Loch Toftingall BESS

Appendix 11.2 – Outline Feasibility Surface Water Drainage Strategy

August 2023

Project No.: 0669684

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Acronyms and Abbreviations

Name	Description
BESS	Battery Energy Storage System
BGS	British Geological Survey
DS	Outline Feasibility Surface Water Drainage Strategy Report
DTM	Digital Terrain Model
LDP	Local Development Plan
m AOD	Metres Above Ordnance Datum
NPF	National Planning Framework
OS	Ordnance Survey
SEPA	Scottish Environmental Protection Agency
SPP	Scottish Planning Policy
SuDS or SUD	Sustainable Urban Drainage System
SUDSWP	Sustainable Urban Drainage Scottish Working Party

1. INTRODUCTION

1.1 Background

This Outline Feasibility Surface Water Drainage Strategy Report (DS) was prepared by ERM to support the Proposed Development.

It is understood that a Sustainable Drainage (SuDS) feature is required to enable the management of surface water runoff and sediment control from the Proposed Battery Energy Storage System (BESS) Development.

1.2 Relevant Legislation

This DS is intended to meet the requirements of the following:

- The National Planning Framework ('NPF') 4, 20231.
- Scottish Environment Protection Agency's (SEPA) Regulatory Method: Sustainable Urban Drainage Systems, 20192.
- Sustainable Urban Drainage Scottish Working Party's (SUDSWP) Water Assessment and Drainage Assessment Guide, 20163.
- The CIRIA SuDS Manual4, 2015.
- The Highland Council's Supplementary Guidance: Flood Risk & Drainage Impact5, 2013.
- The Highland Council's Local Development Plan (LDP)6, 2012.
- The General Binding Rules 10, 11 and 21 of the Water Environment (Controlled Activities) (Scotland) Regulations 20117.
- SEPA's Guidance Note 2: Planning advice on Sustainable Drainage Systems (SuDS), 20108.
- The Flood Risk Management (Scotland) Act 20099.
- The Flood Risk Management (Scotland) Act 2009: Surface Water Management Planning Guidance10.

[1] Scottish Government. (2023) *National Planning Framework 4,* accessed 19/06/2023, <https://www.gov.scot/publications/national-planning-framework-4/>.
[2] SEPA. (2019) *Regulatory Method (WAT-RM-08): Sustainable Urban Drainage Systems*, accessed 19/06/2023, <https://www.sepa.org.uk/media/219048/wat-rm-08-regulation-of-sustainable-urban-drainage-systems-suds.pdf>.
[3] SUDSWP. (2016) *Water Assessment and Drainage Assessment Guide*, accessed 19/06/2023, <https://www.sepa.org.uk/media/163472/water_assessment_and_drainage_assessment_guide.pdf>.
[4] CIRIA. (2015) *The SuDS Manual*, accessed 19/06/2023, <https://www.ciria.org/CIRIA/CIRIA/Item_Detail.aspx?iProductCode=C753>.
[5] The Highland Council. (2013) *Supplementary Guidance: Flood Risk & Drainage Impact*, accessed 19/06/2023, <https://www.highland.gov.uk/downloads/file/2954/flood_risk_and_drainage_impact_assessment_supplementary_guidance>.
[6] The Highland Council. (2012) *Highland-wide Local Development Plan*, accessed 19/06/2023, <https://www.highland.gov.uk/info/178/local_and_statutory_development_plans/199/highland-wide_local_development_plan>.
[7] Scottish Government. (2011) *The Water Environment (Controlled Activities) (Scotland) Regulations 2011,* accessed 20/06/2023, <https://www.legislation.gov.uk/ssi/2011/209/contents/made>.
[8] SEPA. (2010) *Guidance Note 2: Planning advice on Sustainable Drainage Systems (SUDS)*, accessed 19/06/2023, <https://www.sepa.org.uk/media/143195/lups-gu2-planning-guidance-on-sustainable-drainage-systems-suds.pdf>.
[9] Scottish Government. (2009) *Flood Risk Management (Scotland) Act 2009*, accessed 19/06/2023, <https://www.legislation.gov.uk/asp/2009/6/contents>.
[10] Scottish Government. (2018) *The Flood Risk Management (Scotland) Act 2009: Surface Water Management Planning Guidance*, accessed 19/06/2023, <https://www.gov.scot/publications/flood-risk-management-scotland-act-2009-surface-water-management-planning/pages/3/>.

2. EXISTING SITE

This section of the report summarises the existing Site, characteristics, and existing surface water drainage regime.

2.1 Site Location

The Site occupies an area of approximately 40.6 hectares (ha) and is located approximately 940 metres (m) to the southeast of the village of Mybster, centred on Ordnance Survey National Grid Reference (OSNGR) 317637 E, 952008 N, as shown in Figure 1 below.

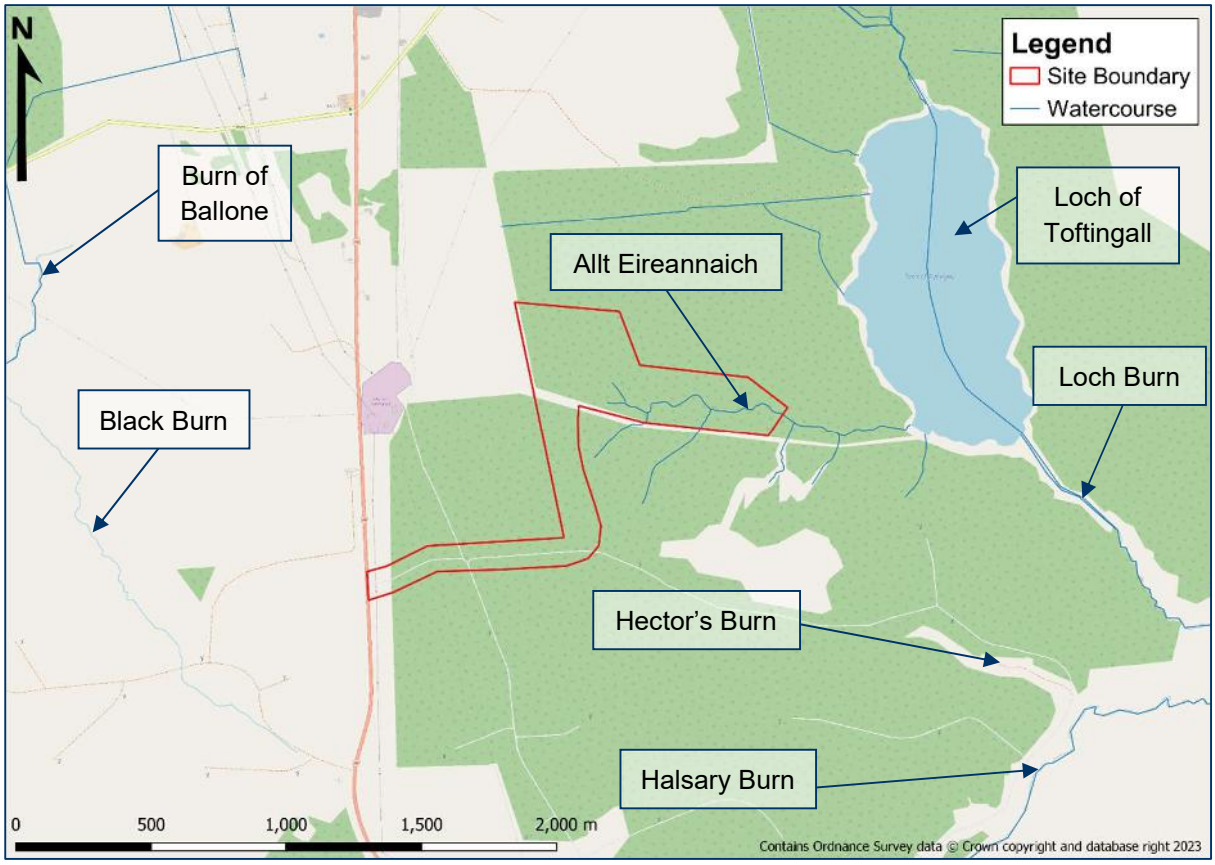


Figure 1 - Site Location

The Site is bound by existing mature forestry plantation and then Loch Toftingall to the east, felled forestry forming part of the existing Halsary Wind Farm to the south, greenfield land and then Mybster Substation to the west, existing mature forestry plantation to the northeast, and felled forestry to the north, as shown in Figure 2 below.

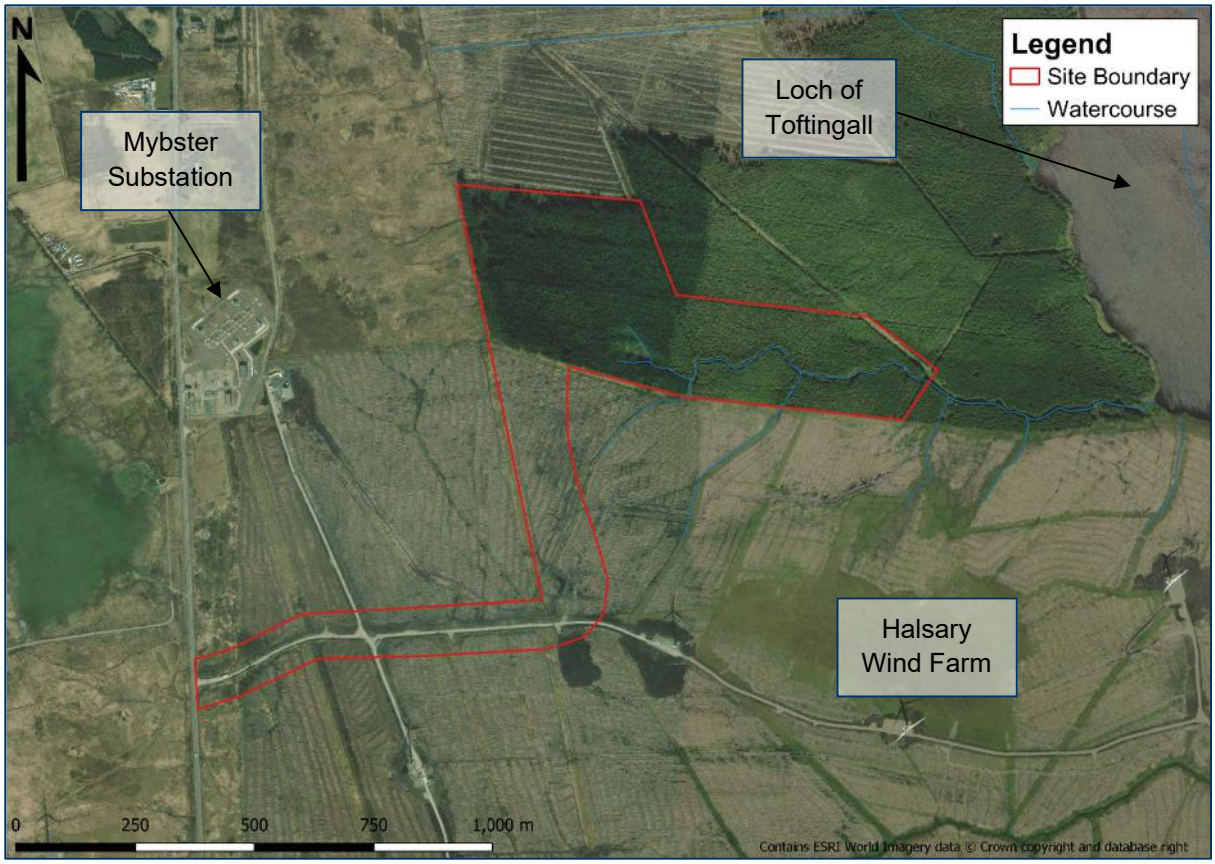


Figure 2 - Local Context of Site Location

2.2 Site Characteristics

The Site occupies a lowland location which consists of mature forestry plantation across the northern area of the Site and felled forestry to the south.

2.2.1 Site Elevations

At this time of writing this report, a topographical survey of the Site was not available. Instead, a detailed digital terrain model (DTM) at 5m resolution was obtained from Ordnance Survey11. The Site has a slight slope from west to east, the topographic high point being the Site entrance at 100m above ordnance datum (m AOD) and the topographical low point being the eastern site boundary at 80m AOD.

2.2.2 Surrounding Hydrological Features

The Site is largely located within the Wick River Catchment; a small portion of the eastern aspect of the Site, at the junction of the A9 with the existing access track through Halsary Wind Farm, lies within the River Thurso Catchment12.

The local hydrological features which surround the Site are summarised in below, with their location also indicated in Figure 1 above.

[11] Ordnance Survey. (2023). *OS Terrain 5,* accessed 20/06/2023, <https://www.ordnancesurvey.co.uk/products/os-terrain-5>.
[12] SEPA. (2021) *Water Environment Hub*, accessed 20/06/2023, <https://informatics.sepa.org.uk/RBMP3/>.

As the Site comprises mature plantation forestry and the surrounding area contains felled forestry, there are several artificial drains across the Site and surrounding land which ultimately drain into the Loch of Toftingall directly or via Allt Eireannaich.

Table 1 - Local Watercourses

Name	Description
Allt Eireannaich	Allt Eireannaich is located within the Site boundary, draining in an easterly direction, and discharging into the Loch of Toftingall approx. 500m to the east of the Site. There are a number of artificial land drains across the surrounding land which discharge into Allt Eireannaich.
Hector's Burn	Hector's Burn is located approx. 730m to the southeast of the Site at its closest point. Hector's Burn drains in a general easterly direction and is a tributary of Halsary Burn.
Halsary Burn	Halsary Burn is located approx. 1.8km to the southeast of the Site and drains in a general north-easterly direction, towards Loch Burn, via Snottergill Burn.
Loch Burn	Loch Burn drains from the southern edge of the Loch of Toftingall in a general south-easterly direction away from the Site. This watercourse is a tributary of the Burn of Acharole, which ultimately discharges into the Wick River via Scouthal Burn.
Black Burn	Black Burn is a tributary of Achlachan Burn, which discharges into the River Thurso. Black Burn is located approx. 745m to the west of the Site, on the opposite side of the A9.
Burn of Ballone	The Burn of Ballone is located approx. 1.5km to the northwest of the Site and drains in a general south-westerly direction away from Mybster village. This watercourse then discharges into Black Burn approx. 2km to the west of the Site.

2.3 Existing Surface Water Drainage Regime

The SEPA surface water flood mapping for the area, as shown in Figure 3, indicates that there are no major surface water flood flow routes present across the Site. Instead, surface water is shown to collect within depressions on the Site.

As the Site and surrounding area comprise mature forestry plantation and areas of felled forestry, much of the surface water runoff is managed through artificial drainage channels which help drain water from the land to either Allt Eireannaich or the Loch of Toftingall directly. These drains can be seen on the surface water flood map below, shown by the unnaturally straight lines of surface water flooding; two of these drains have been marked on the map to provide an example, although many more can be seen.

Surface water runoff which exceeds the infiltration capacity of the Peat soils is expected to run overground in a general easterly, following the topography of the Site and surrounding area towards Allt Eireannaich and the Loch of Toftingall.

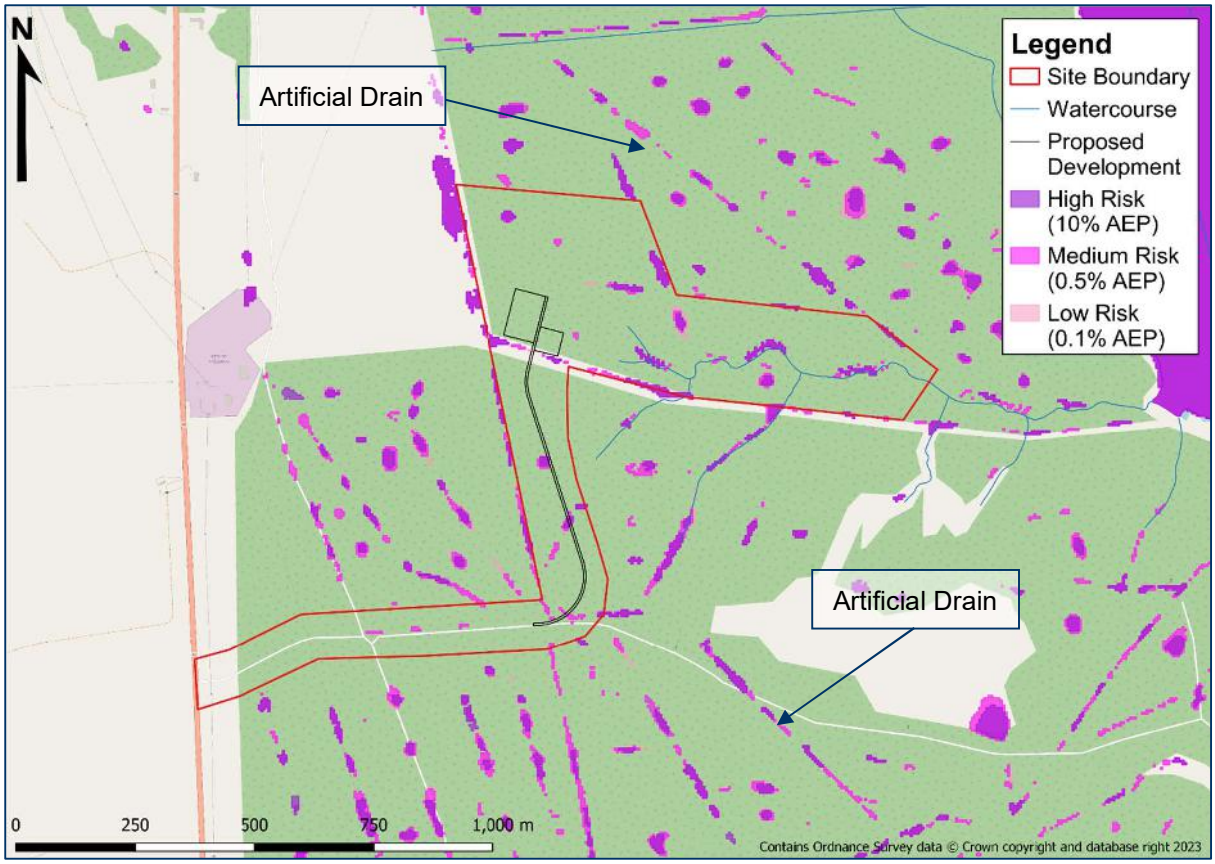


Figure 3 - Risk of Flooding from Surface Water (Source: SEPA)

3. THE PROPOSED DEVELOPMENT

3.1 Introduction

The Proposed Development comprises the construction and operation of a battery energy storage facility consisting of up to 52 battery energy storage units, electrical connection and control buildings, landscaping, fencing and ancillary infrastructure. The Proposed Development will import and export electricity, however it would not generate any additional electricity. The facility will have a maximum export capacity of up to 49.9MW. The project has been designed with a 4-hour discharge period. The Proposed Development layout is included in **Appendix A**.

3.2 Key Components

The Proposed Development consists of the following main components.

- Fifty-two energy storage units, each measuring circa 6.1m in length, 2.4m in width, and 2.9m in height.
- Thirteen combined inverter and transformer units, typically measuring 6.1m in length, 2.4m in width, and 2.9m in height.
- Two switchgear and control buildings, measuring approximately 23.9m in length, 5.9m in width, and 4.0m in height to the ridgeline of the roof.
- One fire suppression water tank.
- A new access track, and four associated car parking spaces.
- One construction compound and potential future augmentation area.
- 4m high acoustic fencing.
- Seven CCTV masts.

3.3 Permeable and Impermeable Areas

Most of the 40.6ha Site is to remain undeveloped, with large areas of the Proposed Development planned to be constructed from permeable materials.

The energy storage units and combined inverter and transformer units will be situated on concrete footings underlain by permeable aggregate, as shown in **Appendix B**. As such, these units have been classified as permeable for the purpose of this DS.

The construction compound and potential future augmentation area will also comprise permeable aggregate.

Therefore, the only elements of the Proposed Development which are to comprise impermeable surfaces are:

- The two switchgear and control buildings.
- The four car parking spaces.
- The new main access track, which is proposed to comprise a tarmac surface, and the second fire service access track which is to consist of crushed rock with a compacted running surface.

In turn, the total impermeable footprint for the Proposed Development has been calculated to be **0.51ha.**

4. PEAK RAINFALL CLIMATE CHANGE ALLOWANCE

In line with SEPA's guidance on Climate change allowances for flood risk assessment in land use planning13, peak rainfall intensity within the North Highland River Basin District is estimated to increase by 42% by 2100.

[13] SEPA. (2023) *Climate change allowances for flood risk assessment in land use planning*, accessed 20/06/2023, <https://www.sepa.org.uk/media/594168/climate-change-guidance.pdf>.

5. DRAINAGE STRATEGY

The Proposed Development should consider the wider impacts of surface water flooding and the required management of surface water runoff as part of the detailed design for the Site. The detailed drainage design for the Site should follow the principles set out within this DS.

The surface water drainage system should be designed to attenuate surface runoff to greenfield runoff rates, ensuring that flows up to and including the 1 in 200-year plus 42% climate change event do not impact the Proposed Development or its neighbouring lands and property.

5.1 Drainage Hierarchy

Section 3.6 of the Building Standards technical handbook for non-domestic buildings14 recommends that surface water runoff shall discharge to one of the following, listed in order of priority:

a) A storage container with an overflow discharging to any of the 4 following options, or

b) A sustainable urban drainage (SUD) system designed and constructed in accordance with clause 3.6.4, or

c) A soakaway constructed in accordance with:

   i. Clause 3.6.5, or

   ii. The guidance in BRE Digest 365, ‘Soakaway Design’, or

   iii. National Annex NA 4 of BS EN 752: 2008, or

b) A public sewer provided under the Sewerage (Scotland) Act 1968, or

c) An outfall to a watercourse, such as a ricer, stream, loch or coastal waters, that complies with any notice and/or consent by SEPA.

It is necessary to identify the most appropriate method of controlling and discharging surface water. The design should seek to improve the local runoff profile by using systems that can either attenuate runoff and reduce peak flow rates or positively impact on the existing flood profile.

5.2 Existing Constraints

5.2.1 Infiltration Based Systems

The bedrock aquifer underlying most of the Site is indicated to consist of Spital Flagstone Formation - Siltstone, Mudstone, and Sandstone. The very southwest of the Site, is shown to be situated on bedrock geology indicated to comprise Lybster Flagstone Formation – Siltstone, Mudstone, and Sandstone.

The bedrock groundwater units are indicated to be overlain by Peat superficial deposits within the vast majority of the Site. A small area to the south-east of the Site is shown to be overlain by Devensian Till.

The Site is shown situated on soils classified as Blanket Peats; poorly drained upland soil with an organic surface layer more than 50cm thick. It is unconfined and blankets the landscape. A very small area to the southwest of the Site is indicated to comprise soils classified as Gleys; soils that are periodically or permanently waterlogged. They are typically greyish with greenish or blueish tinges and often have a blotchy appearance.

[14] The Scottish Government. (2023) *Building Standards technical handbook February 2023: non-domestic buildings, accessed 20/06/2023, <https://www.gov.scot/publications/building-standards-technical-handbook-february-2023-non-domestic-buildings/>.*

Peat probing carried out in 2019 and 2022 identified a range of peat depths across the Site, with an average Peat depth of 2.54m.

Based on the above information, it is unlikely that the discharge of surface water runoff by infiltration-based systems will be feasible as the primary method for surface water disposal from the Proposed Development. Whilst any proposed SuDS feature should encourage infiltration, they will also require a positive outfall.

5.2.2 Sewers

Given the rural setting of the Site, there are no existing sewers within the vicinity of the Proposed Development. As such, it will not be possible to discharge surface water runoff to a sewer.

5.2.3 Open Watercourses

As infiltration or discharge to an existing sewer is not possible, it is proposed to discharge surface water runoff from the Proposed Development at an attenuated rate to an open watercourse.

Allt Eireannaich is suitably located within the Site boundary, downslope of the Proposed Development and will be the outfall location for surface water runoff from the Proposed Development.

5.3 Greenfield Runoff Assessment

The 40.6ha Site currently comprises entirely of greenfield land. However, as most of the Site is to remain undeveloped, the existing greenfield runoff rate has been calculated for the impermeable areas of the Proposed Development only.

As such, the ICP SUDS and IH124 (Flood Studies Report) methods have been used to calculate the surface water runoff from a small (<50ha) greenfield site (QBARRURAL), which are detailed below:

$QBAR_{RURAL} = 0.00108 \times (0.01 \times AREA)^{0.89} \times SAAR^{1.17} \times SPR^{2.17}$

Where

AREA = Area (ha)

SAAR = Standard Average Annual Rainfall (mm, 1941-1970)

SPR = Standard Percentage Runoff Coefficient

With an impermeable Site area of 0.51ha and using Flood Studies Report values for SAAR (972mm) and SPR (0.500), this results in a QBARRURAL rate of 4.1 litres per second (l/s) and the subsequent discharge rates for the following return periods:

1 in 1-year	3.5/s
1 in 30-year	7.8l/s
1 in 100-year	10.3l/s
1 in 200-year	11.6l/s
1 in 200-year + 42% Climate Change	16.5l/s

Greenfield runoff calculations are provided in **Appendix C.**

5.4 Return Period Design

The proposed surface water drainage system should be designed to ensure that the post-development runoff rate and volume does not exceed the pre-development greenfield runoff rate.

Formal on-site drainage should be provided up to the 1 in 30-year return period event and attenuation measures should be designed such that SuDS features will not surcharge during a 30-year return period rainfall event.

No flooding to property or critical roads should occur during the 1 in 200-year event, with all surface water during this event (with an appropriate allowance for climate change) contained on-site15.

5.5 Proposed Discharge Rate

In accordance with local Highland Council guidance, the peak surface water runoff rate for greenfield developments should be restricted to the pre-development discharge rate, where reasonably practicable. As most of the Site is to remain undeveloped, the greenfield runoff rate has been calculated for the impermeable areas of the Site only. This results in a pre-development greenfield runoff rate of 4.1/s.

However, the SUDSWP specify that the minimum discharge rate for any new development site be set at 5 l/s16. As such, surface water discharge from the Proposed Development should be restricted to 5.0l/s.

5.6 Outline Feasibility Surface Water Drainage Strategy

The proposed development will comprise on an impermeable footprint of approximately 0.51ha. In order to maintain the discharge rate of 5.0l/s for all storms up to and including the 1 in 200-year return period with a 42% allowance for climate change, attenuation is required which provides in the order of 266.7m³ of surface water storage.

The required surface water attenuation volume is proposed to be provisioned by a shallow surface level detention basin before restricted discharge into Allt Eireannaich. The detention basin is proposed to be approximately 800mm deep, including a 300mm freeboard, but will be subject to detailed drainage design.

Surface water runoff from the impermeable areas of the Proposed Development will be captured by a stone filled filter trench aligned adjacent to the downslope of the proposed access tracks, directing surface water towards the proposed attenuation basin. The attenuation basin will then outfall to a swale which drains to Allt Eireannaich. The roads should be graded to fall towards the proposed filter trenched to ensure surface water runoff enters the proposed drainage system.

Figure 11.2.1 illustrates the initial outline feasibility surface water drainage strategy plan, with supporting calculations provided in **Appendix D**.

Following consultation with the local fire brigade a strategy should be developed to suitably control potentially contaminated fire water runoff.

The proposed surface water drainage strategy is subject to agreement from The Highland Council and SEPA and should be designed in accordance with General Binding Rules 10, 11 and 21 of the Water Environment (Controlled Activities) (Scotland) Regulations 2011.

The proposed outfall into Allt Eireannaich is subject to agreement with SEPA and will require a simple licence to be obtained following the submission and authorisation of a Controlled Activities Regulations (CAR) application.

The proposed surface water drainage strategy is subject to detailed drainage design. Post-consent, a topographical survey of the Site should be completed which records the invert level and water level of Allt Eireannaich. This will be required to inform the detailed drainage design for the Proposed

[15] The Highland Council. (2013) *Supplementary Guidance: Flood Risk & Drainage Impact*, accessed 19/06/2023, <https://www.highland.gov.uk/downloads/file/2954/flood_risk_and_drainage_impact_assessment_supplementary_guidance>.
[16] SUDSWP. (2016) *Water Assessment and Drainage Assessment Guide*, accessed 19/06/2023, <https://www.sepa.org.uk/media/163472/water_assessment_and_drainage_assessment_guide.pdf>.

Development. The detailed drainage design for the Proposed Development should also give consideration to the volume of Peat required to be removed to ensure no significant impact is caused.

The addition of any impermeable surfaces in the future has not been allowed for in this DS and would require further attenuation to be provided.

5.7 Water Quality

5.7.1 Simple Index Approach

In order to determine whether the proposed SuDS features for the Proposed Development will be sufficient at removing pollutants from surface water runoff, the CIRIA SuDS Manual (2015) Simple Index Approach has been applied. This approach provides pollution hazard levels and indices to relevant pollutants based upon contributing hardstanding surfaces.

Table 2 below provides an extract of the land use types and pollutant indices from the CIRIA SuDS Manual which are relevant to the Proposed Development.

Table 2 - Pollution Hazard Indices (Source: CIRIA SuDS Manual, 2015)

Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Other roofs	Low	0.3	0.2	0.05
Low traffic roads and non-residential car parking with infrequent change (i.e., < 300 traffic movements a day)	Low	0.5	0.4	0.4

Based upon the above, the worst-case indices for the Proposed Development are 0.5 (Total Suspended Solids), 0.4 (Metals) and 0.4 (Hydrocarbons).

Under the Simple Index Approach, in order to suitably mitigate surface water pollutants, the total combined indices for any SuDS components will need to be greater than the worst-case indices above. Where multiple SuDS components are proposed, the primary component is given its full indices, while subsequent component indices are applied with a factor of 50%.

Table 3 below indicates the mitigation indices for different types of SuDS components, with only those relevant to the Proposed Development included.

Table 3 - Indicative SuDS mitigation indices for discharges to surface waters (Source: CIRIA SuDS Manual, 2015)

Proposed SuDS Component	Mitigation Indices		
	TSS	Metals	Hydrocarbons
Filter Drain	0.4	0.4	0.4
Detention Basin	0.5	0.5	0.6
Swale	0.5	0.6	0.6

Based upon the above, the proposed series of SuDS features will be able to sufficiently mitigate surface water runoff pollution from the Proposed Development.

5.8 Maintenance

The proposed surface water drainage system will require routine maintenance to ensure it remains fully operational and effective. The proposed SuDS features will remain under private ownership and should therefore, be maintained by either the Site owner or a suitable private management company.

Draft maintenance schedules for the proposed SuDS features have been provided in **Appendix E**. However, a pre-commencement condition should be applied to ensure a final Site-specific maintenance plan is provided post-consent for the proposed SuDS features.

6. CONCLUSIONS & RECOMMENDATIONS

This section of the report presents the conclusions and recommendations of the Outline Feasibility Surface Water Drainage Strategy.

6.1 Conclusions

In order to maintain the discharge rate of 5.0l/s for all storms up to and including the 1 in 200-year return period with a 42% allowance for climate change, attenuation is required which provides in the order of 266.7m³ of surface water storage.

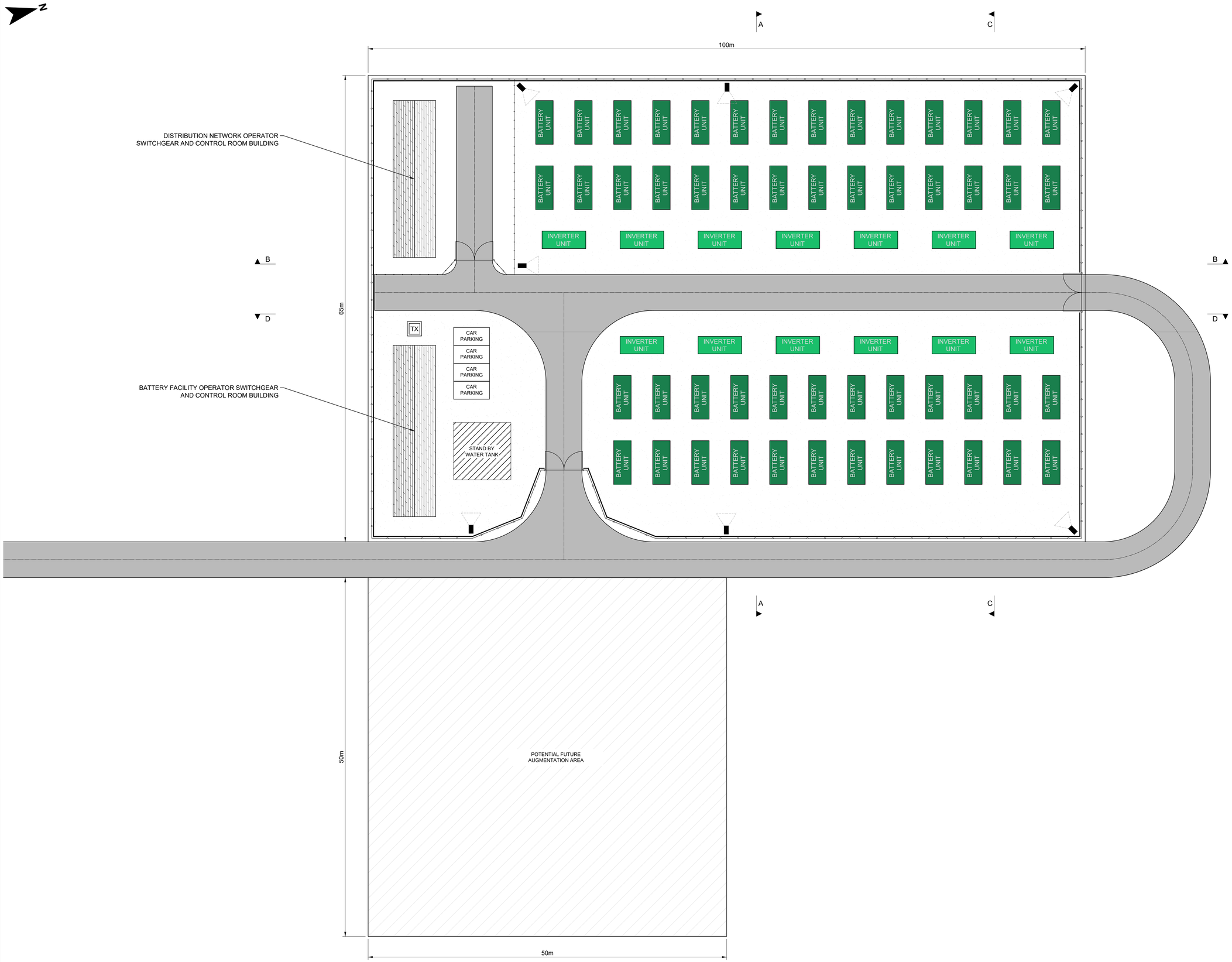
The required surface water attenuation volume is proposed to be provisioned by a shallow surface level detention basin before restricted discharge into Allt Eireannaich. Surface water runoff from the impermeable areas of the Proposed Development should be captured by conveyance features, such as a stone filled filter trench, French drain, or shallow grass ditch, directing surface water towards the proposed attenuation feature. The attenuation feature will then outfall to a swale which drains to Allt Eireannaich.

The addition of any impermeable surfaces in the future has not been allowed for in this DS and would require further attenuation to be provided.

6.2 Recommendations

- Post-consent, a topographical survey of the Site should be completed which records the invert level and water level of Allt Eireannaich. This will be required to inform the detailed drainage design of the Proposed Development.
- Following consultation with the local fire brigade a strategy should be developed to suitably control potentially contaminated fire water runoff.
- Detailed drainage design for the Proposed Development should give consideration to the volume of Peat required to be removed to ensure no significant impact is caused.
- A pre-commencement condition should be applied to ensure a final Site-specific maintenance plan is provided post-consent for the proposed SuDS features.

APPENDIX A PROPOSED DEVELOPMENT LAYOUT PLAN



SCALE AT 1:250

0m 5 10 15 20m

INDICATIVE BESS LAYOUT - 4HR SYSTEM

SCALE 1:250

LEGAL: NATURAL POWER CONSULTANTS LTD TAKE NO RESPONSIBILITY FOR THE ACCURACY OF DATA PROVIDED BY THIRD PARTIES.

NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE STATED.
2. THIS IS AN INDICATIVE ARRANGEMENT ONLY.
3. FINAL DIMENSIONS TO BE DETERMINED DURING DETAILED DESIGN.
4. REFER TO DRAWING 17959_LAY_1003

KEY:

- PROPOSED 3m HIGH PALISADE FENCE
- PROPOSED 4m HIGH ACOUSTIC FENCE
- PROPOSED ACCESS TRACK
- BATTERY INFRASTRUCTURE
- INVERTER INFRASTRUCTURE
- PROPOSED CCTV

REV	DESCRIPTION	BY	CH	APP	DATE
A	FIRST ISSUE	MH	MB	CG	14/06/23

CLIENT: BORALEX

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STATUS: **FOR INFORMATION**

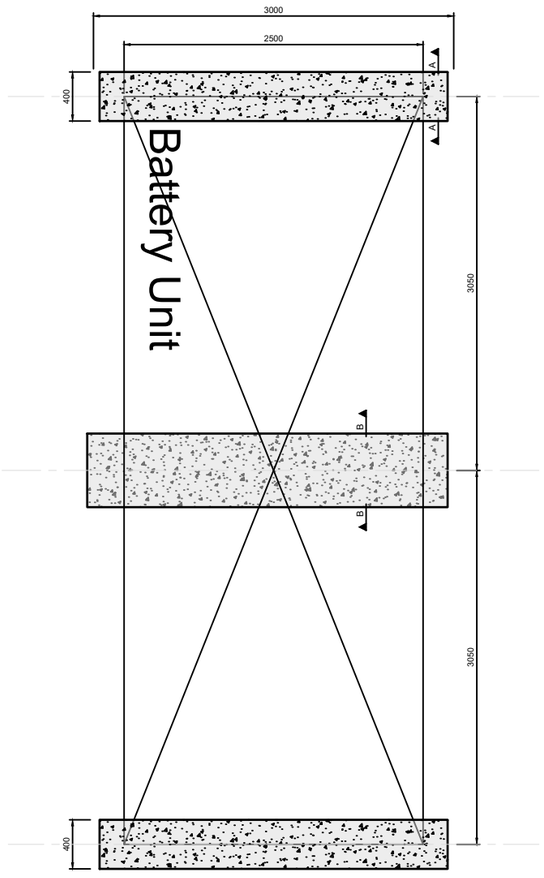
PROJECT: TOFTINGALL BESS

DRAWING TITLE: INDICATIVE BESS LAYOUT

DRAWING NO.: 17959_LAY_1002

REVISION: A

APPENDIX B SUBSTATION AND BESS ELEVATIONS



INDICATIVE BATTERY FOUNDATION PLAN

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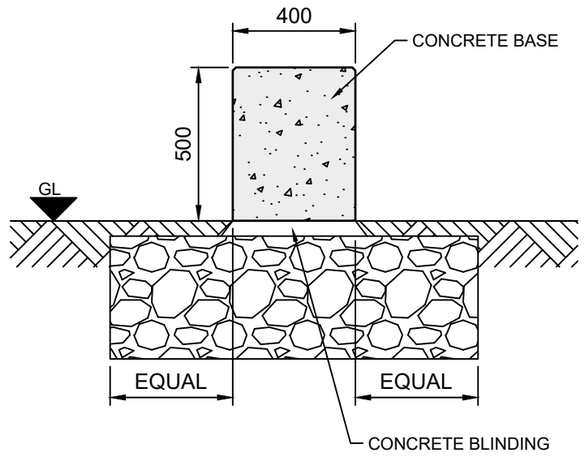

SECTION A-A THROUGH BATTERY FOUNDATION

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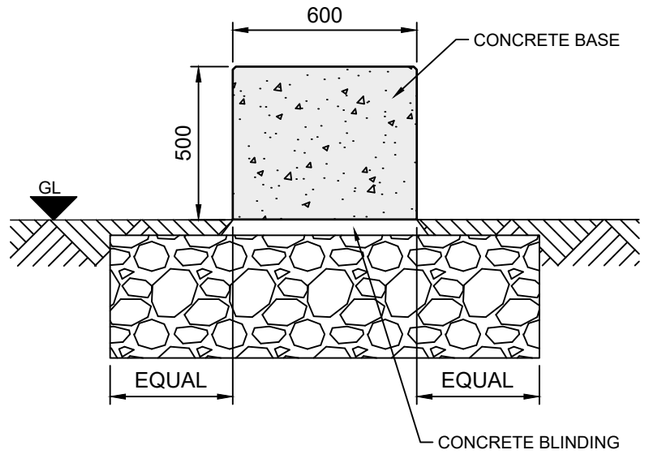

SECTION B-B THROUGH BATTERY FOUNDATION

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SCALE: VARIOUS @ A3	SHEET NO.: 1 OF 1

STATUS: **FOR INFORMATION**

PROJECT: TOFTINGALL BESS

DRAWING TITLE: INDICATIVE BATTERY FOUNDATION PLAN & SECTIONS A-A & B-B

DRAWING NO.:	REVISION
17959_DET_3001	**A**

APPENDIX C GREENFIELD RUNOFF CALCULATIONS

ICP SUDS Mean Annual Flood

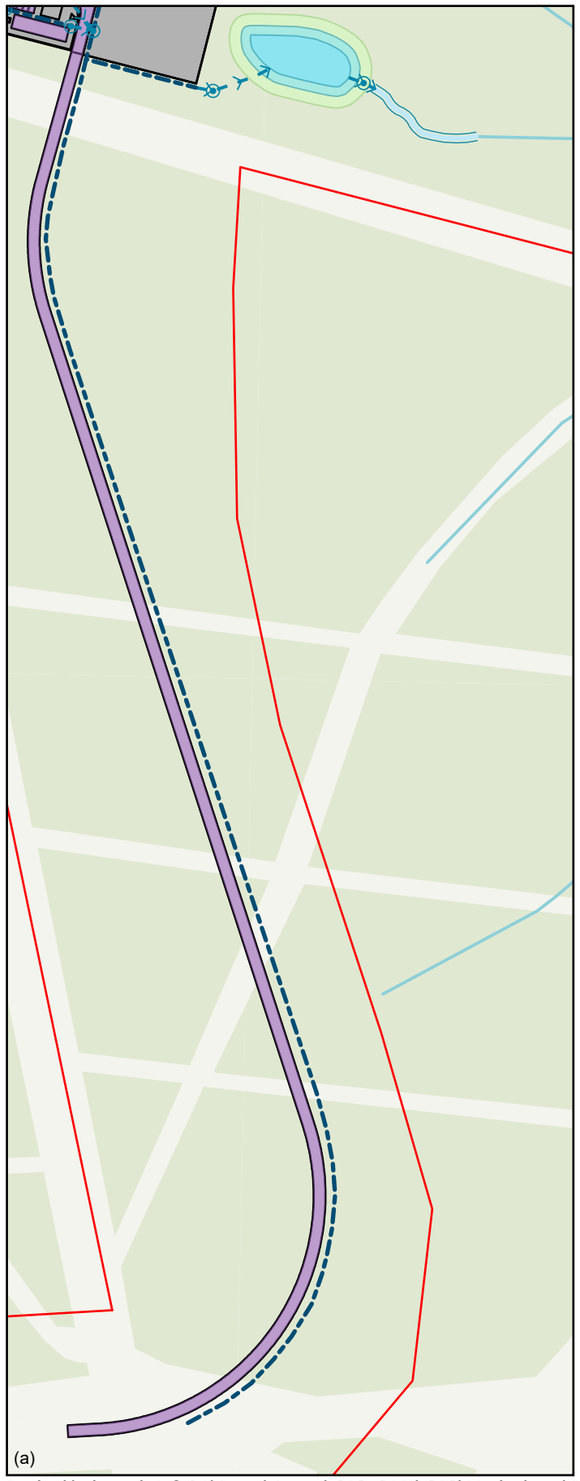
Input

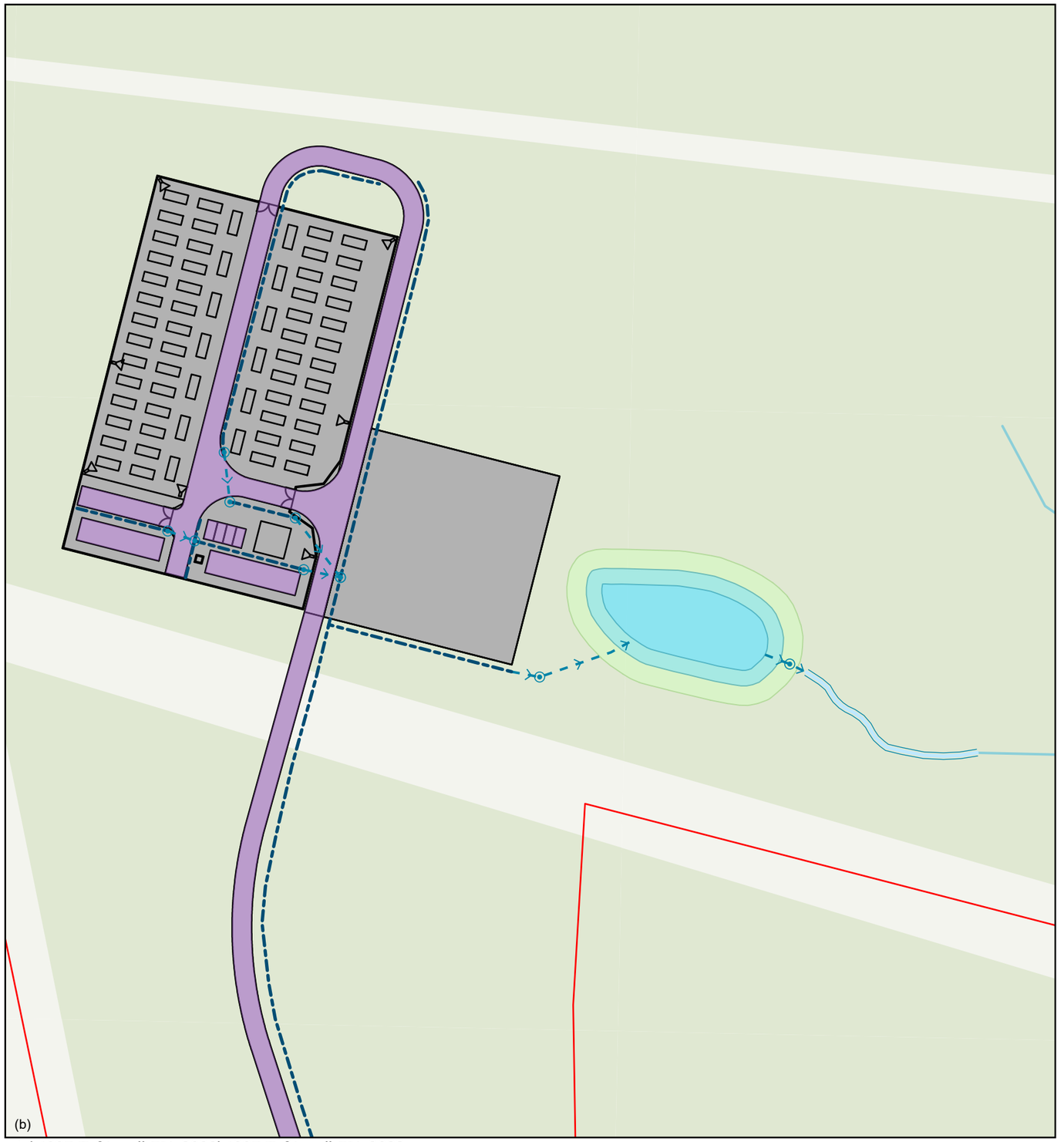
Return Period (years)	200	Soil	0.500
Area (ha)	0.510	Urban	0.000
SAAR (mm)	972	Region Number	Region 1

Results l/s

QBAR Rural	4.1
QBAR Urban	4.1
Q200 years	11.6
Q1 year	3.5
Q30 years	7.8
Q100 years	10.3

APPENDIX D FIGURE 11.2.1: OUTLINE FEASIBILITY DRAINAGE STRATEGY PLAN & SUPPORTING CALCULATIONS





Projection: British National Grid

Legend:

- Site Boundary - Core Study Area
- Proposed Development
- Impermeable Area
- Proposed Surface Water Manhole
- Proposed Filter Drain
- Proposed Surface Water Pipe
- Proposed Swale
- Proposed Attenuation Basin
- Proposed Access & Maintenance Strip

Title

Outline Feasibility Surface Water Drainage Strategy

Project:

Loch Toftingall BESS

Source:

Esri Community Maps Contributors, Esri UK, Esri, HERE, Garmin, Foursquare, GeoTechnologies, Inc, METI/NASA, USGS

Client:

BORALEX

Drawn by:	Checked:
AS	AC
Date:	Figure:
04/07/2023	Appendix D
Scale:	Revision No.
1:2,621 (a) / 1:1,217 (b)	P01

BORALEX

0 5 10 20 30 40 50

Meters

N

Path: \\uksprdgisfs01\Data\Arcus\GIS-CAD\GIS\Hydrology\Projects\4887 Toftingall EIA 2022\4887 Toftingall EIA 2022.aprx

Summary of Results for 200 year Return Period (+42%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	89.917	0.217	4.9	68.7	O K
30 min Summer	89.978	0.278	4.9	99.9	O K
60 min Summer	90.039	0.339	4.9	137.3	O K
120 min Summer	90.091	0.391	4.9	175.1	O K
180 min Summer	90.116	0.416	4.9	195.0	O K
240 min Summer	90.131	0.431	4.9	207.3	O K
360 min Summer	90.146	0.446	4.9	219.7	O K
480 min Summer	90.153	0.453	4.9	225.6	O K
600 min Summer	90.157	0.457	4.9	229.0	O K
720 min Summer	90.159	0.459	4.9	230.6	O K
960 min Summer	90.159	0.459	4.9	231.3	O K
1440 min Summer	90.154	0.454	4.9	226.9	O K
2160 min Summer	90.140	0.440	4.9	214.8	O K
2880 min Summer	90.121	0.421	4.9	199.3	O K
4320 min Summer	90.077	0.377	4.9	164.0	O K
5760 min Summer	90.019	0.319	4.9	124.1	O K
7200 min Summer	89.965	0.265	4.9	92.5	O K
8640 min Summer	89.917	0.217	4.9	68.3	O K
10080 min Summer	89.876	0.176	4.9	50.9	O K
15 min Winter	89.936	0.236	4.9	77.4	O K
30 min Winter	90.000	0.300	4.9	112.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	76.123	0.0	72.0	22
30 min Summer	55.948	0.0	106.1	36
60 min Summer	39.431	0.0	150.4	66
120 min Summer	26.339	0.0	201.0	124
180 min Summer	20.516	0.0	234.9	182
240 min Summer	17.117	0.0	261.4	242
360 min Summer	13.200	0.0	302.4	354
480 min Summer	10.952	0.0	334.5	412
600 min Summer	9.466	0.0	361.4	478
720 min Summer	8.398	0.0	384.8	542
960 min Summer	6.947	0.0	424.4	678
1440 min Summer	5.313	0.0	486.5	964
2160 min Summer	4.062	0.0	559.0	1384
2880 min Summer	3.354	0.0	615.4	1792
4320 min Summer	2.554	0.0	702.8	2596
5760 min Summer	2.102	0.0	771.8	3296
7200 min Summer	1.807	0.0	829.1	3968
8640 min Summer	1.596	0.0	878.8	4672
10080 min Summer	1.437	0.0	923.0	5344
15 min Winter	76.123	0.0	80.7	22
30 min Winter	55.948	0.0	118.9	36

Summary of Results for 200 year Return Period (+42%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	90.065	0.365	4.9	155.4	O K
120 min Winter	90.121	0.421	4.9	198.8	O K
180 min Winter	90.149	0.449	4.9	222.6	O K
240 min Winter	90.167	0.467	4.9	237.8	O K
360 min Winter	90.186	0.486	4.9	254.9	O K
480 min Winter	90.194	0.494	4.9	262.5	O K
600 min Winter	90.197	0.497	4.9	265.1	O K
720 min Winter	90.199	0.499	4.9	266.7	O K
960 min Winter	90.198	0.498	4.9	266.2	O K
1440 min Winter	90.187	0.487	4.9	256.1	O K
2160 min Winter	90.161	0.461	4.9	232.6	O K
2880 min Winter	90.129	0.429	4.9	205.1	O K
4320 min Winter	90.043	0.343	4.9	140.4	O K
5760 min Winter	89.945	0.245	4.9	82.2	O K
7200 min Winter	89.862	0.162	4.9	45.4	O K
8640 min Winter	89.821	0.121	4.7	30.9	O K
10080 min Winter	89.810	0.110	4.3	27.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	39.431	0.0	168.5	64
120 min Winter	26.339	0.0	225.2	122
180 min Winter	20.516	0.0	263.2	180
240 min Winter	17.117	0.0	292.8	236
360 min Winter	13.200	0.0	338.7	348
480 min Winter	10.952	0.0	374.7	456
600 min Winter	9.466	0.0	404.8	546
720 min Winter	8.398	0.0	431.0	574
960 min Winter	6.947	0.0	475.3	732
1440 min Winter	5.313	0.0	544.8	1042
2160 min Winter	4.062	0.0	626.1	1496
2880 min Winter	3.354	0.0	689.3	1932
4320 min Winter	2.554	0.0	787.2	2728
5760 min Winter	2.102	0.0	864.5	3400
7200 min Winter	1.807	0.0	928.6	3960
8640 min Winter	1.596	0.0	984.4	4416
10080 min Winter	1.437	0.0	1033.9	5144

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	200	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	12.000	Shortest Storm (mins)	15
Ratio R	0.211	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+42

Time Area Diagram

Total Area (ha) 0.510

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.255	4	8	0.255

Model Details

Storage is Online Cover Level (m) 90.500

Tank or Pond Structure

Invert Level (m) 89.700

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	188.3	0.400	790.8	0.800	1393.3

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0112-5000-0500-5000
Design Head (m)	0.500
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	112
Invert Level (m)	89.700
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.500	5.0
Flush-Flo™	0.178	4.9
Kick-Flo®	0.370	4.3
Mean Flow over Head Range	-	4.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.9	1.200	7.4	3.000	11.5	7.000	17.3
0.200	4.9	1.400	8.0	3.500	12.4	7.500	17.9
0.300	4.7	1.600	8.5	4.000	13.2	8.000	18.5
0.400	4.5	1.800	9.0	4.500	13.9	8.500	19.0
0.500	5.0	2.000	9.5	5.000	14.7	9.000	19.6
0.600	5.4	2.200	9.9	5.500	15.3	9.500	20.1
0.800	6.2	2.400	10.3	6.000	16.0		
1.000	6.8	2.600	10.7	6.500	16.6		

APPENDIX E DRAFT SUDS MAINTENANCE SCHEDULES

ERM

New Barclay House, Citibase,
234 Botley Road,
Oxford,
OX2 0HP

Telephone: +44 (0)1865 384800

www.erm.com

SUDS MAINTAINACE MANUAL DATA SHEET

SuDS Element:

Filter Trench.

Function Served:

Cleanses surface water and facilitates conveyance.

Features:

Stone filled trench.

Ownership:

Site Owner.

Maintenance Responsibility:

Site Owner or Private Management Company.

Location:

Refer to Appendix D of the ERM Outline Feasibility Surface Water Drainage Strategy (Version 1-0).

General Notes:

Maintenance strategy should be reviewed on a regular basis and performance of the maintenance activities assessed.

Reference should be made to recognised industry standards in undertaking maintenance.

Where activities are required outside ownership, permission must be sought from relevant party.

Refer to section 22 of CIRIA C697 for discussion on maintenance techniques.

Requirement for reporting of inspections to be confirmed by responsible party.

May be required as evidence of activities to prove activity as part of funding arrangements.

Routine Maintenance (typically monthly):

Maintenance Activity	Comments	Frequency
Litter and debris removal	Litter and debris (removed prior to any grass cutting activity) to minimise risk of shredding litter	Monthly
Grass cutting of landscaped areas	All cuttings to be removed from SUDS components	Monthly (during growing season) or as required
Remove nuisance plants	Invasive species should be removed in accordance with best practice	Monthly (at implementation) then as required.
Inspect any inlet and outlet structures for evidence of poor operation		Monthly
Safety signage and safety equipment inspection	Generally limited to knee-rail fencing	Monthly

Occasional Maintenance (typically every 6 months):

Maintenance Activity	Comments	Frequency
Inspect inlet catch pit and pre-treatment components for silt accumulation	Includes visual inspection of inlet chamber, forebay and inspection of flow control.	6 monthly
Visual inspection catch-pits, linking pipework etc for evidence of physical damage	Visual inspection from surface only, CCTV survey required if evidence present of structural issues.	6 monthly

Annual Activities:

Maintenance Activity	Comments	Frequency
Tidy all dead growth before start of growing season		Annually
Prune and trim nearby trees and remove cuttings	Where vegetation is planted as a barrier management of upward growth to encourage outward growth is necessary (after shrub seedlings are established).	As required
Remove sediment from catch-pit	Remove accumulated silt with suction tanker when 50% full.	As required

Infrequent/Corrective Activities:

Maintenance Activity	Comments	Frequency
Remove dead vegetation from trench edges		As required
Repair erosion or other damage	Required to maintain the bed at original design level	As required
Repair/rehabilitation of any inlets and outlets.		As required
Rehabilitation following a pollution event		As required
Rehabilitate/replace filter medium	Required when all mechanical elements checked and performance remains inadequate.	As required
Jetting of any linking pipework	Where CCTV survey shows siltation of pipework has occurred	As required

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SUDS MAINTAINACE MANUAL DATA SHEET

SuDS Element:

Detention Basin.

Function Served:

Attenuate and treat surface water runoff. Restricted outfall.

Features:

Shallow basin with 1-in-4 slopes, inlet pipes, and outlet headwalls to flow control chamber.

Ownership:

Site Owner.

Maintenance Responsibility:

Site Owner or Private Management Company.

Location:

Refer to Appendix D of the ERM Outline Feasibility Surface Water Drainage Strategy (Version 1-0).

General Notes:

Maintenance strategy should be reviewed on a regular basis and performance of the maintenance activities assessed.

Reference should be made to recognised industry standards in undertaking maintenance.

Where activities are required outside ownership, permission must be sought from relevant party.

Refer to section 22 of CIRIA C697 for discussion on maintenance techniques.

Requirement for reporting of inspections to be confirmed by responsible party.

May be required as evidence of activities to prove activity as part of funding arrangements.

Routine Maintenance (typically monthly):

Maintenance Activity	Comments	Frequency
Litter and debris removal	Litter and debris (removed prior to any grass cutting activity) to minimise risk of shredding litter. Particular attention should be paid to inlet/outlet pipes. i.e. rake the trash screen	Monthly
Grass cutting: Landscaped areas and access routes	All cuttings to be removed from SUDS components	Monthly (during growing season) or as required
Cut and remove bank vegetation from water's edge to a minimum of 1m above water level.	To provide access to pond edge/emergent vegetation for maintenance inspection.	Monthly (for the first 3 years) then as required.
Manage other vegetation and remove nuisance plants.	To include wetland plants in permanent pools. Weeding should be conducted by hand or use non-toxic and biodegradable weed killer. Invasive species should be removed in accordance with best practice	Monthly (at implementation) then as required.
Inspect inlet and outlet structures for evidence of poor operation		Monthly
Inspect banksides, structures, pipework etc for evidence of physical damage		Monthly
Inspect water body for signs of eutrophication		Monthly (May-October)
Safety signage and safety equipment inspection	Ensure permanent and seasonal safety signs are in place. Safety equipment should be inspected to ensure it available and in good repair	Monthly
Inspection of safety fencing		Monthly

Occasional Maintenance (typically every 6 months):

Maintenance Activity	Comments	Frequency
Inspect inlets for silt accumulation	Includes visual inspection of inlet chambers	6 monthly
Check mechanical devices within chambers	Checks undertaken under maintenance contract by specialist	6 monthly
Ice warning safety signage		To be erected at the end of September and removed at the end of March

Annual Activities:

Maintenance Activity	Comments	Frequency
Tidy all dead growth before start of growing season		Annually
Prune and trim trees and remove cuttings	Where vegetation is planted as a barrier management of upward growth to encourage outward growth is necessary (after shrub seedlings are established).	As required
Inspect ancillary structures	Inspection of banks for signs of deterioration. Remove troublesome plant growth.	Annually
Remove sediment from sumps	Remove accumulated silt with suction tanker when 50% full.	As required

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SUDS MAINTAINACE MANUAL DATA SHEET

SuDS Element:

Swale.

Function Served:

Conveyance of surface water.

Features:

Shallow side slopes and margin for safety.

Ownership:

Site Owner.

Maintenance Responsibility:

Site Owner or Private Management Company.

Location:

Refer to Appendix D of the ERM Outline Feasibility Surface Water Drainage Strategy (Version 1-0).

General Notes:

Maintenance strategy should be reviewed on a regular basis and performance of the maintenance activities assessed.

Reference should be made to recognised industry standards in undertaking maintenance.

Where activities are required outside ownership, permission must be sought from relevant party.

Refer to section 22 of CIRIA C697 for discussion on maintenance techniques.

Requirement for reporting of inspections to be confirmed by responsible party.

May be required as evidence of activities to prove activity as part of funding arrangements.

Routine Maintenance (typically monthly):

Maintenance Activity	Comments	Frequency
Litter and debris removal	Litter and debris (removed prior to any grass cutting activity) to minimise risk of shredding litter. Particular attention should be paid to inlet/outlet pipes	Monthly
Grass cutting of landscaped areas	All cuttings to be removed from SUDS components	Monthly (during growing season) or as required
Manage other vegetation and remove nuisance plants.	To include wetland plants in swale. Weeding should be conducted by hand or use non-toxic and biodegradable weed killer. Invasive species should be removed in accordance with best practice	Monthly (at implementation) then as required.
Inspect inlet and outlet structures for evidence of poor operation		Monthly
Safety signage and safety equipment inspection	Generally limited to knee-rail fencing	Monthly

Occasional Maintenance (typically every 6 months):

Maintenance Activity	Comments	Frequency
Inspect inlet catch pits and pre-treatment components for silt accumulation	Includes visual inspection of inlet chamber, forebay and inspection of flow control.	6 monthly
Check mechanical devices within chambers	Includes inspection of hydrobrakes for signs of damage	6 monthly
Visual inspection catch-pits, linking pipework etc for evidence of physical damage	Visual inspection from surface only, CCTV survey required if evidence present of structural issues.	6 monthly

Annual Activities:

Maintenance Activity	Comments	Frequency
Tidy all dead growth before start of growing season	-	Annually
Prune and trim trees and remove cuttings	Where vegetation is planted as a barrier management of upward growth to encourage outward growth is necessary (after shrub seedlings are established).	As required
Remove sediment from catch-pits	Remove accumulated silt with suction tanker when 50% full.	As required

Infrequent/Corrective Activities:

Maintenance Activity	Comments	Frequency
Remove dead vegetation from swale edge		1-3 years or as required
Re-seed or replant areas of poor vegetation growth		As required
Repair erosion or other damage	Required to maintain the bed at original design level	As required
Repair/rehabilitation of inlets and outlets.		As required
Rehabilitation following a pollution event		As required
Repair / replace flow control device	Required when checks on mechanical elements demonstrate damage.	As required
Jetting linking pipework	Where CCTV survey shows siltation of pipework has occurred	As required

Emergency Procedure:

Emergency procedure boards should be displayed around the attenuation basin, where necessary, these will contain current contact details for the maintenance team.

Infrequent/Corrective Activities:

Maintenance Activity	Comments	Frequency
Remove dead vegetation from pond edge		1-3 years or as required
Hand cut submerged and emergent aquatic plants (at a minimum of 0.1m above pond base; max 1/3 of pond surface	Thinning of emergent barrier vegetation. Areas of tall emergent plants obscuring visual inspection (for safety) of the open water should be regularly trimmed.	As required
Re-seed or replant areas of poor vegetation growth		As required
Remove sediment from main body of large ponds when pool volume is reduced by 20%	Sediment level will be dependent upon presence and type of upstream SUDS, size and land us of catchment as well as local soil conditions. Care must be taken not o damage the pond liner	>25 years usually or as required
Repair erosion or other damage	Required to maintain the bed at original design level	As required
Aerate pond when signs of eutrophication are detected		As required
Repair/rehabilitation of inlets, outlets and overflows.		As required
Rehabilitation following a pollution event		As required

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