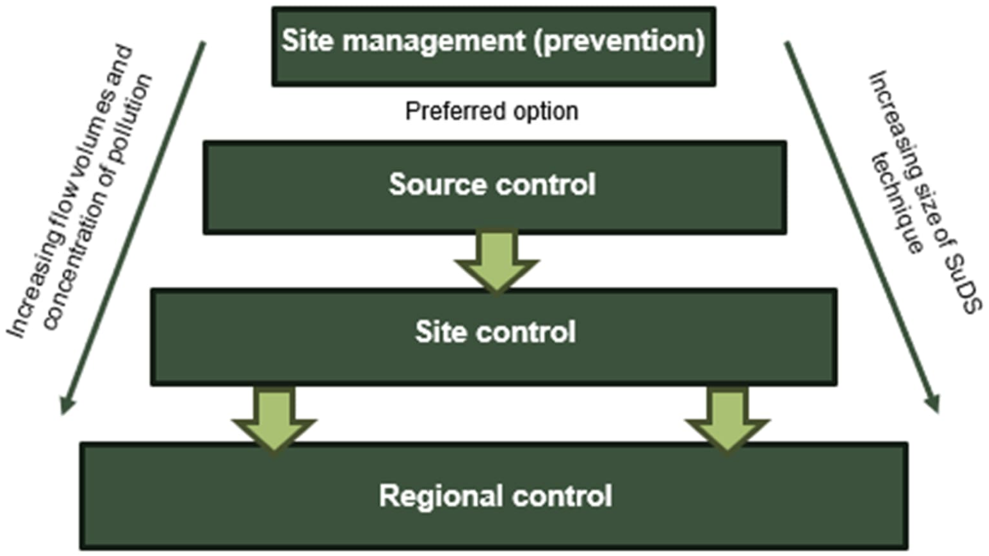
The SuDS Manual identifies a hierarchy of SuDS for managing runoff, which is commonly referred to as a 'management train.' The hierarchy of techniques is identified as:

- Prevention – the use of good site design and housekeeping measures on individual sites to prevent runoff and pollution (e.g., minimise areas of hard standing).
- Source Control – control of runoff at or very near its source (such as the use of rainwater harvesting).

[19] Report C753, The SuDS Manual; CIRIA (2015). Report C753F, December 2015.

- Site Control – management of water from several sub-catchments.
- Regional Control – management of runoff from several sites, typically in a retention pond or wetland.

Figure 6 : SuDS Management Train



It is generally accepted that the implementation of SuDS, as opposed to conventional drainage systems, provides a number of benefits by:

- reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding downstream;
- reducing the volumes and frequency of water flowing directly to watercourses or sewers from developed sites;
- improving water quality over conventional surface water sewers by removing pollutants from diffuse pollutant sources;
- reducing potable water demand through rainwater harvesting; and,
- improving amenity through the provision of public open spaces and wildlife habitat; and replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

5.2 Existing Surface Water Drainage Regime

5.2.1 BESS

The proposed BESS site is located on the reinstated temporary construction compound area which was used for Limekiln Wind Farm. There are no existing drainage provisions at the BESS site.

5.2.2 Substation Extension

The proposed Substation Extension site is partially served by an existing surface water drainage system which drains to a ditch that flows through the proposed extension location. The ditch is shown in Photograph 1. The sizing of the outlet from the platform drainage into the ditch could not be ascertained during the site inspection.

The existing ditch will require to be re-routed around or culverted beneath the proposed platform extension area. This should be accounted for at the detailed design stage.

Photograph 1 : Existing drainage ditch

5.3 Pre-Development Runoff Rates (Greenfield)

Greenfield runoff rates for the area equivalent to the proposed impermeable areas resulting from the development were estimated using industry-standard ReFH2 methodology[20], with the application of the latest FEH22 rainfall data and hydrological descriptors from the Flood Estimation Handbook (FEH) Web Service[21].

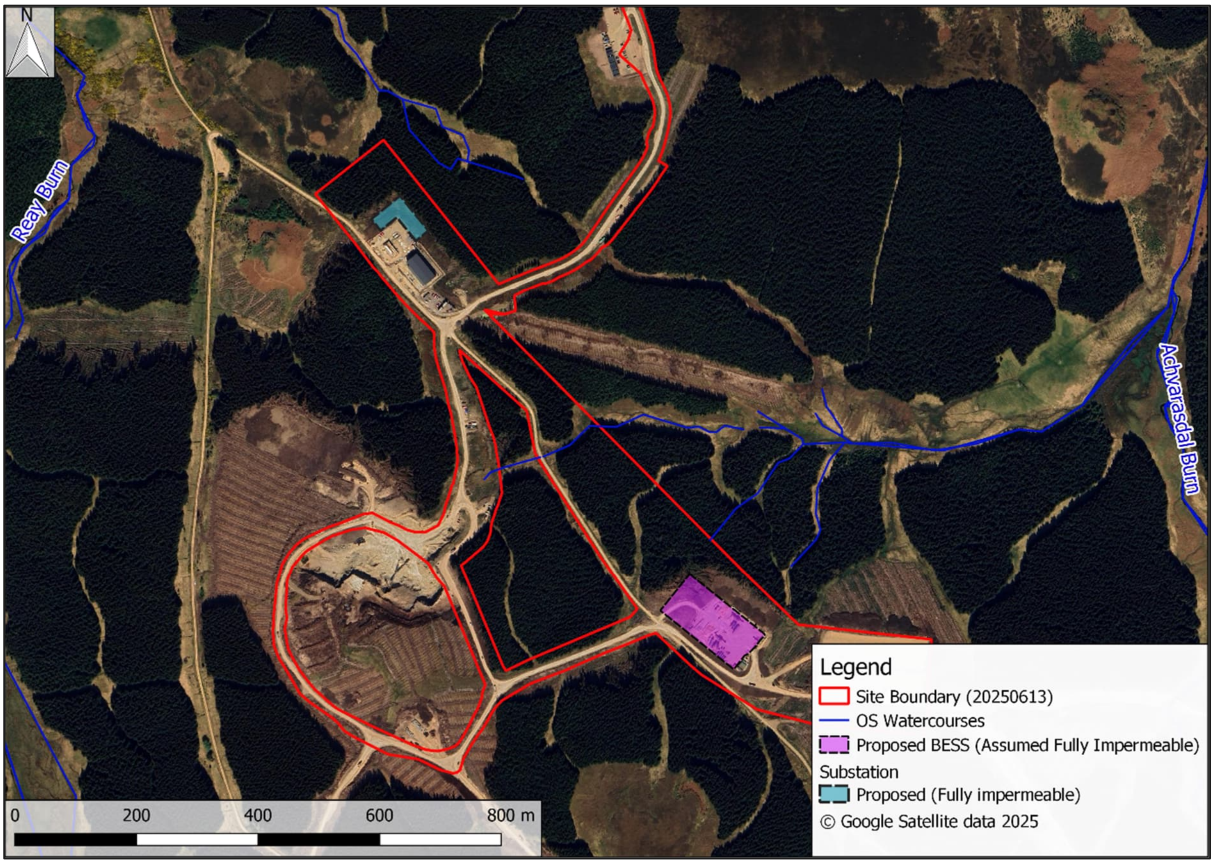
The impermeable area of the proposed BESS compound was determined by calculating the total compound area of 0.86ha for a conservative approach to the greenfield runoff estimation. Similarly for the proposed Substation Extension, the area outwith the existing drained platform area was calculated to be 0.27ha, which was also assumed to be fully impermeable for a conservative approach to the greenfield runoff estimation.

The assumed impermeable areas for each development are shown in Figure 7.

[20] Wallingford Hydro Solutions (2023), ReFH 2, available at: https://www.hydrosolutions.co.uk/software/refh-2/, last accessed June 2025

[21] UK Centre for Ecology and Hydrology, Flood Estimation Handbook Web Service, available online at https://fehweb.ceh.ac.uk/, last accessed June 2025

Figure 7 : Impermeable Areas



It is understood that some areas within each development location will comprise gravelled surfacing, and areas outwith these locations will remain undeveloped greenfield land. These changes will be incorporated at the detailed design stage.

The greenfield runoff rates for the assumed impermeable areas of the proposed development resulting from the ReFH2 analysis are summarised below in Table 2. Full ReFH2 calculations and results are included in Appendix B.

Table 2 : Greenfield Runoff Rates

Annual Exceedance Probability	Greenfield Runoff Rate (l/s)	
	Substation Extension	BESS
1:1	1.48	7.28
1:2	1.64	8.06
1:30	3.38	16.68
1:30 + 42%CC	4.91	24.26
1:200	5.37	26.49
1:200 + 42%CC	7.98	39.24

**Based on an impermeable area of 0.27ha for the Substation Extension and 1.2ha for the BESS.*

5.4 Proposed Discharge Arrangement

With reference to the SuDS Manual, the hierarchy of preferred disposal options for surface water runoff from development sites in decreasing order of sustainability is as follows:

- infiltration to ground;
- discharge to surface waters; or,
- discharge to sewer.

Table 3 summarises the suitability of disposal methods in the context of the Site and the Proposed Development. Based on this, runoff from the Site is proposed to drain to a watercourse.

Table 3 : Suitability of Surface Water Disposal Methods

Surface Water Disposal Method (in order of preference)	Suitability Description	Method Suitable (Y / N)
Infiltration to Ground	As discussed in Section 1.5, the soil and superficial geology at the site is considered low permeability and therefore infiltration is not considered a viable drainage option.	N
Surface Water Discharge	There are no major watercourses in the immediate vicinity of the proposed Substation Extension or BESS site. Some minor tributaries of the Reay Burn flow in a north-westerly direction to the northeast of the proposed Substation Extension location. A minor tributary of the Achvarasdal Burn is located to the northeast of the proposed BESS site and flows in a north-easterly direction towards the burn. New connections would be required to these minor tributaries for each of the proposed development locations. The proposed method of drainage for the Substation Extension would be a swale with limited outflow to the catchment of the Reay Burn tributary. The proposed method of drainage for the BESS site would be drainage to a detention basin with limited outflow to the minor tributary of the Achvarasdal Burn. Any exceedance of the proposed swale and detention basin would be expected to follow the natural/existing drainage regime to ultimately discharge to the respective burn tributaries.	Y

Surface Water Disposal Method (in order of preference)	Suitability Description	Method Suitable (Y / N)
Sewer Discharge	There are no formal sewers serving the site.	N

5.5 Conceptual Surface Water Drainage Strategy

The proposed drainage strategies detailed below will manage surface water runoff as close to the source as possible, seeking to mimic the existing runoff regimes and ensuring that there are no increases in peak discharge from the proposed impermeable areas on site. The analysis has been carried out using Causeway Flow software.

The final routing and details of the surface water drainage strategy which could be applied at the site are to be determined at detailed design stage. This would normally be undertaken during the post-planning stage or via an appropriately worded planning condition, in which individual hydraulic design parameters would be detailed as required. Notwithstanding, the following sections provide details of the intended system concept.

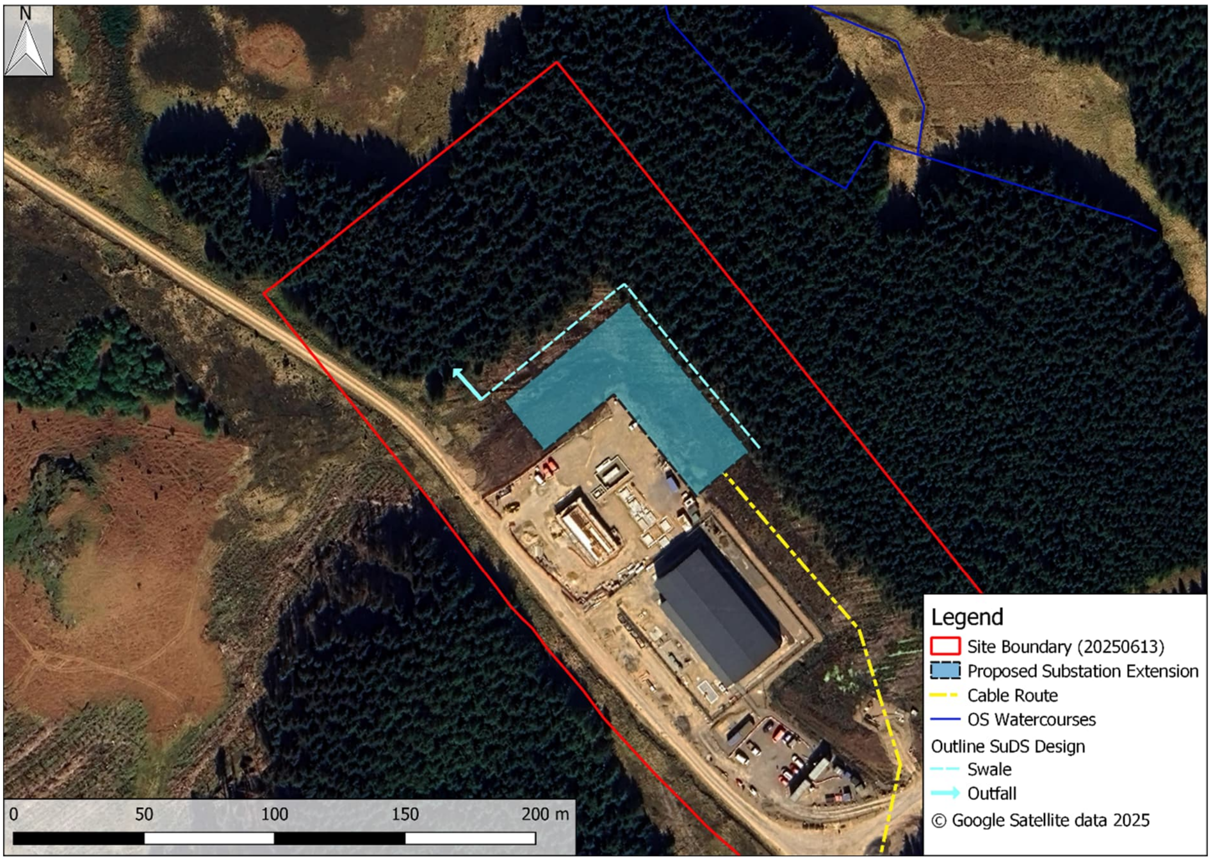
5.5.1 Substation Extension

Given that an existing portion of the proposed Substation Extension site is served by existing drainage, the proposed Substation Extension is estimated to result in an increase in impermeable area of up to 0.27ha. It is noted that some re-routing and/or culverting of the existing surface water drainage network may be required at the detailed design stage.

The proposed surface water drainage strategy will require the installation of a swale network along the northern boundaries of the proposed platform extension. The flows would then be discharged at a limited rate to the existing natural surface water drainage pathways to the nearby tributary of the Reay Burn.

The conceptual drainage strategy for this location is shown in Figure 8.

Figure 8 : Proposed Substation Extension – Conceptual Drainage Strategy

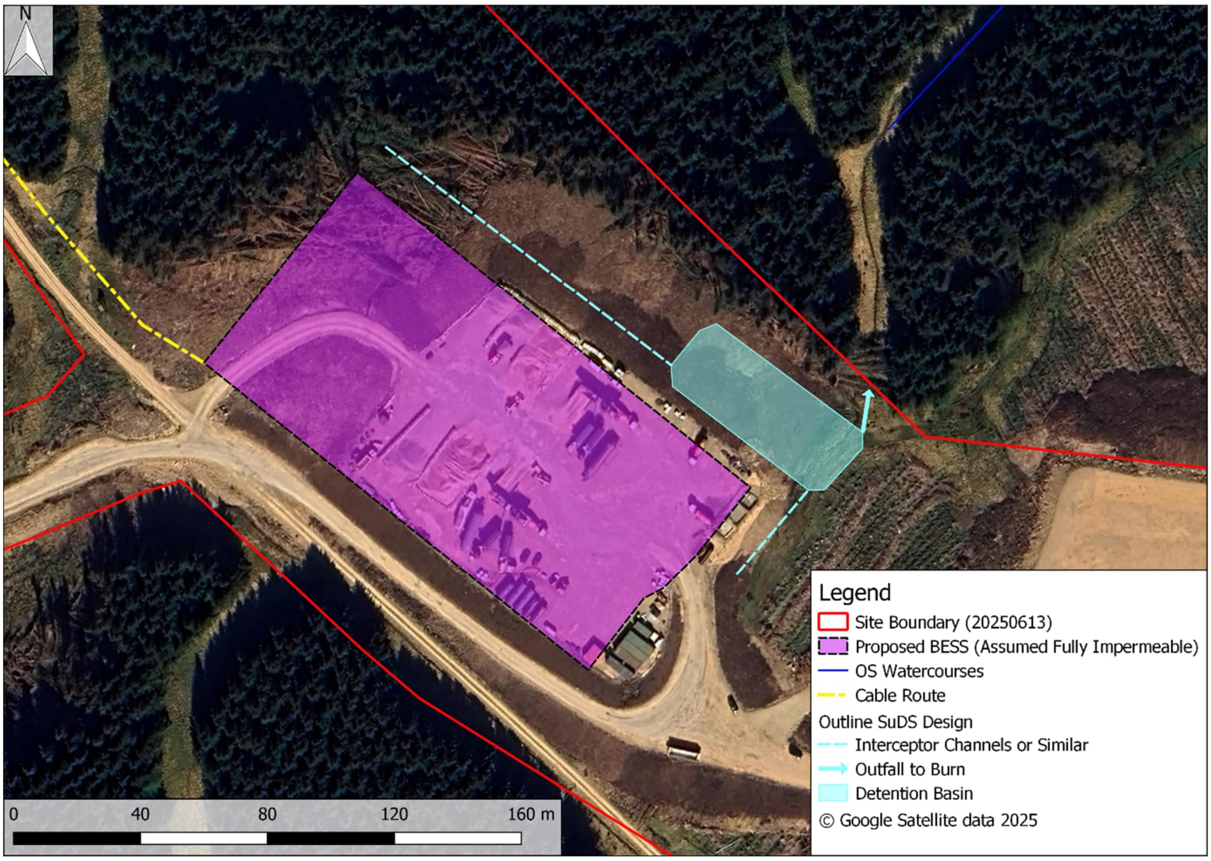


5.5.2 BESS

The proposed BESS site is understood to have no existing surface water drainage network. For a conservative approach to the drainage provisions at this initial stage, it is assumed that the full 1.2ha compound area is to be of impermeable surfacing.

The proposed surface water drainage strategy in this area will require the installation of interceptor drains/ditches to capture water and feed into a detention basin. The flows would then be discharged at a limited rate to the nearby tributary of the Achvarasdal Burn. The conceptual drainage strategy is shown in Figure 9.

Figure 9 : BESS Conceptual Drainage Strategy



It is noted that the detention basin at the BESS site would be required to store firewater in the event of a fire, and as such would require lining and a penstock at the outfall to prevent contaminated fire water entering the Achvarasdal Burn system or wider environment. It would also be recommended that the interceptor drains/ditches directing flows to the basin are lined. Further details on the assessment of firewater are provided in Section 5.12.

5.6 SuDS Attenuation Storage

5.6.1 Substation Extension

The parameters outlined in Table 4 have been incorporated in the modelling of the proposed swale system, however, the exact dimensions will be determined at the detailed design stage.

Table 4 : Preliminary Drainage Model Parameters

Attribute	Swale
Impermeable area	0.27ha
Slope	1:1000
Side slopes	1:3
Upstream Cover Level	72.981m AOD (based on ground level immediately adjacent to platform extension)
Upstream Invert Level	71.935m AOD
Length	157m (combined total)

Attribute	Swale
Dimensions	1500mm wide, 650mm deep

The above parameters are indicative only, and the downstream cover/invert levels will be designed in accordance with the existing ground levels at the downstream end of each section of the proposed swale feature. The proposed swale is to be stepped in order to ensure that each section has a suitable slope, with check dams at each cascade level to ensure the appropriate amount of storage is provided at each level. For a conservative approach, no infiltration has been assumed.

The swale would require a piped outfall to the existing natural drainage pathway towards the Reay Burn tributary. It is proposed that the swale would drain to the piped outfall through a HydroBrake of minimum diameter 75mm, restricting flows to the 1:1 AEP greenfield runoff rate of 1.5l/s for all events up to and including the 0.5% AEP + CC event.

Supporting calculations demonstrating the performance of the proposed swale system are provided in Appendix C.

5.6.2 BESS

It is proposed that the required surface water attenuation is provided by a detention basin, which will be situated to the northeast of the compound, ensuring that surface water runoff can drain to the basin via gravity through interceptor drains. The proposed basin would be located outwith the BESS fencing but within the red line boundary and is proposed to be privately operated and maintained.

The parameters outlined in Table 5 have been incorporated in the modelling of the proposed swale system, however, the exact dimensions will be determined at the detailed design stage.

Table 5 : Preliminary Drainage Model Parameters

Attribute	Detention Basin
Impermeable area	1.2ha (+ assumed 0.2ha basin area)
Side slopes	1:3
Cover Level	80.2 AOD (indicative level for modelling purposes - based on ground level downstream of BESS site)
Depth	1.5m
Dimensions	1150m^2 at base 1538.9m^2 at 1m from base 1754.6m^2 at 1.5m from base

The discharge rate from the detention basin to the Achvarasdal Burn tributary would be restricted to the 1:1 AEP greenfield runoff rate of 7l/s for all events up to and including the 0.5% AEP + CC event. The volume of storage required for the 0.5% AEP + CC event with this discharge rate would be 1205.3m^3. The basin dimensions are oversized for this event, allowing for a total attenuation volume of 2195.8m^3 in order to fully accommodate fire water in the event of a fire, as detailed in Section 5.12. Given that the basin will be lined and fitted with a penstock, the estimated area of the pond has been added to the impermeable area for sizing purposes.

Attenuation calculations demonstrating the performance of the proposed detention basin is included in Appendix D.

5.7 SuDS Performance Assessment: Water Levels

It is proposed that attenuation will be provided by a swale system for the proposed Substation Extension, and by a detention basin for the proposed BESS. In line with NPF4 and THC guidance, the proposed SuDS systems accommodate up to and including the 0.5% AEP event plus an allowance for climate change with no flooding.

Full results for the critical events are presented in Appendix C & D, and the 3.33% AEP + CC and 0.5% AEP + CC events are summarised in Table 6. The final volume required for the detention basin is detailed in Section 5.12.

Table 6 : Summary of SuDS Performance – Attenuation Volume

SuDS Feature	AEP Event	Peak Water Depth (m)	Peak Water Volume (m^3)	Flood Volume (m^3)
Detention Basin (BESS)	3.33% AEP + 42%CC	0.58	743.0	0
	0.5% AEP + 42%CC	0.89	1205.3	0
Swale* (Substation Extension)	3.33% AEP + 42%CC	0.27, 0.36	69.3, 50.8	0
	0.5% AEP + 42%CC	0.41, 0.49	117.2, 80.4	0

**Swale water depth and volume values are taken from the downstream end of each swale section in the Flow model. Depths and volumes in each section of the swale will vary depending on the final detailed design.*

5.8 SuDS Performance Assessment – Water Quality

The simple index method, as outlined within the SuDS Manual, provides a way of quantifying the benefit to water quality of the SuDS Management Train. The pollution hazard from the land use and the mitigation from the SuDS component are each assigned an index. The total mitigation index must be greater than the pollution hazard index for adequate treatment to be delivered.

Total SuDS mitigation index ≥ pollution hazard index

(for each contaminant type) (for each containment type)

The total SuDS mitigation is the summation of the first components mitigation index and half the mitigation index of any subsequent component.

With reference to the SuDS Manual, post-development surface water runoff generated from each of the developments is considered to have a ‘Low’ Pollution Hazard Level respectively as presented in Table 7.

Table 7 : Pollution Hazard Potential for the Proposed Development

Land Use	Pollution Hazard Level	Pollution Hazard Indices		
		Total Suspended Solids (TSS)	Metals	Hydro-Carbons
Other Roofs (typically commercial/industrial roofs)	Low	0.3	0.2	0.05
Low Traffic Surfaces with Infrequent Change	Low	0.5	0.4	0.4

Land Use	Pollution Hazard Level	Pollution Hazard Indices		
		Total Suspended Solids (TSS)	Metals	Hydro-Carbons

The proposed surface water drainage system is required to provide sufficient treatment to mitigate the Pollution Hazard Indices indicated in the above table. The SuDS Mitigation Indices are therefore indicated in Table 8.

Table 8 : SuDS Mitigation Indices for Proposed Development

SuDS Component	Pollution Hazard Indices		
	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Detention Basin	0.5	0.5	0.6
Swale	0.5	0.6	0.6

Table 9 and Table 10 compare the SuDS Mitigation Indices, provided by the proposed ‘Source Control’, ‘Conveyance’ and ‘Site Control’ measures against the Pollution Hazard Indices for each of the SuDS features.

Table 9 : SuDS Performance: Water Quality Indices Assessment – Detention Basin

Land Use	Pollution Hazard Level	Pollution Hazard and SuDS Mitigation Indices Comparison					
		Total Suspended Solids (TSS)		Metals		Hydrocarbons	
		Pollution Index	SuDS Mitigation Index	Pollution Index	SuDS Mitigation Index	Pollution Index	SuDS Mitigation Index
Other Roofs (typically commercial/industrial roofs)	Low	0.3	0.5	0.2	0.5	0.05	0.6
Low Traffic Surfaces with Infrequent Change	Low	0.5	0.5	0.4	0.5	0.4	0.6

Table 10 : SuDS Performance: Water Quality Indices Assessment - Swale

Land Use	Pollution Hazard Level	Pollution Hazard and SuDS Mitigation Indices Comparison					
		Total Suspended Solids (TSS)		Metals		Hydrocarbons	
		Pollution Index	SuDS Mitigation Index	Pollution Index	SuDS Mitigation Index	Pollution Index	SuDS Mitigation Index
Other Roofs (typically commercial/industrial roofs)	Low	0.3	0.5	0.2	0.6	0.05	0.6
Low Traffic Surfaces with Infrequent Change	Low	0.5	0.5	0.4	0.6	0.4	0.6

As the SuDS Mitigation Index provided by the proposed SuDS measures are greater than or equal to the Pollution Hazard Index, the water quality assessment criteria are satisfied for all Land Use criteria.

5.9 SuDS Operational Maintenance Requirements

A full SuDS maintenance plan would be produced as part of the detailed drainage design post-development and the precise requirement would depend on manufacture specification of the final design.

An outline of the typical maintenance requirements of the proposed SuDS features is outlined below.

5.9.1 Detention Basin

A recommended operation and maintenance plan for the detention basin is summarised in Table 11.

Table 11 : Detention Basin Operation and Maintenance Requirements

Maintenance Schedule	Required Action	Minimum Frequency
Regular maintenance	Remove litter and debris	Monthly, or as required
	Cut grass – for spillways and access routes	Monthly (during growing season), or as required
	Cut grass – meadow grass in and around basin	Half yearly (spring – before nesting season, and autumn)
	Manage vegetation/remove nuisance plants	Monthly at start, then as required
	Inspect inlets, outlets, and overflows for blockages, and clear if required	Monthly

Maintenance Schedule	Required Action	Minimum Frequency
	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 or as required
	Check any penstocks and other mechanical devices	Annually
	Tidy all dead growth before start of growing season	Annually
	Remove sediment from inlets, outlet and forebay	Annually (or as required)
	Manage wetland plants in outlet pool – where provided	Annually
Occasional maintenance	Reseed areas of poor vegetation growth	As required if bare soil is exposed within 10% or more of the basin treatment area
	Prune and trim any trees and remove cuttings	Every 2 years, or as required
	Remove sediment from inlets, outlets, forebay, and main basin when required	Every 5 years, or as required
Remedial actions	Repair erosion or other damage by re-turfing or reseeding	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Repair/rehabilitation of inlets, outlets and overflows	As required
	Relevel uneven surfaces and reinstate design levels	As required

5.9.2 Swale

A recommended operation and maintenance plan for the swale is summarised in Table 12. The final operation and maintenance plan for the drainage strategy should be determined based on the final detailed design.

Table 12 : Swale Operation and Maintenance Requirements

Maintenance Schedule	Required Action	Minimum Frequency
Regular maintenance	Remove litter and debris	Monthly, or as required

Maintenance Schedule	Required Action	Minimum Frequency
	Manage vegetation/remove nuisance plants	Monthly at start, then as required
	Inspect outlet for blockages, and clear if required	Monthly
	Inspect swale for compaction and silt accumulation, note any remedial works required	Monthly, or as required
	Inspect outlet for silt accumulation, establish silt removal frequency	Half yearly
	Cut grass to within desired range	Monthly (during growing season), or as required
	Inspect vegetation coverage	Monthly
Occasional maintenance	Reseed areas of poor vegetation growth, alter plant types to better suit conditions, if required	As required if bare soil is exposed of 10% or more of the swale treatment area
Remedial actions	Repair erosion or other damage by re-turfing or reseeding	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits, and prevent compaction of the soil surface	As required
	Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required

5.10 Exceedance

In the low probability event of exceedance of the swale or detention basin, flows would be expected to follow natural topographical gradients off-site, flowing in a northerly/north-easterly direction from the swale at the Substation Extension site and in a north-easterly direction from the detention basin at the BESS site to the watercourses in each location.

The exceedance flow paths for the two development locations are demonstrated in Figure 10 and Figure 11.

Figure 10 : Proposed Substation Extension - Drainage Exceedance

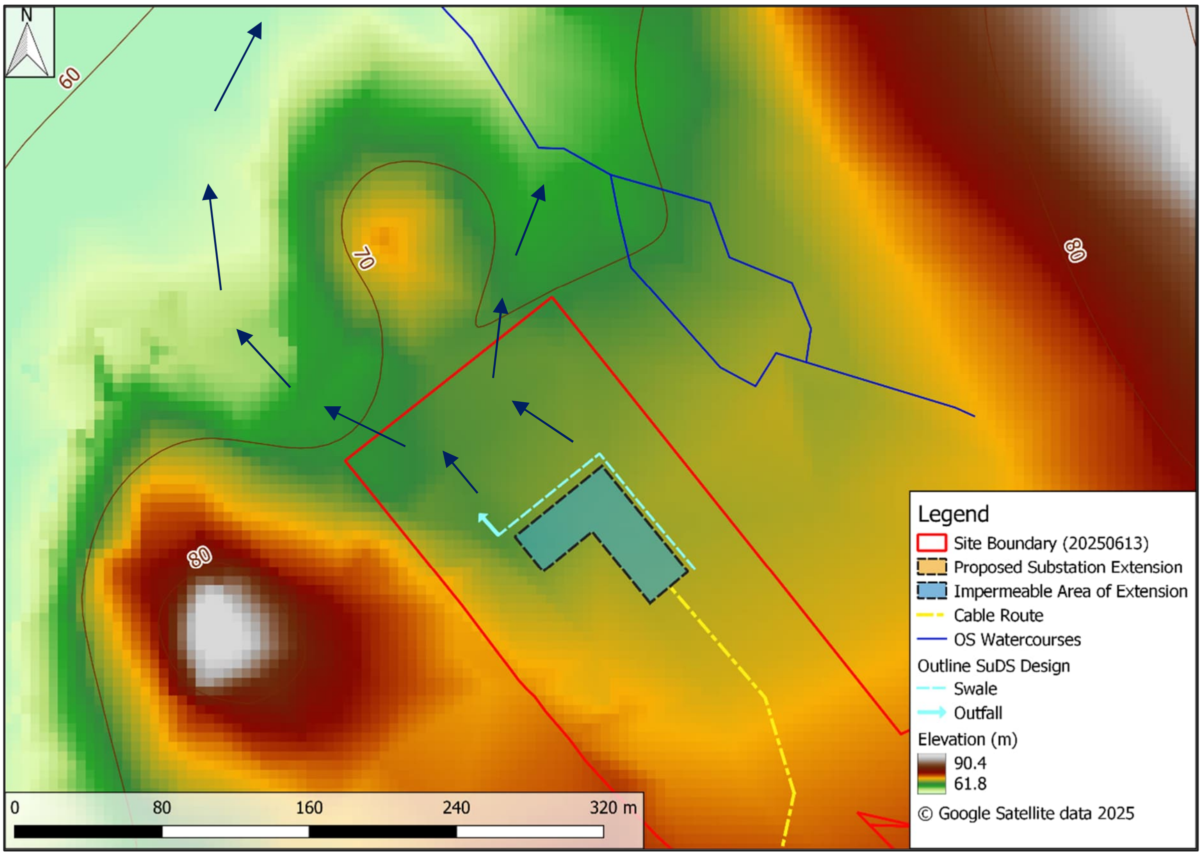
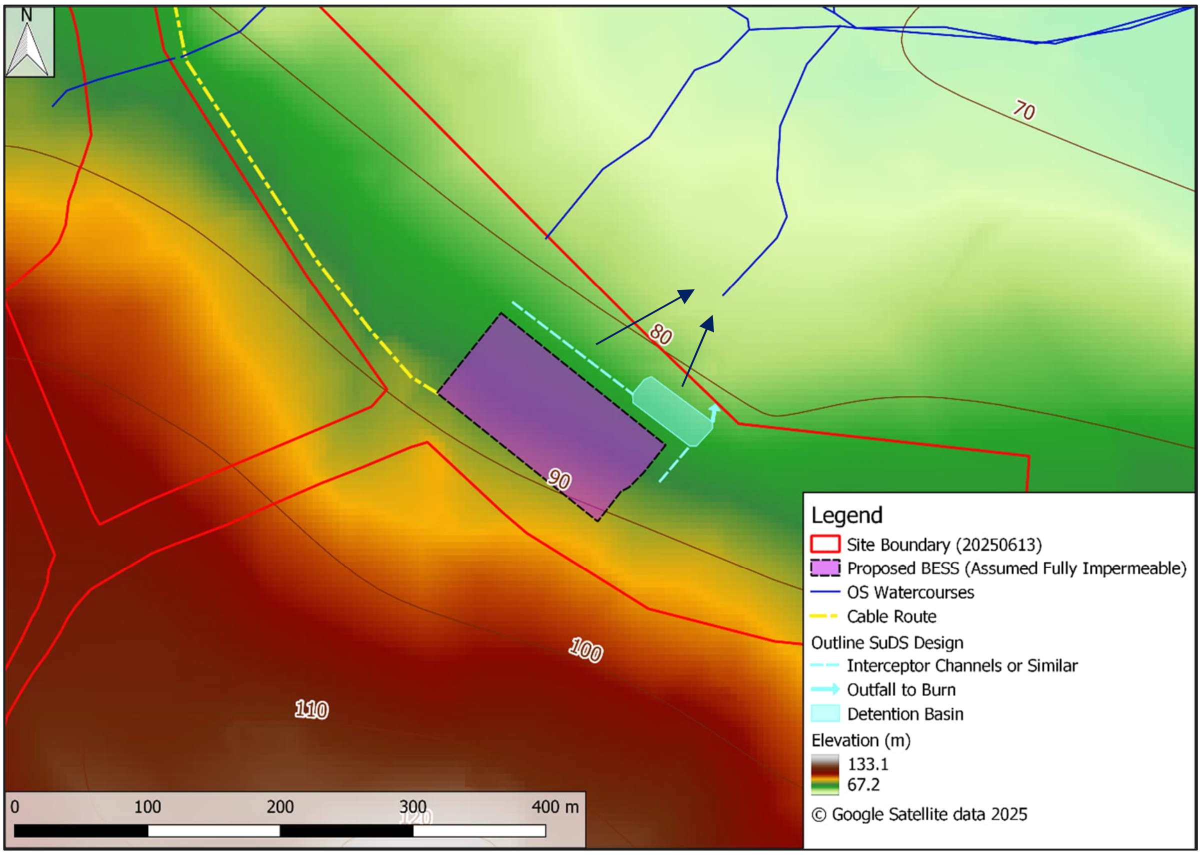


Figure 11 : Proposed BESS – Drainage Exceedance



5.11 Foul Water Drainage Strategy

The proposed BESS development is to be unmanned during normal operation. As such, no provision for foul drainage is required. It is understood that any foul drainage measures at the existing substation will serve the extension, and that no foul drainage provisions are required. There is therefore no requirement for a foul water drainage strategy for this proposed development.

5.12 Fire Water Management

Notwithstanding the SuDS mitigation index, provision will be made for firewater containment in the BESS site. This is proposed to be provided by lining the proposed detention basin with a low permeability liner and provision of a penstock/shutoff valve on the outfall which can be used in the unlikely event of a fire to contain firewater in the basin, thus preventing a discharge from site.

With reference to GPP18, it is understood that the capacity of the basin must be sufficient to store the following

- 10-year return period, 8 days rainfall prior to the incident;
- 10-year return, 24 hour rainfall;
- An allowance for rain falling directly on to remote containment and areas of the site draining into it, immediately after the incident;
- Fire-fighting and cooling water;
- Foam – a freeboard of not less than 100mm; and
- Dynamic effects – allow 250 mm for surge of liquid and for wind-blown waves.

An outline estimation of the required volume of each of these GPP18 components and the total volume of the proposed basin are shown in Table 13. Full details of this will be provided during the detailed design stage of the proposed development.

In order to allow for rain falling directly on remote containment following the incident, an additional area of 2000m^2 has been added to the drainage area calculations. No outflow has been allowed for the 10% AEP 24-hour event, assuming activation of the penstock. It is noted that 340m^3 of firewater is to be stored on site for use in the event of a fire.

Table 13 : GPP18 Required Volumes

Event	Volume (m^3)
10% AEP, 8 days rainfall* (winter)	134.7
10% AEP, 24-hour rainfall (winter)	340.2
Fire-fighting and cooling water;	340
10% AEP, 24-hour rainfall (winter) – no discharge due to penstock	645.7
Total	**1,460.6**
Total Basin Capacity	**2195.8**

**10% AEP 7-day rainfall modelled as the maximum duration in Causeway Flow. The additional 10% AEP 24-hour rainfall has therefore been added to the total volume to account for the 8-day event.*

Modelling the total required volume in Causeway Flow indicates that there will be approximately 350mm freeboard, sufficient for the required allowance for foam and dynamic effects.

An additional check was carried out on the 0.5% AEP event plus climate change followed by a fire-fighting incident. The resulting volume required is shown in Table 14.

Table 14 : 0.5% AEP event + CC and Subsequent Fire Incident Volumes

Event	Volume (m^3)
0.5% AEP + 42% (winter)	1205.3
Fire-fighting and cooling water	340
Total Required Volume	**1,545.3**
Total Basin Capacity	**2195.8**

6.0 Conclusions

6.1 Flood Risk

The flood risk screening indicates that the proposed development is not at flood risk for the NPF4 design event of 0.5% AEP + CC for the proposed Substation Extension or BESS site. It is understood that access/egress is to be afforded by the existing windfarm tracks and that no alterations to these routes are required.

Some isolated pockets of surface water flooding of less than 300mm in depth are indicated to be located adjacent to the proposed development areas but are not expected to present a risk to the development. Any direct rainfall on the proposed development locations will be managed through the SuDS design.

Given that the proposed development is not at flood risk and does not increase flood risk elsewhere, it is considered that the requirements of NPF4 and the Highland-wide Local Development Plan have been met.

6.2 Surface Water Drainage Strategy

It is proposed that surface water runoff from the impermeable areas associated with the proposed Substation Extension and BESS is captured, attenuated, and drained via SuDS systems. A swale is proposed to drain the Substation Extension, ultimately discharging surface water at a restricted rate of 1.5l/s to a tributary of the Reay Burn. Based on the outline calculations, the swale would be required to store a volume of approximately 197m^3 for the 0.5% AEP event + CC. For a conservative approach, no infiltration has been assumed for the swale.

A detention basin is proposed for the BESS site, discharging surface water at a restricted rate of 7l/s to a tributary of the Achvarasdal Burn. The detention basin would also be designed for the retention of firewater and would be fitted with a penstock. The total volume of the proposed detention basin is 2195.8m^3.

The proposed surface water drainage designs are indicative only and exact dimensions and levels will be determined at the detailed design stage.

Appendix A Proposed Site Layout

Limekiln BESS and Substation Extension

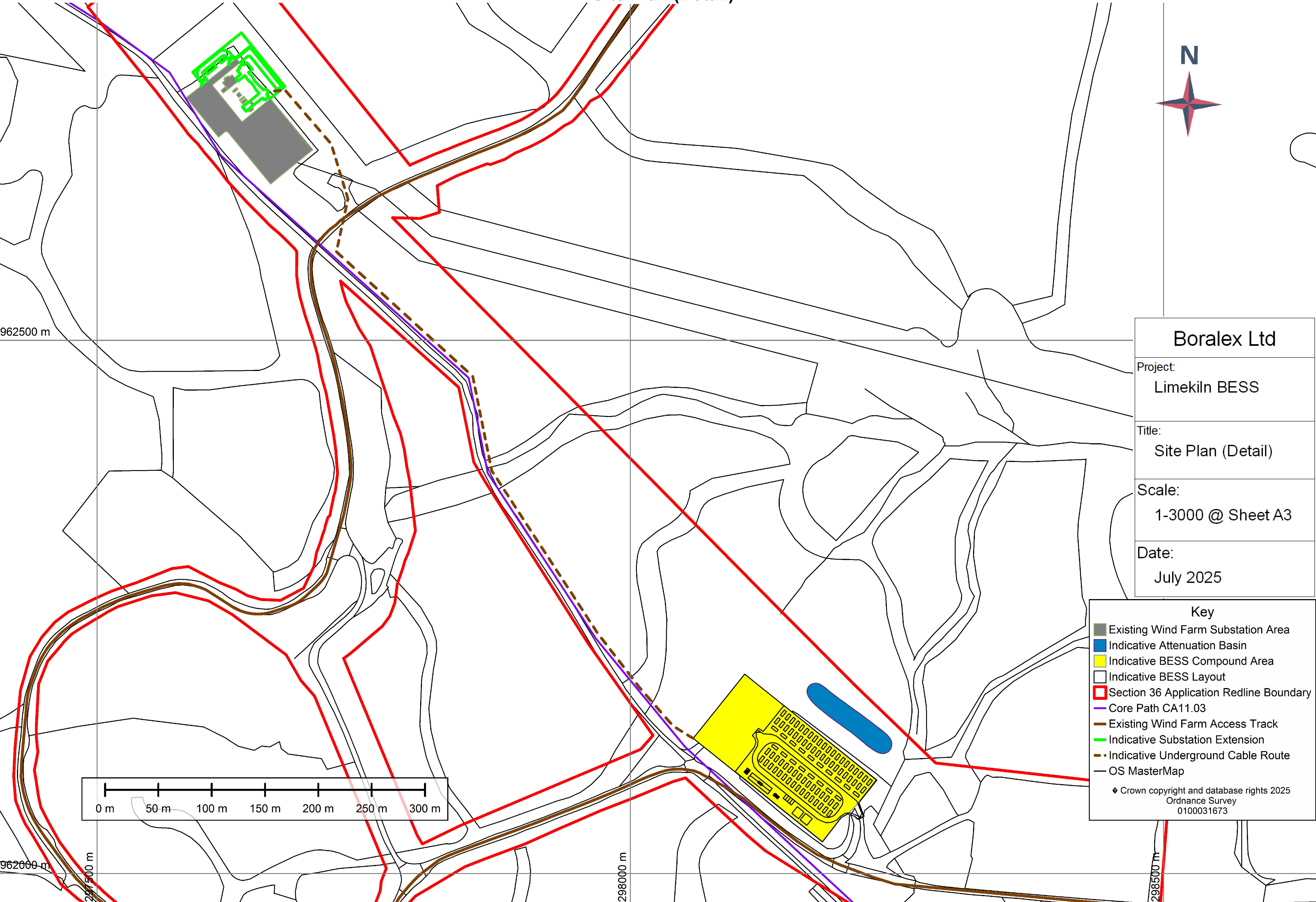
Flood Risk Assessment & Drainage Impact Assessment

BH24 3FH

SLR Project No.: 428.013385.00001

17 November 2025

Site Plan (Detail)



Appendix B Greenfield ReFH2 Outputs

Limekiln BESS and Substation Extension

Flood Risk Assessment & Drainage Impact Assessment

BH24 3FH

SLR Project No.: 428.013385.00001

17 November 2025

UK Design Flood Estimation

Generated on 14 July 2025 14:07:06 by ahay
Printed from the ReFH2 Flood Modelling software package, version 4.1.8985.14298

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH2)

Site details

Checksum: 4FD5-DC5A

Site name: FEH_Point_Descriptors_298155_962088_v5_0_1

Easting: 298155

Northing: 962088

Country: Scotland

Catchment Area (km²): 0.01 [0.5]*

Using plot scale calculations: Yes

Model: 2.3

Site description: None

Model run: 1 year

Summary of results

Rainfall - FEH22 (mm):	21.54	Total runoff (ML):	0.14
Total Rainfall (mm):	16.83	Total flow (ML):	0.20
Peak Rainfall (mm):	3.28	Peak flow (m³/s):	0.01

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH22)

Name	Value	User-defined?
Duration (hh:mm:ss)	06:30:00	No
Timestep (hh:mm:ss)	00:30:00	No
SCF (Seasonal correction factor)	0.78	No
ARF (Areal reduction factor)	1 [1]	Yes
Seasonality	Winter	No

Loss model parameters

Name	Value	User-defined?
Cini (mm)	173.93	No
Cmax (mm)	255.64	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	3.09	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	13.35	No
BR	0.4	No

Urbanisation parameters

Name	Value	User-defined?
Sewer capacity (m^3/s)	0	No
Exporting drained area (km^2)	0	No
Urban area (km^2)	0	No
Effective URBEXT2000	0	n/a
Impervious runoff factor	0.7	No
Imperviousness factor	0.4	No
Tp scaling factor	0.75	No
Depression storage depth (mm)	0.5	No

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	0.2996	0.0000	0.2040	0.0000	0.000781	0.000781
00:30:00	0.4639	0.0000	0.3166	0.0000	0.000753	0.000764
01:00:00	0.7158	0.0000	0.4902	0.0001	0.000726	0.000778
01:30:00	1.0995	0.0000	0.7568	0.0001	0.0007	0.000839
02:00:00	1.6769	0.0000	1.1633	0.0003	0.000678	0.000974
02:30:00	2.5200	0.0000	1.7690	0.0006	0.000659	0.00122
03:00:00	3.2821	0.0000	2.3412	0.0010	0.000647	0.00164
03:30:00	2.5200	0.0000	1.8262	0.0016	0.000642	0.00229
04:00:00	1.6769	0.0000	1.2289	0.0025	0.000649	0.00314
04:30:00	1.0995	0.0000	0.8118	0.0034	0.000669	0.00411
05:00:00	0.7158	0.0000	0.5310	0.0044	0.000703	0.00511
05:30:00	0.4639	0.0000	0.3452	0.0053	0.000749	0.00604
06:00:00	0.2996	0.0000	0.2234	0.0060	0.000804	0.00678
06:30:00	0.0000	0.0000	0.0000	0.0063	0.000866	0.00721
07:00:00	0.0000	0.0000	0.0000	0.0064	0.000928	0.00728
07:30:00	0.0000	0.0000	0.0000	0.0061	0.000985	0.00706
08:00:00	0.0000	0.0000	0.0000	0.0056	0.00104	0.00666
08:30:00	0.0000	0.0000	0.0000	0.0051	0.00108	0.00614
09:00:00	0.0000	0.0000	0.0000	0.0045	0.00111	0.00558
09:30:00	0.0000	0.0000	0.0000	0.0039	0.00113	0.00502
10:00:00	0.0000	0.0000	0.0000	0.0034	0.00114	0.0045
10:30:00	0.0000	0.0000	0.0000	0.0029	0.00114	0.00404
11:00:00	0.0000	0.0000	0.0000	0.0025	0.00114	0.00362
11:30:00	0.0000	0.0000	0.0000	0.0021	0.00113	0.00322
12:00:00	0.0000	0.0000	0.0000	0.0017	0.00112	0.00284
12:30:00	0.0000	0.0000	0.0000	0.0014	0.0011	0.00248
13:00:00	0.0000	0.0000	0.0000	0.0011	0.00108	0.00214
13:30:00	0.0000	0.0000	0.0000	0.0008	0.00105	0.00182
14:00:00	0.0000	0.0000	0.0000	0.0005	0.00102	0.00154
14:30:00	0.0000	0.0000	0.0000	0.0003	0.000992	0.00131
15:00:00	0.0000	0.0000	0.0000	0.0002	0.00096	0.00114
15:30:00	0.0000	0.0000	0.0000	0.0001	0.000926	0.00103
16:00:00	0.0000	0.0000	0.0000	0.0000	0.000893	0.000942
16:30:00	0.0000	0.0000	0.0000	0.0000	0.000861	0.000881

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
17:00:00	0.0000	0.0000	0.0000	0.0000	0.00083	0.000835
17:30:00	0.0000	0.0000	0.0000	0.0000	0.000799	0.000799

Appendix

Catchment descriptors *

Name	Value	User-defined value used?
BFIHOST	0.26	No
BFIHOST19	0.26	No
PROPWET	0.5	No
SAAR (mm)	987	No

Values in square brackets are the original values loaded from the FEH Web Service or FEH CD-ROM

UK Design Flood Estimation

Generated on 01 July 2025 16:52:19 by ahay
Printed from the ReFH2 Flood Modelling software package, version 4.1.8985.14298

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH2)

Site details

Checksum: F78A-9F0D

Site name: FEH_Point_Descriptors_297611_962744_v5_0_1

Easting: 297611

Northing: 962744

Country: Scotland

Catchment Area (km^2): 0 [0.5]*

Using plot scale calculations: Yes

Model: 2.3

Site description: None

Model run: 1 year

Summary of results

Rainfall - FEH22 (mm):	21.45	Total runoff (ML):	0.03
Total Rainfall (mm):	16.72	Total flow (ML):	0.05
Peak Rainfall (mm):	3.26	Peak flow (m^3/s):	0.00

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH22)

Name	Value	User-defined?
Duration (hh:mm:ss)	06:30:00	No
Timestep (hh:mm:ss)	00:30:00	No
SCF (Seasonal correction factor)	0.78	No
ARF (Areal reduction factor)	1 [1]	Yes
Seasonality	Winter	No

Loss model parameters

Name	Value	User-defined?
Cini (mm)	166.88	No
Cmax (mm)	266.13	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	3.25 [3.06]	Yes
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	22.48 [10.99]	Yes
BR	0.52	No

Urbanisation parameters

Name	Value	User-defined?
Sewer capacity (m^3/s)	0	No
Exporting drained area (km^2)	0	No
Urban area (km^2)	0	No
Effective URBEXT2000	0	n/a
Impervious runoff factor	0.7	No
Imperviousness factor	0.4	No
Tp scaling factor	0.75	No
Depression storage depth (mm)	0.5	No

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m³/s)	Net Rain (mm)	Runoff (m³/s)	Baseflow (m³/s)	Total Flow (m³/s)
00:00:00	0.2976	0.0000	0.1868	0.0000	0.000167	0.000167
00:30:00	0.4608	0.0000	0.2899	0.0000	0.000164	0.000166
01:00:00	0.7111	0.0000	0.4489	0.0000	0.00016	0.00017
01:30:00	1.0923	0.0000	0.6932	0.0000	0.000157	0.000183
02:00:00	1.6658	0.0000	1.0658	0.0001	0.000154	0.00021
02:30:00	2.5035	0.0000	1.6214	0.0001	0.000151	0.000258
03:00:00	3.2606	0.0000	2.1470	0.0002	0.00015	0.000338
03:30:00	2.5035	0.0000	1.6756	0.0003	0.000149	0.000462
04:00:00	1.6658	0.0000	1.1280	0.0005	0.000151	0.000627
04:30:00	1.0923	0.0000	0.7453	0.0007	0.000154	0.000814
05:00:00	0.7111	0.0000	0.4876	0.0009	0.000159	0.00101
05:30:00	0.4608	0.0000	0.3170	0.0010	0.000166	0.00119
06:00:00	0.2976	0.0000	0.2051	0.0012	0.000175	0.00135
06:30:00	0.0000	0.0000	0.0000	0.0013	0.000185	0.00145
07:00:00	0.0000	0.0000	0.0000	0.0013	0.000196	0.00148
07:30:00	0.0000	0.0000	0.0000	0.0012	0.000206	0.00145
08:00:00	0.0000	0.0000	0.0000	0.0012	0.000215	0.00138
08:30:00	0.0000	0.0000	0.0000	0.0011	0.000223	0.00129
09:00:00	0.0000	0.0000	0.0000	0.0010	0.00023	0.00118
09:30:00	0.0000	0.0000	0.0000	0.0008	0.000235	0.00107
10:00:00	0.0000	0.0000	0.0000	0.0007	0.000239	0.000967
10:30:00	0.0000	0.0000	0.0000	0.0006	0.000241	0.000875
11:00:00	0.0000	0.0000	0.0000	0.0005	0.000243	0.000792
11:30:00	0.0000	0.0000	0.0000	0.0005	0.000243	0.000715
12:00:00	0.0000	0.0000	0.0000	0.0004	0.000243	0.000642
12:30:00	0.0000	0.0000	0.0000	0.0003	0.000242	0.000573
13:00:00	0.0000	0.0000	0.0000	0.0003	0.00024	0.000507
13:30:00	0.0000	0.0000	0.0000	0.0002	0.000237	0.000443
14:00:00	0.0000	0.0000	0.0000	0.0002	0.000234	0.000384
14:30:00	0.0000	0.0000	0.0000	0.0001	0.00023	0.000332
15:00:00	0.0000	0.0000	0.0000	0.0001	0.000226	0.000289
15:30:00	0.0000	0.0000	0.0000	0.0000	0.000222	0.000258
16:00:00	0.0000	0.0000	0.0000	0.0000	0.000217	0.000237
16:30:00	0.0000	0.0000	0.0000	0.0000	0.000213	0.000222

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m³/s)	Net Rain (mm)	Runoff (m³/s)	Baseflow (m³/s)	Total Flow (m³/s)
17:00:00	0.0000	0.0000	0.0000	0.0000	0.000208	0.000212
17:30:00	0.0000	0.0000	0.0000	0.0000	0.000203	0.000205
18:00:00	0.0000	0.0000	0.0000	0.0000	0.000199	0.000199
18:30:00	0.0000	0.0000	0.0000	0.0000	0.000195	0.000195
19:00:00	0.0000	0.0000	0.0000	0.0000	0.00019	0.00019
19:30:00	0.0000	0.0000	0.0000	0.0000	0.000186	0.000186
20:00:00	0.0000	0.0000	0.0000	0.0000	0.000182	0.000182
20:30:00	0.0000	0.0000	0.0000	0.0000	0.000178	0.000178
21:00:00	0.0000	0.0000	0.0000	0.0000	0.000174	0.000174
21:30:00	0.0000	0.0000	0.0000	0.0000	0.00017	0.00017

Appendix

Catchment descriptors *

Name	Value	User-defined value used?
BFIHOST	0.34	No
BFIHOST19	0.28	No
PROPWET	0.5	No
SAAR (mm)	980	No

Values in square brackets are the original values loaded from the FEH Web Service or FEH CD-ROM

UK Design Flood Estimation

Generated on 14 July 2025 14:06:32 by ahay
Printed from the ReFH2 Flood Modelling software package, version 4.1.8985.14298

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH2)

Site details

Checksum: 4FD5-DC5A

Site name: FEH_Point_Descriptors_298155_962088_v5_0_1

Easting: 298155

Northing: 962088

Country: Scotland

Catchment Area (km²): 0.01 [0.5]*

Using plot scale calculations: Yes

Model: 2.3

Site description: None

Model run: 200 year 1.42 CC

Summary of results

Rainfall - FEH22 (mm):	107.09	Total runoff (ML):	0.85
Total Rainfall (mm):	83.67	Total flow (ML):	1.00
Peak Rainfall (mm):	16.31	Peak flow (m³/s):	0.04

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH22)

Name	Value	User-defined?
Duration (hh:mm:ss)	06:30:00	No
Timestep (hh:mm:ss)	00:30:00	No
SCF (Seasonal correction factor)	0.78	No
ARF (Areal reduction factor)	1 [1]	Yes
Seasonality	Winter	No
Climate change factor	1.42	Yes

Loss model parameters

Name	Value	User-defined?
Cini (mm)	173.93	No
Cmax (mm)	255.64	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	3.09	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	13.35	No
BR	0.18	No

Urbanisation parameters

Name	Value	User-defined?
Sewer capacity (m^3/s)	0	No
Exporting drained area (km^2)	0	No
Urban area (km^2)	0	No
Effective URBEXT2000	0	n/a
Impervious runoff factor	0.7	No
Imperviousness factor	0.4	No
Tp scaling factor	0.75	No
Depression storage depth (mm)	0.5	No

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	1.4890	0.0000	1.0174	0.0000	0.000781	0.000781
00:30:00	2.3057	0.0000	1.5926	0.0001	0.000753	0.00081
01:00:00	3.5580	0.0000	2.4984	0.0003	0.000726	0.000989
01:30:00	5.4652	0.0000	3.9341	0.0007	0.000703	0.0014
02:00:00	8.3347	0.0000	6.2246	0.0015	0.000685	0.00218
02:30:00	12.5257	0.0000	9.8656	0.0029	0.000674	0.00355
03:00:00	16.3135	0.0000	13.7692	0.0052	0.000677	0.00584
03:30:00	12.5257	0.0000	11.2786	0.0087	0.000699	0.00942
04:00:00	8.3347	0.0000	7.8449	0.0135	0.000749	0.0142
04:30:00	5.4652	0.0000	5.2916	0.0190	0.000832	0.0198
05:00:00	3.5580	0.0000	3.5078	0.0247	0.00095	0.0257
05:30:00	2.3057	0.0000	2.2995	0.0301	0.0011	0.0312
06:00:00	1.4890	0.0000	1.4890	0.0345	0.00128	0.0358
06:30:00	0.0000	0.0000	0.0000	0.0371	0.00148	0.0386
07:00:00	0.0000	0.0000	0.0000	0.0376	0.00168	0.0392
07:30:00	0.0000	0.0000	0.0000	0.0362	0.00187	0.0381
08:00:00	0.0000	0.0000	0.0000	0.0337	0.00204	0.0358
08:30:00	0.0000	0.0000	0.0000	0.0305	0.00218	0.0327
09:00:00	0.0000	0.0000	0.0000	0.0270	0.00229	0.0293
09:30:00	0.0000	0.0000	0.0000	0.0236	0.00238	0.0259
10:00:00	0.0000	0.0000	0.0000	0.0204	0.00244	0.0228
10:30:00	0.0000	0.0000	0.0000	0.0176	0.00248	0.02
11:00:00	0.0000	0.0000	0.0000	0.0150	0.0025	0.0175
11:30:00	0.0000	0.0000	0.0000	0.0127	0.0025	0.0152
12:00:00	0.0000	0.0000	0.0000	0.0105	0.00249	0.013
12:30:00	0.0000	0.0000	0.0000	0.0085	0.00246	0.011
13:00:00	0.0000	0.0000	0.0000	0.0066	0.00242	0.00903
13:30:00	0.0000	0.0000	0.0000	0.0048	0.00237	0.00722
14:00:00	0.0000	0.0000	0.0000	0.0033	0.00231	0.00561
14:30:00	0.0000	0.0000	0.0000	0.0021	0.00225	0.0043
15:00:00	0.0000	0.0000	0.0000	0.0012	0.00218	0.00338
15:30:00	0.0000	0.0000	0.0000	0.0007	0.0021	0.00276
16:00:00	0.0000	0.0000	0.0000	0.0003	0.00203	0.00235
16:30:00	0.0000	0.0000	0.0000	0.0001	0.00196	0.00209

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
17:00:00	0.0000	0.0000	0.0000	0.0000	0.00188	0.00192
17:30:00	0.0000	0.0000	0.0000	0.0000	0.00182	0.00182
18:00:00	0.0000	0.0000	0.0000	0.0000	0.00175	0.00175
18:30:00	0.0000	0.0000	0.0000	0.0000	0.00168	0.00168
19:00:00	0.0000	0.0000	0.0000	0.0000	0.00162	0.00162
19:30:00	0.0000	0.0000	0.0000	0.0000	0.00156	0.00156
20:00:00	0.0000	0.0000	0.0000	0.0000	0.00151	0.00151
20:30:00	0.0000	0.0000	0.0000	0.0000	0.00145	0.00145
21:00:00	0.0000	0.0000	0.0000	0.0000	0.0014	0.0014
21:30:00	0.0000	0.0000	0.0000	0.0000	0.00135	0.00135
22:00:00	0.0000	0.0000	0.0000	0.0000	0.0013	0.0013
22:30:00	0.0000	0.0000	0.0000	0.0000	0.00125	0.00125
23:00:00	0.0000	0.0000	0.0000	0.0000	0.0012	0.0012
23:30:00	0.0000	0.0000	0.0000	0.0000	0.00116	0.00116
24:00:00	0.0000	0.0000	0.0000	0.0000	0.00112	0.00112
24:30:00	0.0000	0.0000	0.0000	0.0000	0.00107	0.00107
25:00:00	0.0000	0.0000	0.0000	0.0000	0.00104	0.00104
25:30:00	0.0000	0.0000	0.0000	0.0000	0.000997	0.000997
26:00:00	0.0000	0.0000	0.0000	0.0000	0.00096	0.00096
26:30:00	0.0000	0.0000	0.0000	0.0000	0.000925	0.000925
27:00:00	0.0000	0.0000	0.0000	0.0000	0.000891	0.000891
27:30:00	0.0000	0.0000	0.0000	0.0000	0.000858	0.000858
28:00:00	0.0000	0.0000	0.0000	0.0000	0.000827	0.000827
28:30:00	0.0000	0.0000	0.0000	0.0000	0.000796	0.000796

Appendix

Catchment descriptors *

Name	Value	User-defined value used?
BFIHOST	0.26	No
BFIHOST19	0.26	No
PROPWET	0.5	No
SAAR (mm)	987	No

Values in square brackets are the original values loaded from the FEH Web Service or FEH CD-ROM

UK Design Flood Estimation

Generated on 17 June 2025 11:38:50 by ahay
Printed from the ReFH2 Flood Modelling software package, version 4.1.8985.14298

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH2)

Site details

Checksum: EE0D-A55A

Site name: FEH_Point_Descriptors_297611_962744_v5_0_1

Easting: 297611

Northing: 962744

Country: Scotland

Catchment Area (km^2): 0 [0.5]*

Using plot scale calculations: Yes

Model: 2.3

Site description: None

Model run: 200 year 1.42 CC

Summary of results

Rainfall - FEH22 (mm):	106.67	Total runoff (ML):	0.18
Total Rainfall (mm):	82.96	Total flow (ML):	0.23
Peak Rainfall (mm):	16.17	Peak flow (m^3/s):	0.01

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH22)

Name	Value	User-defined?
Duration (hh:mm:ss)	06:30:00	No
Timestep (hh:mm:ss)	00:30:00	No
SCF (Seasonal correction factor)	0.78	No
ARF (Areal reduction factor)	1	No
Seasonality	Winter	No
Climate change factor	1.42	Yes

Loss model parameters

Name	Value	User-defined?
Cini (mm)	166.88	No
Cmax (mm)	266.13	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	3.25 [3.06]	Yes
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	22.48 [10.99]	Yes
BR	0.28	No

Urbanisation parameters

Name	Value	User-defined?
Sewer capacity (m^3/s)	0	No
Exporting drained area (km^2)	0	No
Urban area (km^2)	0	No
Effective URBEXT2000	0	n/a
Impervious runoff factor	0.7	No
Imperviousness factor	0.4	No
Tp scaling factor	0.75	No
Depression storage depth (mm)	0.5	No

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	1.4763	0.0000	0.9298	0.0000	0.000167	0.000167
00:30:00	2.2860	0.0000	1.4560	0.0000	0.000164	0.000175
01:00:00	3.5278	0.0000	2.2854	0.0000	0.00016	0.00021
01:30:00	5.4187	0.0000	3.6015	0.0001	0.000157	0.000289
02:00:00	8.2638	0.0000	5.7048	0.0003	0.000155	0.000439
02:30:00	12.4192	0.0000	9.0560	0.0005	0.000154	0.000698
03:00:00	16.1748	0.0000	12.6635	0.0010	0.000156	0.00113
03:30:00	12.4192	0.0000	10.3903	0.0017	0.00016	0.00182
04:00:00	8.2638	0.0000	7.2349	0.0026	0.00017	0.00275
04:30:00	5.4187	0.0000	4.8834	0.0036	0.000185	0.00383
05:00:00	3.5278	0.0000	3.2385	0.0048	0.000206	0.00498
05:30:00	2.2860	0.0000	2.1236	0.0059	0.000234	0.00609
06:00:00	1.4763	0.0000	1.3818	0.0068	0.000268	0.00704
06:30:00	0.0000	0.0000	0.0000	0.0074	0.000305	0.00771
07:00:00	0.0000	0.0000	0.0000	0.0076	0.000344	0.00796
07:30:00	0.0000	0.0000	0.0000	0.0074	0.000382	0.00783
08:00:00	0.0000	0.0000	0.0000	0.0070	0.000418	0.00744
08:30:00	0.0000	0.0000	0.0000	0.0064	0.00045	0.00689
09:00:00	0.0000	0.0000	0.0000	0.0058	0.000477	0.00625
09:30:00	0.0000	0.0000	0.0000	0.0051	0.0005	0.00558
10:00:00	0.0000	0.0000	0.0000	0.0044	0.000518	0.00494
10:30:00	0.0000	0.0000	0.0000	0.0038	0.000532	0.00438
11:00:00	0.0000	0.0000	0.0000	0.0033	0.000542	0.00388
11:30:00	0.0000	0.0000	0.0000	0.0029	0.000549	0.00342
12:00:00	0.0000	0.0000	0.0000	0.0024	0.000553	0.00299
12:30:00	0.0000	0.0000	0.0000	0.0020	0.000555	0.00259
13:00:00	0.0000	0.0000	0.0000	0.0017	0.000554	0.00221
13:30:00	0.0000	0.0000	0.0000	0.0013	0.00055	0.00184
14:00:00	0.0000	0.0000	0.0000	0.0010	0.000545	0.0015
14:30:00	0.0000	0.0000	0.0000	0.0007	0.000538	0.00119
15:00:00	0.0000	0.0000	0.0000	0.0004	0.00053	0.00094
15:30:00	0.0000	0.0000	0.0000	0.0002	0.00052	0.000762
16:00:00	0.0000	0.0000	0.0000	0.0001	0.00051	0.000643
16:30:00	0.0000	0.0000	0.0000	0.0001	0.000499	0.000565

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
17:00:00	0.0000	0.0000	0.0000	0.0000	0.000488	0.000516
17:30:00	0.0000	0.0000	0.0000	0.0000	0.000478	0.000486
18:00:00	0.0000	0.0000	0.0000	0.0000	0.000467	0.000468
18:30:00	0.0000	0.0000	0.0000	0.0000	0.000457	0.000457
19:00:00	0.0000	0.0000	0.0000	0.0000	0.000447	0.000447
19:30:00	0.0000	0.0000	0.0000	0.0000	0.000437	0.000437
20:00:00	0.0000	0.0000	0.0000	0.0000	0.000427	0.000427
20:30:00	0.0000	0.0000	0.0000	0.0000	0.000418	0.000418
21:00:00	0.0000	0.0000	0.0000	0.0000	0.000409	0.000409
21:30:00	0.0000	0.0000	0.0000	0.0000	0.0004	0.0004
22:00:00	0.0000	0.0000	0.0000	0.0000	0.000391	0.000391
22:30:00	0.0000	0.0000	0.0000	0.0000	0.000382	0.000382
23:00:00	0.0000	0.0000	0.0000	0.0000	0.000374	0.000374
23:30:00	0.0000	0.0000	0.0000	0.0000	0.000366	0.000366
24:00:00	0.0000	0.0000	0.0000	0.0000	0.000358	0.000358
24:30:00	0.0000	0.0000	0.0000	0.0000	0.00035	0.00035
25:00:00	0.0000	0.0000	0.0000	0.0000	0.000342	0.000342
25:30:00	0.0000	0.0000	0.0000	0.0000	0.000335	0.000335
26:00:00	0.0000	0.0000	0.0000	0.0000	0.000327	0.000327
26:30:00	0.0000	0.0000	0.0000	0.0000	0.00032	0.00032
27:00:00	0.0000	0.0000	0.0000	0.0000	0.000313	0.000313
27:30:00	0.0000	0.0000	0.0000	0.0000	0.000306	0.000306
28:00:00	0.0000	0.0000	0.0000	0.0000	0.000299	0.000299
28:30:00	0.0000	0.0000	0.0000	0.0000	0.000293	0.000293
29:00:00	0.0000	0.0000	0.0000	0.0000	0.000286	0.000286
29:30:00	0.0000	0.0000	0.0000	0.0000	0.00028	0.00028
30:00:00	0.0000	0.0000	0.0000	0.0000	0.000274	0.000274
30:30:00	0.0000	0.0000	0.0000	0.0000	0.000268	0.000268
31:00:00	0.0000	0.0000	0.0000	0.0000	0.000262	0.000262
31:30:00	0.0000	0.0000	0.0000	0.0000	0.000256	0.000256
32:00:00	0.0000	0.0000	0.0000	0.0000	0.000251	0.000251
32:30:00	0.0000	0.0000	0.0000	0.0000	0.000245	0.000245
33:00:00	0.0000	0.0000	0.0000	0.0000	0.00024	0.00024
33:30:00	0.0000	0.0000	0.0000	0.0000	0.000234	0.000234
34:00:00	0.0000	0.0000	0.0000	0.0000	0.000229	0.000229

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
34:30:00	0.0000	0.0000	0.0000	0.0000	0.000224	0.000224
35:00:00	0.0000	0.0000	0.0000	0.0000	0.000219	0.000219
35:30:00	0.0000	0.0000	0.0000	0.0000	0.000214	0.000214
36:00:00	0.0000	0.0000	0.0000	0.0000	0.00021	0.00021
36:30:00	0.0000	0.0000	0.0000	0.0000	0.000205	0.000205
37:00:00	0.0000	0.0000	0.0000	0.0000	0.000201	0.000201
37:30:00	0.0000	0.0000	0.0000	0.0000	0.000196	0.000196
38:00:00	0.0000	0.0000	0.0000	0.0000	0.000192	0.000192
38:30:00	0.0000	0.0000	0.0000	0.0000	0.000188	0.000188
39:00:00	0.0000	0.0000	0.0000	0.0000	0.000184	0.000184
39:30:00	0.0000	0.0000	0.0000	0.0000	0.00018	0.00018
40:00:00	0.0000	0.0000	0.0000	0.0000	0.000176	0.000176
40:30:00	0.0000	0.0000	0.0000	0.0000	0.000172	0.000172

Appendix

Catchment descriptors *

Name	Value	User-defined value used?
BFIHOST	0.34	No
BFIHOST19	0.28	No
PROPWET	0.5	No
SAAR (mm)	980	No

Values in square brackets are the original values loaded from the FEH Web Service or FEH CD-ROM

Appendix C Causeway Flow Results – Substation Extension Swale

Limekiln BESS and Substation Extension

Flood Risk Assessment & Drainage Impact Assessment

BH24 3FH

SLR Project No.: 428.013385.00001

17 November 2025

Design Settings

Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	30	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.200
CV	0.750	Preferred Cover Depth (m)	1.200
Time of Entry (mins)	3.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	✓
Maximum Rainfall (mm/hr)	50.0		

Nodes

Name	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
3		70.100	1200	-1.447	65.270	1.100
1	3.00	70.900		28.454	84.007	1.300
2		70.200		7.403	59.034	0.700
4		70.000	1200	-6.465	68.521	1.100

Links

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)
1.001_1	2	3	50.000	0.035	69.500	69.450	0.050	1000.0	1500	6.70	50.0
1.001	1	2	100.000	0.035	69.600	69.500	0.100	1000.0	1500	5.00	50.0
1.002	3	4	10.000	0.600	69.000	68.900	0.100	100.0	225	6.83	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.001_1	0.490	1099.3	36.6	0.050	0.000	0.270	0.0	109	0.183
1.001	0.490	1099.3	36.6	0.650	0.050	0.270	0.0	109	0.183
1.002	1.307	52.0	36.6	0.875	0.875	0.270	0.0	139	1.412

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.001_1	50.000	1000.0	1500	Swale	70.200	69.500	0.050	70.100	69.450	0.000
1.001	100.000	1000.0	1500	Swale	70.900	69.600	0.650	70.200	69.500	0.050
1.002	10.000	100.0	225	Circular	70.100	69.000	0.875	70.000	68.900	0.875

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.001_1	2		Junction		3	1200	Manhole	Adoptable
1.001	1		Junction		2		Junction	
1.002	3	1200	Manhole	Adoptable	4	1200	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
3	-1.447	65.270	70.100	1.100	1200	1	1.001_1	69.450	1500
						0	1.002	69.000	225
1	28.454	84.007	70.900	1.300		0	1.001	69.600	1500
2	7.403	59.034	70.200	0.700		1	1.001	69.500	1500
						0	1.001_1	69.500	1500
4	-6.465	68.521	70.000	1.100	1200	1	1.002	68.900	225

Simulation Settings

Rainfall Methodology	FEH-22	Analysis Speed	Detailed	Starting Level (m)	
Rainfall Events	Singular	Skip Steady State	x	Check Discharge Rate(s)	x
Summer CV	0.750	Drain Down Time (mins)	240	Check Discharge Volume	x
Winter CV	0.840	Additional Storage (m^3/ha)	20.0		

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	0	0
30	0	0	0
30	42	0	0
200	0	0	0
200	42	0	0
1000	0	0	0
1000	42	0	0

Node 3 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Downstream Link	1.002	Sump Available	✓
Replaces Downstream Link	x	Product Number	CTL-SHE-0062-1500-0700-1500
Invert Level (m)	69.000	Min Outlet Diameter (m)	0.075
Design Depth (m)	0.700	Min Node Diameter (mm)	1200
Design Flow (l/s)	1.5		

Results for 2 year Critical Storm Duration. Lowest mass balance: 95.82%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
480 minute winter	3	360	69.632	0.632	3.9	0.7148	0.0000	SURCHARGED
30 minute winter	1	20	69.681	0.081	1.6	0.0000	0.0000	OK
30 minute winter	1.001:10%	20	69.680	0.090	23.8	0.0000	0.0000	OK
480 minute winter	2	360	69.632	0.132	5.1	0.0000	0.0000	OK
600 minute winter	4	225	68.926	0.026	1.5	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)
480 minute winter	3	1.002	4	1.5	0.574	0.029	0.0261	50.2
30 minute winter	1	1.001	1.001:10%	-1.6	-0.031	-0.001	1.5032	
30 minute winter	1	1.001	2	17.2	0.165	0.016	9.6996	
480 minute winter	2	1.001_1	3	3.9	0.075	0.004	15.5644	

Results for 30 year Critical Storm Duration. Lowest mass balance: 95.82%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
360 minute winter	3	352	69.763	0.763	4.1	0.8630	0.0000	SURCHARGED
360 minute winter	1	352	69.763	0.163	0.3	0.0000	0.0000	OK
360 minute winter	1.001:10%	352	69.763	0.173	12.7	0.0000	0.0000	OK
360 minute winter	2	352	69.763	0.263	10.4	0.0000	0.0000	OK
360 minute winter	4	352	68.927	0.027	1.5	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)
360 minute winter	3	1.002	4	1.5	0.578	0.030	0.0266	48.3
360 minute winter	1	1.001	1.001:10%	-0.3	-0.013	0.000	3.3691	
360 minute winter	1	1.001	2	10.4	0.083	0.009	42.8266	
360 minute winter	2	1.001_1	3	4.1	0.074	0.004	34.1482	

Results for 30 year +42% CC Critical Storm Duration. Lowest mass balance: 95.82%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
480 minute winter	3	464	69.858	0.858	4.0	0.9704	0.0000	FLOOD RISK
480 minute winter	1	464	69.858	0.258	0.4	0.0000	0.0000	OK
480 minute winter	1.001:10%	464	69.858	0.268	14.5	0.0000	0.0000	OK
480 minute winter	2	464	69.858	0.358	10.3	0.0000	0.0000	OK
480 minute winter	4	464	68.927	0.027	1.6	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)
480 minute winter	3	1.002	4	1.6	0.588	0.031	0.0276	61.3
480 minute winter	1	1.001	1.001:10%	-0.4	-0.011	0.000	6.0206	
480 minute winter	1	1.001	2	10.3	0.077	0.009	69.2517	
480 minute winter	2	1.001_1	3	4.0	0.076	0.004	50.8215	

Results for 200 year Critical Storm Duration. Lowest mass balance: 95.82%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
360 minute winter	3	352	69.878	0.878	5.0	0.9934	0.0000	FLOOD RISK
360 minute winter	1	352	69.878	0.278	0.5	0.0000	0.0000	OK
360 minute winter	1.001:10%	352	69.878	0.288	19.6	0.0000	0.0000	OK
360 minute winter	2	352	69.878	0.378	13.7	0.0000	0.0000	OK
360 minute winter	4	352	68.927	0.027	1.6	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)
360 minute winter	3	1.002	4	1.6	0.590	0.032	0.0279	51.9
360 minute winter	1	1.001	1.001:10%	-0.5	-0.011	0.000	6.6595	
360 minute winter	1	1.001	2	13.7	0.086	0.012	75.5524	
360 minute winter	2	1.001_1	3	5.0	0.081	0.005	54.7501	

Results for 200 year +42% CC Critical Storm Duration. Lowest mass balance: 95.82%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
600 minute winter	3	585	69.998	0.998	4.7	1.1291	0.0000	FLOOD RISK
600 minute winter	1	585	69.998	0.398	0.5	0.0000	0.0000	OK
600 minute winter	1.001:10%	585	69.998	0.408	18.2	0.0000	0.0000	OK
600 minute winter	2	585	69.998	0.498	12.6	0.0000	0.0000	OK
600 minute winter	4	585	68.928	0.028	1.7	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)
600 minute winter	3	1.002	4	1.7	0.600	0.034	0.0290	76.0
600 minute winter	1	1.001	1.001:10%	-0.5	-0.014	0.000	10.9311	
600 minute winter	1	1.001	2	12.6	0.081	0.012	117.2370	
600 minute winter	2	1.001_1	3	4.7	0.075	0.004	80.4283	

Results for 1000 year Critical Storm Duration. Lowest mass balance: 95.82%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
480 minute winter	3	472	69.976	0.976	5.2	1.1044	0.0000	FLOOD RISK
480 minute winter	1	472	69.976	0.376	0.6	0.0000	0.0000	OK
480 minute winter	1.001:10%	472	69.976	0.386	20.7	0.0000	0.0000	OK
480 minute winter	2	472	69.976	0.476	14.3	0.0000	0.0000	OK
480 minute winter	4	472	68.928	0.028	1.7	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)
480 minute winter	3	1.002	4	1.7	0.598	0.033	0.0288	65.2
480 minute winter	1	1.001	1.001:10%	-0.6	-0.014	-0.001	10.0893	
480 minute winter	1	1.001	2	14.3	0.087	0.013	109.0723	
480 minute winter	2	1.001_1	3	5.2	0.080	0.005	75.4342	

Results for 1000 year +42% CC Critical Storm Duration. Lowest mass balance: 95.82%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
600 minute winter	3	495	70.100	1.100	5.8	1.2441	14.7881	FLOOD
360 minute winter	1	344	70.100	0.500	1.1	0.0000	0.0000	OK
360 minute winter	1.001:10%	344	70.100	0.510	37.7	0.0000	0.0000	OK
360 minute winter	2	344	70.100	0.600	25.5	0.0000	0.0000	OK
360 minute winter	4	328	68.929	0.029	1.8	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)
600 minute winter	3	1.002	4	1.8	0.608	0.035	0.0299	79.7
360 minute winter	1	1.001	1.001:10%	-1.1	-0.021	-0.001	15.2401	
360 minute winter	1	1.001	2	25.5	0.108	0.023	158.7435	
360 minute winter	2	1.001_1	3	8.9	0.103	0.008	105.5928	

Appendix D Causeway Flow Results – BESS Detention Basin

Limekiln BESS and Substation Extension

Flood Risk Assessment & Drainage Impact Assessment

BH24 3FH

SLR Project No.: 428.013385.00001

17 November 2025

Design Settings

Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	30	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.200
CV	0.750	Preferred Cover Depth (m)	1.200
Time of Entry (mins)	3.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	✓
Maximum Rainfall (mm/hr)	50.0		

Nodes

Name	Area (ha)	Cover Level (m)	Easting (m)	Northing (m)	Depth (m)
SuDS Pond	1.400	80.200	56.913	59.151	1.500

Simulation Settings

Rainfall Methodology	FEH-22	Analysis Speed	Normal	Starting Level (m)	
Rainfall Events	Singular	Skip Steady State	x	Check Discharge Rate(s)	x
Summer CV	0.750	Drain Down Time (mins)	240	Check Discharge Volume	x
Winter CV	0.840	Additional Storage (m³/ha)	20.0		

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0
2	0	0	0
10	0	0	0
30	0	0	0
30	42	0	0
200	0	0	0
200	42	0	0
1000	0	0	0
1000	25	0	0
1000	30	0	0
1000	37	0	0
1000	42	0	0

Node SuDS Pond Offline Head/Flow Control

Flap Valve	x	Invert Level (m)	78.700	Design Flow (l/s)	5.0
Loop to Node		Design Depth (m)	1.200		

Head (m)	Flow (l/s)
1.500	0.000

Node SuDS Pond Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	3.0	Invert Level (m)	78.700
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)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	1150.0	1150.0	1.000	1538.9	1559.9	1.500	1754.6	1787.3

Results for 1 year Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
10080 minute winter	SuDS Pond	10080	79.326	0.626	3.4	807.1156	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
10080 minute winter	SuDS Pond	Head/Flow	0.0	0.0

Results for 2 year Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
10080 minute winter	SuDS Pond	10080	79.408	0.708	3.9	924.4750	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
10080 minute winter	SuDS Pond	Head/Flow	0.0	0.0

Results for 10 year Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
10080 minute winter	SuDS Pond	10140	79.621	0.921	5.2	1241.0940	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
10080 minute winter	SuDS Pond	Head/Flow	0.0	0.0

Results for 30 year Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
10080 minute winter	SuDS Pond	10140	79.766	1.066	6.1	1466.0920	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
10080 minute winter	SuDS Pond	Head/Flow	0.0	0.0

Results for 30 year +42% CC Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
10080 minute winter	SuDS Pond	10140	80.131	1.431	8.7	2074.1290	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
10080 minute winter	SuDS Pond	Head/Flow	0.0	0.0

Results for 200 year Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
10080 minute winter	SuDS Pond	10140	80.045	1.345	8.1	1925.4500	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
10080 minute winter	SuDS Pond	Head/Flow	0.0	0.0

Results for 200 year +42% CC Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
10080 minute winter	SuDS Pond	6600	80.200	1.500	11.5	2195.8250	540.7324	FLOOD

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
10080 minute winter	SuDS Pond	Head/Flow	0.0	0.0

Results for 1000 year Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
10080 minute winter	SuDS Pond	7980	80.200	1.500	10.0	2195.8250	196.2038	FLOOD

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
10080 minute winter	SuDS Pond	Head/Flow	0.0	0.0

Results for 1000 year +25% CC Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m^3)	Flood (m^3)	Status
10080 minute winter	SuDS Pond	6180	80.200	1.500	12.5	2195.8250	782.6572	FLOOD

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m^3)
10080 minute winter	SuDS Pond	Head/Flow	0.0	0.0

Results for 1000 year +30% CC Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
10080 minute winter	SuDS Pond	6000	80.200	1.500	13.0	2195.8250	918.0200	FLOOD

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
10080 minute winter	SuDS Pond	Head/Flow	0.0	0.0

Results for 1000 year +37% CC Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
10080 minute winter	SuDS Pond	5820	80.200	1.500	13.7	2195.8250	1083.2630	FLOOD

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
10080 minute winter	SuDS Pond	Head/Flow	0.0	0.0

Results for 1000 year +42% CC Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
10080 minute winter	SuDS Pond	5700	80.200	1.500	14.2	2195.8250	1211.0650	FLOOD

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
10080 minute winter	SuDS Pond	Head/Flow	0.0	0.0

Design Settings

Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	30	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.200
CV	0.750	Preferred Cover Depth (m)	1.200
Time of Entry (mins)	3.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	✓
Maximum Rainfall (mm/hr)	50.0		

Nodes

Name	Area (ha)	Cover Level (m)	Easting (m)	Northing (m)	Depth (m)
SuDS Pond	1.400	80.200	56.887	59.125	1.500

Simulation Settings

Rainfall Methodology	FEH-22	Analysis Speed	Normal	Starting Level (m)	
Rainfall Events	Singular	Skip Steady State	x	Check Discharge Rate(s)	x
Summer CV	0.750	Drain Down Time (mins)	240	Check Discharge Volume	x
Winter CV	0.840	Additional Storage (m³/ha)	20.0		

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0
2	0	0	0
10	0	0	0
30	0	0	0
30	42	0	0
200	0	0	0
200	42	0	0
1000	0	0	0
1000	35	0	0
1000	42	0	0

Node SuDS Pond Offline Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Loop to Node		Sump Available	✓
Invert Level (m)	78.700	Product Number	CTL-SHE-0121-7000-1200-7000
Design Depth (m)	1.200	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	7.0	Min Node Diameter (mm)	1200

Node SuDS Pond Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	3.0	Invert Level (m)	78.700
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)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	1150.0	1150.0	1.000	1538.9	1559.9	1.500	1754.6	1787.3

Results for 1 year Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
960 minute winter	SuDS Pond	660	78.851	0.151	14.3	181.0394	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
960 minute winter	SuDS Pond	Hydro-Brake®	6.2	245.9

Results for 2 year Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
960 minute winter	SuDS Pond	675	78.885	0.185	17.1	222.3648	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
960 minute winter	SuDS Pond	Hydro-Brake®	6.5	290.0

Results for 10 year Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
720 minute winter	SuDS Pond	555	78.993	0.293	30.9	359.0279	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
720 minute winter	SuDS Pond	Hydro-Brake®	7.0	289.0

Results for 30 year Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
600 minute winter	SuDS Pond	570	79.085	0.385	44.6	478.3377	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
600 minute winter	SuDS Pond	Hydro-Brake®	7.0	267.8

Results for 30 year +42% CC Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
960 minute winter	SuDS Pond	915	79.280	0.580	44.8	743.0258	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
960 minute winter	SuDS Pond	Hydro-Brake®	7.0	385.1

Results for 200 year Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
600 minute winter	SuDS Pond	585	79.310	0.610	66.9	785.9220	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
600 minute winter	SuDS Pond	Hydro-Brake®	7.0	273.7

Results for 200 year +42% CC Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
960 minute winter	SuDS Pond	945	79.597	0.897	65.3	1205.3000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
960 minute winter	SuDS Pond	Hydro-Brake®	7.0	376.7

Results for 1000 year Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
720 minute winter	SuDS Pond	705	79.530	0.830	76.4	1103.2190	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
720 minute winter	SuDS Pond	Hydro-Brake®	7.0	295.4

Results for 1000 year +35% CC Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
960 minute winter	SuDS Pond	945	79.815	1.115	81.1	1545.5750	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
960 minute winter	SuDS Pond	Hydro-Brake®	7.0	408.0

Results for 1000 year +42% CC Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
960 minute winter	SuDS Pond	945	79.871	1.171	85.3	1636.2250	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
960 minute winter	SuDS Pond	Hydro-Brake®	7.0	415.9

Appendix E SEPA Checklist

Limekiln BESS and Substation Extension

Flood Risk Assessment & Drainage Impact Assessment

BH24 3FH

SLR Project No.: 428.013385.00001

17 November 2025

Scotland's 4th National Planning Framework has recently been published. This document is therefore being reviewed and updated to reflect the new policies. You can still find useful and relevant information here but be aware that some parts may be out of date and our responses to planning applications may not match the information set out here.

SEPA Scottish Environment Protection Agency Buidheann Dìon Àrainneachd na h-Alba

Flood Risk Assessment (FRA) Checklist

(SS-NFR-F-001 - Version 16 - Last updated 27/08/2019)

This document must be attached within the front cover of any Flood Risk Assessments issued to Local Planning Authorities (LPA) in support of a development proposal which may be at risk of flooding. The document will take only a few minutes to complete and will assist SEPA in reviewing FRAs, when consulted by LPAs. This document should not be a substitute for a FRA.

Development Proposal Summary

Site Name:		Limekiln BESS and Substation Extension		
Grid Reference:	Easting:	297630	Northing:	962720
Local Authority:		Highland Council		
Planning Reference number (if known):				
Nature of the development:		Utility Infrastructure	If residential, state type:	
Size of the development site:		Total 1.13	Ha	
Identified Flood Risk:	Source:	Fluvial	Source name:	Fluival flood risk for the existing access track only.

Land Use Planning

Is any of the site within the functional floodplain? (refer to SPP para 255)	No	If yes, what is the net loss of storage?		m^3
Is the site identified within the local development plan?	No	Local Development Plan Name:		Year of Publication:
		Allocation Number / Reference:		
If yes, what is the proposed use for the site as identified in the local plan?	Select from List	If Other please specify:		
Does the local development plan and/or any pre-application advice, identify any flood risk issues with or requirements for the site.	No	If so, please specify:		
What is the proposed land use vulnerability?	Essential Infrastructure	Do the proposals represent an increase in land use vulnerability?	No	

Supporting Information

Have clear maps / plans been provided within the FRA (including topographic and flood inundation plans)?	Yes		
Has sufficient supporting information, in line with our Technical Guidance, been provided? For example: site plans, photos, topographic information, structure information and other site specific information.	Yes		
Has a historic flood search been undertaken?	Yes	If flood records in vicinity of the site please provide details:	None - Details provided in FRA
Is a formal flood prevention scheme present?	No	If known, state the standard of protection offered:	
Current / historical site use:	Windfarm and forestry site		
Is the site considered vacant or derelict?	No		

Development Requirements

Freeboard on design water level:		Recommended 600	mm		
Is safe / dry access and egress available?		Neither	Min access/egress level:	As existing	m AOD
Design levels:	Ground level:	As existing	m AOD Min FFL:	As existing	mAOD

Mitigation

Can development be designed to avoid all areas at risk of flooding?	Yes
Is mitigation proposed?	No
If yes, is compenstory storage necessary?	No
Demonstration of compensatory storage on a "like for like" basis?	Select from List
Should water resistant materials and forms of construction be used?	Select from List

Flood Risk Assessment (FRA) Checklist

(SS-NFR-F-001 - Version 16 - Last updated 27/08/2019)

Hydrology

Is there a requirement to consider fluvial flooding?	No		
Area of catchment:	km²	Is a map of catchment area included in FRA?	Select from List
Estimation method(s) used (please select all that apply):	Pooled Analysis ☐ Single Site Analysis ☐ Enhanced Single Site ☐ ReFH2 ☐ FEH RRM ☐ Other ☑	If Pooled analysis have group details been included?	Select from List
		If other (please specify methodology used):	
Estimate of 200 year design flood flow:	m^3/s		
Qmed estimate:	m^3/s	Method:	Select from List
Statistical Distribution Selected:	Select from List	Reasons for selection:	

Hydraulics

Hydraulic modelling method:	Select from List	Software used:	Select from List
		If other please specify:	
Number of cross sections:			
Source of data (i.e. topographic survey, LiDAR etc):		Date obtained / surveyed:	
Modelled reach length:	m		
Any changes to default simulation parameters?		If yes please provide details:	
Model timestep:			
Model grid size:			
Any structures within the modelled length?	Select from List	Specify, if combination:	
Maximum observed velocity:	m/s		
Brief summary of sensitivity tests, and range:			
variation on flow (%)	%	Please specify climate change scenario considered:	
variation on channel roughness (%)	%		
blockage of structure (range of % blocked)	%		
boundary conditions:	**Upstream**		**Downstream**
(1) type	Flow		Select from List
	Specify if other	Specify if other:	
(2) does it influence water levels at the site?	Select from List		Select from List
Has model been calibrated (gauge data / flood records)?	Select from List		
Is the hydraulic model available to SEPA?	Select from List		
Design flood levels:	200 year m AOD	200 year plus climate change	m AOD
Cross section results provided?	Select from List		
Long section results provided?	Select from List		
Cross section ratings provided?	Select from List		
Tabular output provided (i.e. levels, velocities)?			
Mass balance error:	%		

Coastal

Is there a requirement to consider coastal / tidal flooding?	No		
Estimate of 200 year design flood level:	m AOD		
Estimation method(s) used:	Select from List	If other please specify methodology used:	
Allowance for climate change (m):	m		
Allowance for wave action etc (m):	m		
Overall design flood level:	m AOD		

Comments

Any additional comments:	Flood risks have been assessed against local topography and have found that the site is not at significant flood risk from any source. There is some fluvial flooding to the existing access however, the site is energy infrastructure and will be unmanned.
Approved by:	**R. Walker**
Organisation:	**SLR Consulting Ltd**
Date:	**14/07/2025**

Appendix F Compliance Certificate

Limekiln BESS and Substation Extension

Flood Risk Assessment & Drainage Impact Assessment

BH24 3FH

SLR Project No.: 428.013385.00001

17 November 2025

APPENDIX C: SELF CERTIFICATION (overleaf)

The Highland Council Comhairle na Gàidhealtachd	FRA and DIA Guidance Assessment Compliance Certificate

I certify that all reasonable skill, care and attention to be expected of a qualified and experienced professional in this field have been exercised in carrying out the attached Assessment. I also confirm that I maintain the required Professional Indemnity Insurance*. The report has been prepared in support of the below named development in accordance with the reporting requirements issued by The Highland Council.

Please select Assessment type:

Flood Risk Assessment ☒ Drainage Impact Assessment ☒

Additional Information

Assessment Ref No:	SLR Ref: 428.013385.00001	Assessment Revision:	01
Assessment Date:	14/07/2025	Planning Application No:	Not known
Name of Development:	Limekiln Substation Extension and Bess		
Address of Development:	Approx. NGR NC 97681 62684		
Name of Developer:	The Highland Council		
Name and Address of Organisation preparing this Assessment:	SLR Consulting Ltd, The Tun, 4 Jackson's Entry, Edinburgh, EH8 8PJ		

Name of Approver: Robert Walker Date: 14/07/25

Signed: robertwalker Digitally signed by robertwalker DN: cn=robertwalker, email=robertwalker@slrconsulting.com Date: 2025.11.17 10:53:46

Position Held:	Principal Flood Risk Consultant
Qualification of person responsible for signing off this Assessment**	C.WEM CIWEM

* Please attach appropriate evidence of Professional Indemnity Insurance

** A chartered member of a relevant professional institution

Making Sustainability Happen