HIGH MATHERNOCK BESS

SUSTAINABLE DRAINAGE & FLOOD RISK ASSESSMENT

VERSION 2

Updates from Version 1:

- Site area reduced from 3.1ha to 2.7ha
- Runoff rates per hectare increased to account for latest climate change predictions
- Required volume of attenuation increased
- Indicative drainage strategy altered to reflect changes in site layout and increased run off rates

Conclusion

Main Conclusions from Section 6, Summary, (p20), listed below:

- *“The Proposed Development may proceed without being subject to significant flood risk and will not result in an increase in flood risk elsewhere as a result of sustainable management of surface water runoff.”*

Pell Frischmann

High Mathernock BESS

Sustainable Drainage & Flood Risk Assessment

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Ref. reference. Rev revision. Suit suitability.

Prepared for

Harmony HM Ltd

10 St James Business Park,
Grimbald Crag Court,
Knaresborough,
England,
HG5 8QB

Prepared by

Pell Frischmann

Suite 4.2 – 1, The Poynt
Wollaton Road
Nottingham
NG1 5FW

Pell Frischmann

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1 Introduction

1.1 Report Context

1.1.1 Pell Frischmann has been commissioned by Harmony HM Ltd to undertake a Sustainable Drainage & Flood Risk Assessment, for a site located to the west of High Mathernock Farm, to support a planning application.

1.1.2 The purpose of this Sustainable Drainage & Flood Risk Assessment is to review available information and assess the flood risk posed to the site and proposed development from a range of sources, now and in the future and provide a suitable surface water strategy for the site. The Sustainable Drainage & Flood Risk Assessment has been carried out in accordance with the requirements of the National Planning Framework 4 (NPF4) and associated Scottish Planning Policy.

1.2 Sources of Information

1.2.1 A review of the relevant information from a range of sources has been undertaken and includes the following:

- National Planning Framework 4 (NPF4), February 2023
- Scottish Environment Protection Agency (SEPA) Flood Maps
- British Geological Survey Geology Viewer, 2023
- British Geological Survey GeoIndex, 2023
- Inverclyde Local Development Plan, August 2019
- Inverclyde Flood Risk Assessment and Surface Water Management Assessment, March 2024
- Clyde and Loch Lomond Local Flood Risk Management Plan (Cycle 2) December 2022

1.2.2 The NPF4 specifies that surface water arising from a developed site should, as far as is practicable, be managed in a sustainable manner to mimic the surface water flows arising from the site prior to the proposed development. Opportunities to reduce the flood risk to the site itself and elsewhere, taking climate change into account, should be investigated. The drainage proposals within this strategy have been prepared to meet planning policy requirements.

1.3 Site Location

1.3.1 The site is located to the south of Port Glasgow, Inverclyde. A site location plan is included for reference as **Figure 1.1**. In total the Site Boundary has an approximate area of 2.7ha and the Site Wide Allocation has an approximate area of 8.48ha.

1.3.2 The northern and eastern boundary are bound by Auchentiber Road beyond which is agricultural land. The southern boundary is formed by High Mathernock Farm and agricultural land. The western boundary is formed by the watercourse Gryfe Water and agricultural land.

1.3.3 Aerial mapping shows the site is currently undeveloped with no areas of hardstanding structures. Therefore, it is assumed the Proposed Site is subject to a natural regime of drainage involving runoff and infiltration where good conditions permit.

1.3.4 The site is currently accessed off Auchentiber Road via two accesses.

Figure 1.1 Site Location Plan

1.4 Topography

1.4.1 The site generally falls from the north to the south as one total catchment. Elevations range from approximately 149.0m AOD in the north and falling to a minimum elevation of approximately 131.9m AOD in the south.

1.4.2 LiDAR data, provided by Scottish Remote Sensing Portal, covering the wider area, as shown in **Figure 1.2** shows levels beyond the boundary the same as within the boundary, with levels rising north of the site and falling to the south of site to a local low point.

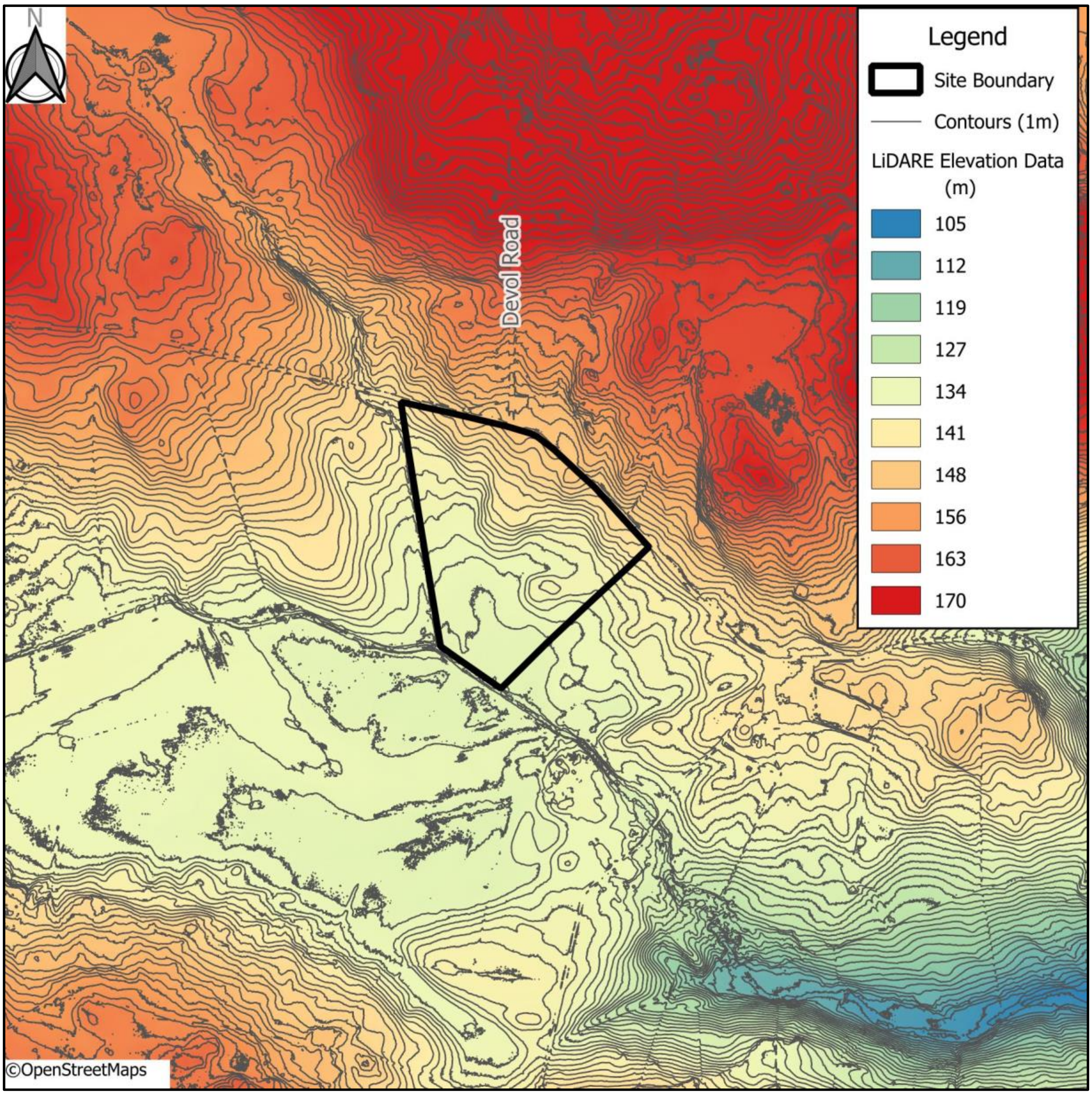


Figure 1.2 LiDAR Elevation Data

1.5 Proposed Development

1.5.1 Development proposals comprise a Battery Energy Storage System (BESS), with associated road infrastructure, landscaping and SuDS features.

2 Existing Conditions

2.1 Existing site

2.1.1 The existing site comprises open agricultural land.

2.1.2 Considering the current usage of the land as being agricultural, the presence of sewers and manholes are unlikely.

2.1.3 There are several watercourses located around the site. This includes the Gryfe Water which runs parallel to the southern boundary and an un-named watercourse which runs parallel to the western boundary and feeds into the Gryfe Water.

2.1.4 All watercourses are shown for reference in **Figure 2.1** below.

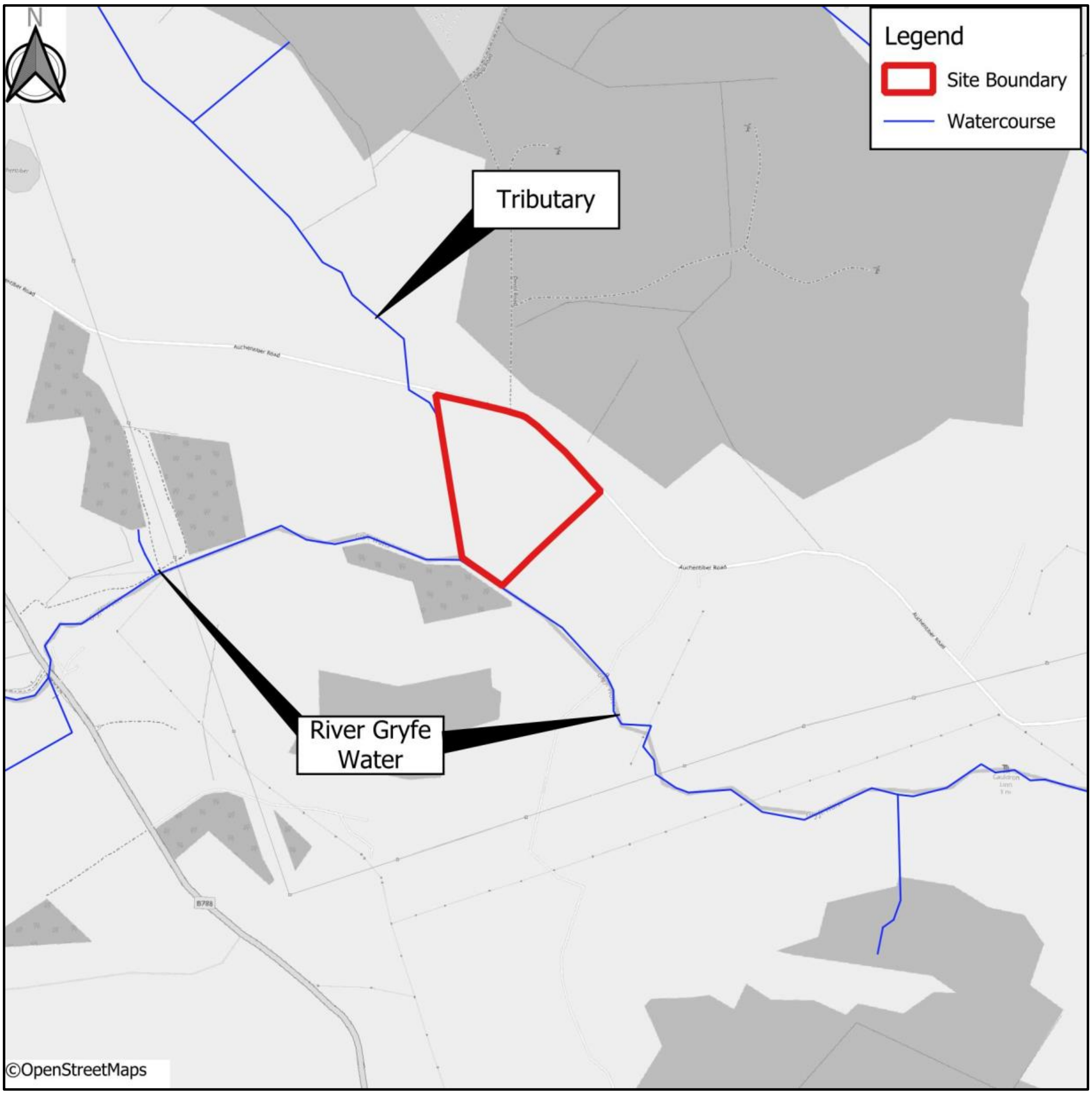


Figure 2.1 Local Watercourses

2.2 Site Geology

2.2.1 British Geological Survey (BGS) mapping suggest the site is underlain by two superficial geologies, Till, Devensian – Diamicton, which is found along the south and western boundary, and Alluvium – Clay, Silt, Sand and Gravel, which is found across most of the site apart from two areas, one in the north and one in the south which have no superficial geology classification. An extract of the Superficial geology mapping is presented within **Figure 2.2**.

2.2.2 The bedrock geology is shown to comprise wholly of Strathgryfe Lave Member – Mugearite.

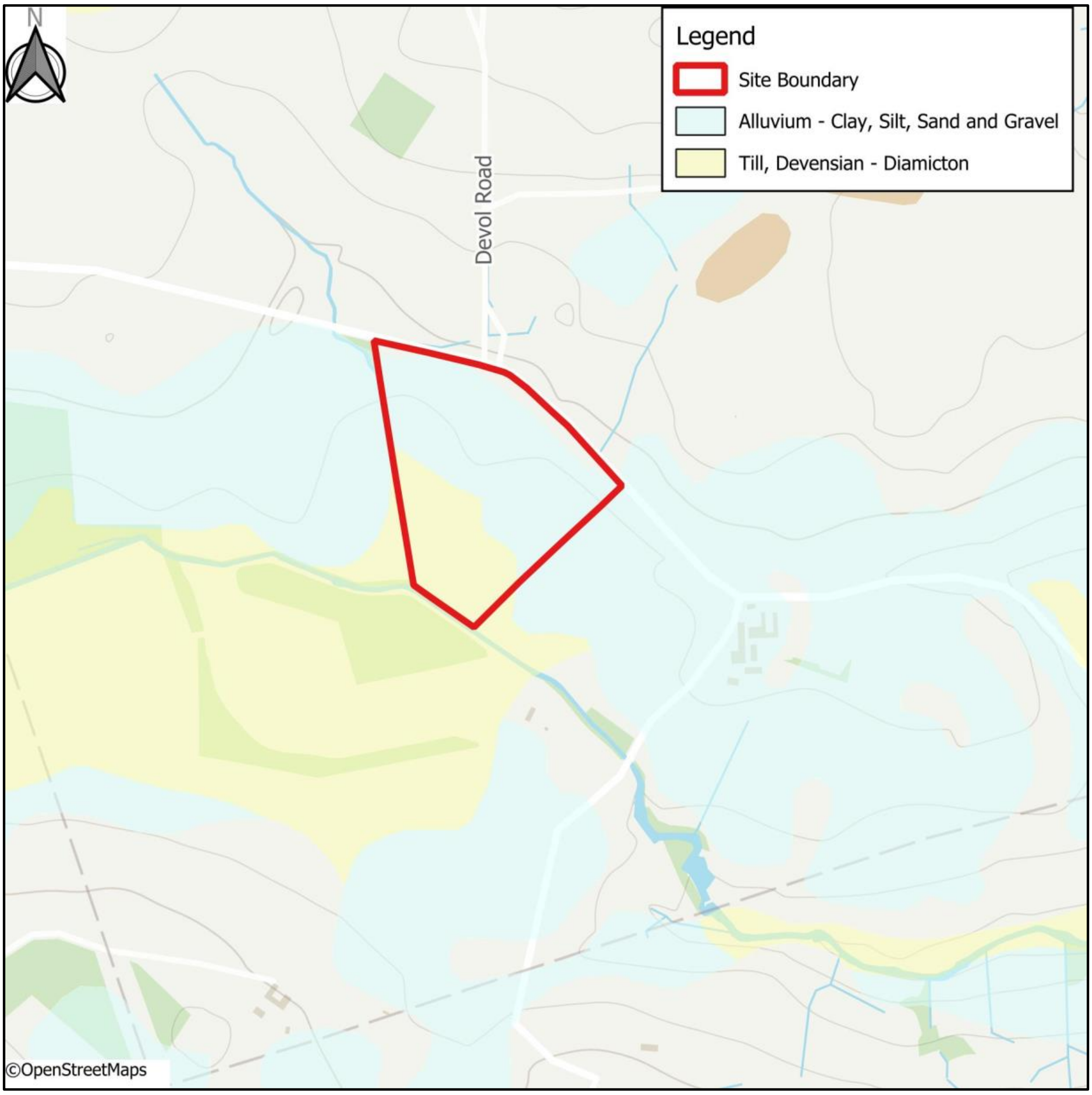


Figure 2.2 Superficial Geology

2.2.3 There are no freely available boreholes records located within the site boundary. The nearest borehole found approximately 0.4km to the east of the site (borehole reference: NS37SW8) drilled in 1898 to a depth of 1.2m bgl. Groundwater was not reported as being struck during the investigation.

2.2.4 It is considered that, due to the evidence implying that the site is underlain be clay, infiltration as a means of surface water disposal will not be feasible. Full soakaway testing to BRE365 may be required in order to satisfy the drainage hierarchy requirements set out in various guidance documents.

2.3 Existing Runoff Rate

2.3.1 The overall application site boundary comprises approximately 8.48ha, of this approximately 2.7ha is to be developed upon. Based upon 95% of this area being impermeable surfaces the area used for calculating the existing discharge rate is 2.57ha.

2.3.2 An assessment of the equivalent greenfield surface water runoff rate from the proposed development areas has been undertaken using MicroDrainage software and is summarised within **Table 2-1**. Outputs from MicroDrainage are included for reference as **Appendix A**.

2.3.3 The runoff rates have been estimated using the ICP SuDS method, with appropriate prorated adjustments for a site of less than 50ha, as recommended in Interim Code of Practice for Sustainable Drainage. This was undertaken within MicroDrainage, which makes the necessary adjustments for small sites automatically.

Table 2-1 Runoff Rates

	Return Period			
	1-year (l/s)	**2-year (l/s)**	**30-year (l/s)**	**200-year (l/s)**
Runoff Rate (per hectare)	13.1	13.7	28.5	44.7
Runoff Rate (for development 2.57ha)	33.7	35.2	73.2	114.9

2.3.4 As shown above, the 2 year greenfield runoff value for the development area is 35.2l/s.

2.3.5 In accordance with Inverclyde Flood Risk Assessment and Surface Water Management Assessment, the discharge from the site must be restricted to the lesser of the 2yr greenfield runoff, or 4.5l/s/ha.

2.3.6 Therefore the based upon the developable area on site of 2.57ha, the discharge rate will be 11.54l/s.

2.4 Existing Runoff Volume

2.4.1 An assessment of the existing surface water runoff volume from the entire area proposed for development has been made for a 1 in 200-year, 6-hour storm event.

2.4.2 As the existing site is wholly undeveloped, the runoff volume has been calculated using the Source Control module within MicroDrainage to be 1002.6m^3, results are included within **Appendix B**.

3 Surface Water Strategy

3.1 Drainage Hierarchy

3.1.1 Prevailing local and national guidance suggests that surface water runoff from a development should be disposed of as high up the following hierarchy as reasonably practicable:

- Water reuse, where a need is identified;
- into the ground (infiltration), where ground conditions permit;
- to a surface water body;
- to a surface water sewer, highway drain, or another drainage system;
- to a combined sewer;

3.1.2 The aim of this approach is to manage surface water runoff close to where it falls and mimic natural drainage as closely as possible.

3.1.3 As discussed in **Section 2.1**, the site is underlain primarily by silt, clay, sand, and gravel. This suggests that there is limited possibility to dispose of surface water runoff by means of infiltration.

3.1.4 Given that discharging surface water generated by areas of hardstanding of the proposed development via infiltration is considered, at this stage, to be unlikely, it is proposed to discharge surface water into a local watercourse.

3.1.5 It is considered that the drainage hierarchy assessment is satisfied by the above.

3.1.6 The location and routes of outfall are shown on the drainage strategy drawing presented in **Appendix C**.

3.2 Surface Water Attenuation

3.2.1 The overall site application area is 8.48ha.

3.2.2 The proposed developable areas total approximately 2.7ha. This includes development space and associated road infrastructure. It is assumed this will comprise 95% impermeable surfacing, based off the Indicative Drainage Strategy prepared by Pell Frischmann.

3.2.3 It is proposed for the development area to drain as a single catchment. A suitable outfall location has been noted as the Gryfe Water, which runs adjacent to the southern boundary of site. The outfall from the SUDS basin would discharge to the small tributary which runs along the boundary of the proposed site.

3.2.4 **Table 3-1** shows the pertinent drainage variables for the development. Calculations for **Table 3-1** are shown in **Appendix D**.

Table 3-1 Plot Area, Runoff Rates and Volume of Attenuation

Catchment	Area (ha)	Developable Area (ha)	Impermeable Area (ha)	Allowable Discharge Rate (l/s)	Required Volume of Attenuation (m^3)
Entire Development	8.48	2.7	2.57	11.54	2,960

3.2.5 The attenuation required for the development will be provided by a grassed attenuation basin. This basin will be dry under normal conditions and will fill up under significant storm events prior to discharge into the receiving watercourse at the catchment greenfield.

3.2.6 The basin provides sufficient storage capacity for all rainfall events up to the 1 in 200 year (+41%CC) under the restrictions outlined in **Table 3-1**. In addition to this primary purpose, the basin treats water by naturally filtering out contaminants, provides a pleasant green landscape when not attenuating runoff and enhances biodiversity through wildflower planting and the associated habitats that offers. This achieves all 4 pillars of SuDS design. The treatment provided by the basin is shown to be adequate through the Simple Index Approach results in **Appendix E**.

3.2.7 The indicative surface water layout for the development shows an indicative location for the attenuation basins as well as the outfall location and is included as **Appendix C**.

3.3 Runoff Volume Control

3.3.1 The Water Assessment and Drainage Assessment Guide states that where reasonably practical the runoff volume from a development for the 1 in 200 year, 6-hour rainfall event should not exceed the runoff volume prior to development or redevelopment. Additionally, if practicable on previously developed sites, the runoff volume should not exceed the equivalent greenfield runoff volume.

3.4 SuDS Features

3.4.1 The proposed strategy is based on sustainable drainage principles, employing SuDS features to manage surface water runoff across the site.

3.4.2 A wide variety of other SuDS features can also be implemented across the development as the design progresses and this could include, but is not limited to;

- Water butts
- Swales
- Rainwater harvesting systems
- Rainwater gardens
- Permeable paving
- Filter drains
- Silt traps
- Sump gullies

3.4.3 A summary of SuDS features and suitability for implementation as part of the drainage strategy for the site is shown in **Table 3-2**.

Table 3-2 SuDS Features Appraisal

SuDS Technique	Applicable to Site? (Y/N/TBC)	Included in current strategy? (Y/N/TBC)	Comments
Rainwater Harvesting	N	N	Rainwater harvesting would not be a suitable SuDS feature for the proposed development.
Green Roofs	N	N	The proposed development would not be suitable for green roofs.
Infiltration Systems	TBC	N	The feasibility of infiltration as a means of surface water has been ruled out
Filter Strips	Y	N	Filter strips placed along access and maintenance roads would be suitable.
Filter Drains	Y	N	Filter drains placed adjacent to access roads and maintenance tracks should be considered, as these will act as an excellent water conveyance system.
Swales	Y	Y	Swales are appropriate in this case and have been shown on the drainage strategy plan for the access roads into the site.
Bioretention Systems	Y	N	Bioretention Systems will provide similar attenuation and treatment to the proposed attenuation basins.
Pervious Pavements	Y	N	Pervious paving could be proposed in the strategy to limit the impermeable area of the site draining to any proposed attenuation/infiltration feature.
Detention Basins	Y	Y	The presence of open space near the outfall means a basin is an appropriate means of attenuation
Wetlands	Y	N	It is feasible to provide permanently wet areas within the basins proposed and thus create wetland areas. These should be considered at detailed design.
Attenuation Storage Tanks	Y	N	The strategy has sought to provide all attenuation above ground in line with prevailing SuDS guidance.

3.4.4 The proposed SUDS features for the site include:

- Swales adjacent to the access tracks into the site which will capture runoff from the roads;
- Filter drains running along the internal roads and concrete podiums in the site to capture, treat and convey the runoff; and
- Attenuation basin in the south of the site to provide treatment as well as attenuation up to the 1 in 200yr+CC event.

3.5 Maintenance and Adoption

3.5.1 For the proposed surface water drainage system to function correctly, it will need to be appropriately maintained. It is proposed that the strategic drainage features on site are to be maintained by a suitable management company, with residents of the development responsible for drainage elements serving individual properties.

3.5.2 Future adoption and maintenance of any surface water features will be required and managed privately by the landowner/operator, however anything which falls outside of the boundary or curtilage ownership and maintenance will fall under Scottish Water.

3.5.3 The maintenance schedule for the network must be comprehensive and detail the specific maintenance requirements for each element of the drainage system. The CIRIA SuDS Manual has extensive information relating to the maintenance of SuDS which should be consulted when specifying the requirements.

3.5.4 For pipes, manholes and gullies, both general best practice and specific manufacturer maintenance protocols should be followed. Example maintenance activities and frequencies for the proposed attenuation basins given in **Table 3-3**.

Table 3-3 Operation and Maintenance Requirements for Attenuation Basin

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Remove Litter and Debris	Monthly
	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 other vegetation and remove nuisance plants	Monthly (at start, then as required)
	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect banksides, structures, pipework etc for evidence of physical damage	Monthly
	Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies	Monthly (for first year), then annually or 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 outlets pool – where provided	Annually (as set out in Chapter 23)
Occasional Maintenance	Reseed areas of poor vegetation growth	As required
	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 (likely to be minimal requirements where effective upstream source control is provided
Remedial actions	Repair erosion or other damage by reseeding or re-turfing	As required
	Realignment of rip-rap	As required
	Repair/rehabilitation of inlets, outlets, and overflows	As required
	Relevel uneven surfaces and reinstate design levels	As required

Table 3-4 Operation and Maintenance Requirements for Swales

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Inspections to determine mowing requirements	Monthly
	Litter removal	Monthly
	Scarifying and spiking following inspection	As required
	Repair damages vegetation following inspection	As required
	Inspect inlets, outlets, and overflows for blockages, and clear if required	Monthly
	Inspect infiltration surfaces for ponding, compaction, silt accumulation, record areas where water is ponding for >48 hours	Monthly, or when required
	Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then half yearly
	Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies	Half yearly
Occasional Maintenance	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface	As required
	Reseed areas of poor vegetation growth, alter plant types to better suit conditions, if required	As required or if bare soil is exposed over 10% or more of the swale treatment area

	Repair erosion or other damage by re-turfing or reseeding	As required
	Relevel uneven surfaces and reinstate design levels	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

3.6 Foul Water Drainage

3.6.1 As the site is undeveloped and its current usage is agricultural land, the presence of foul sewers is unlikely.

3.6.2 As the site is proposed to be a Battery Energy Storage System the need for foul sewers is yet to be determined, however, in the case foul drainage is required, foul water will be drained to low points within the site prior to being discharged to public foul water infrastructure. The foul strategy may require pumping depending on the location of the closest foul manhole.

4 Assessment of Flood Risk

4.1 Desk-Based Information

4.1.1 NPF4 Policy 22 states that all potential sources of flood risk must be understood and addressed. Flooding can occur from a variety of sources individually, or in combination and can result from both natural and artificial processes.

4.1.2 **Table 4-1** provides an initial desk-based review of the level of flood risk from all sources, which are then assessed in further details where the risk is considered significant and merits further investigation.

Table 4-1 Desk-Based Assessment of Flood Risk

Sources of Flood Risk	Degree of Risk			Comments
	Significant	Moderate	Low	
Fluvial		X		Northern parcel is largely outside area of risk. Southern parcel is mostly covered by high likelihood flood extents.
Coastal & Tidal			X	The site is removed from the extent of tidal flooding, now and in the future
Groundwater			X	Low risk posed
Surface Water			X	Isolated area of surface water risk present around the boundary
Sewers			X	Existing sewers are unlikely within the site, but should be confirmed
Canals			X	None nearby
Reservoirs & Waterbodies			X	Low risk posed

4.2 Fluvial Flood Risk

4.2.1 SEPA has produced a range of resources covering Scottish Flood Hazard and Risk Information, which identifies areas at risk of flooding from Main Rivers. An extract of this mapping is included for reference as **Figure 4.1**.

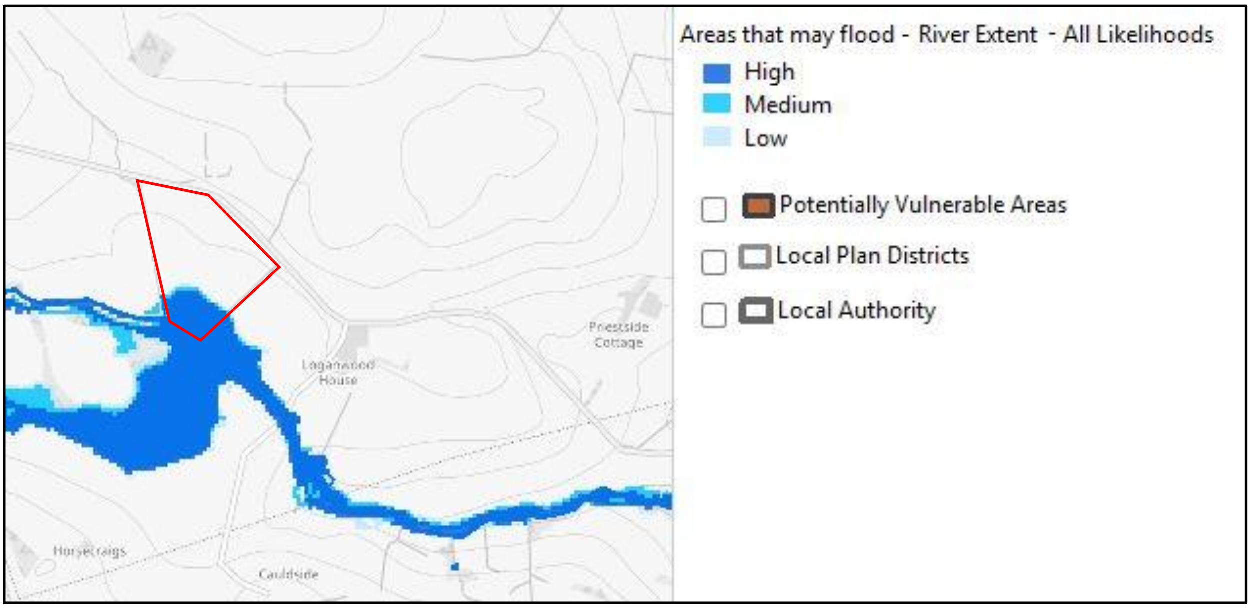


Figure 4.1 SEPA Flood Map for Planning

4.2.2 The mapping shows that the site is mostly outside the areas at fluvial risk, which is considered to be land assessed as having less than a 0.1% annual probability of flooding from rivers. The south-west corner of the site boundary falls within Medium Likelihood and High Likelihood zones, which are considered as land assessed as having a 0.5% annual probability of flooding from rivers or as having a 10% chance of flooding respectively.

4.2.3 These flood extents broadly follow a defined topographical valley associated with the Gryfe Water, and so flooding remains largely contained within this area. Flood extents increase marginally when considering the potential future effects of climate change up to the year 2080.

4.2.4 Therefore, based on the published information the site is considered to be at low to medium risk of fluvial flooding, with the potential of being low risk with appropriate mitigation.

4.3 Coastal & Tidal

4.3.1 The site is well removed from any coastal flooding, both now and in the future. **Figure 4.2** below shows the coastal flooding extents from SEPA's Flood Maps. As such, the site is unlikely to be affected by tidal influences.

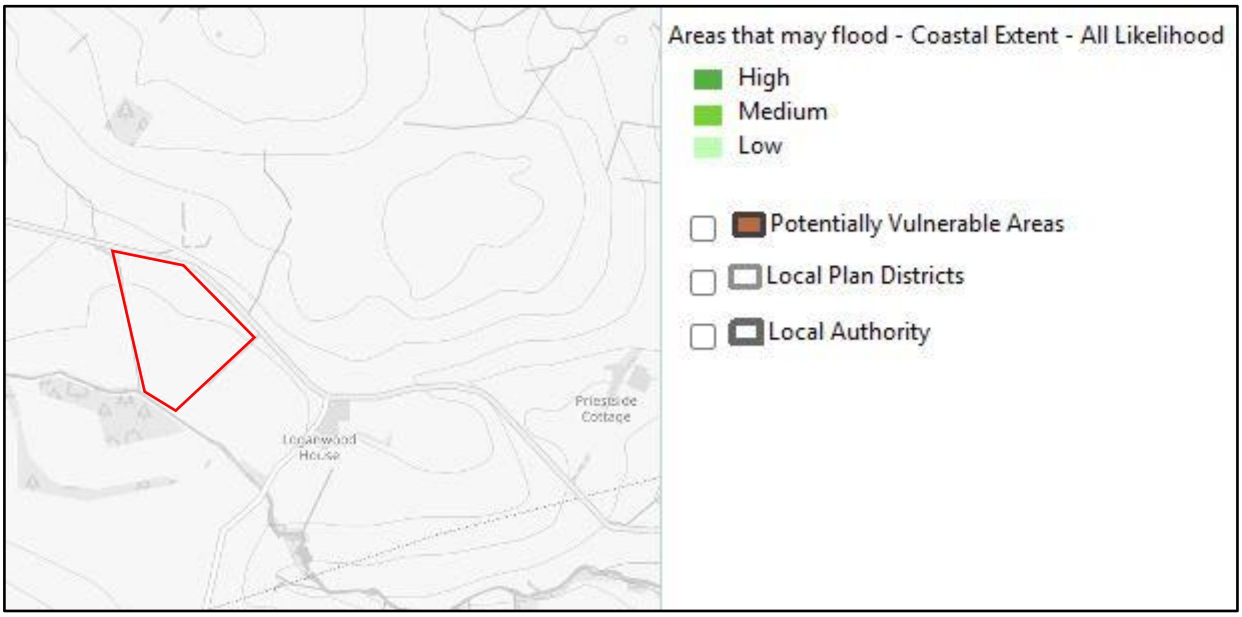


Figure 4.2 Flooding from Coastal Sources

4.4 Groundwater

4.4.1 Groundwater flooding occurs when the water table rises above ground elevations. It is most likely to happen in low lying areas underlain by permeable geology. This may be regional scale chalk or sandstone aquifers, or localised deposits of sands and gravel underlain by less permeable strata such as that in a river valley.

4.4.2 Previously mentioned there are no borehole logs located on the site and the nearest borehole is located 0.4km, meaning the data from the borehole would be unreliable.

4.4.3 The Local Flood Risk Management Plan does not provide any mapping or information relating to groundwater within this area.

4.4.4 Therefore, the risk of flooding from groundwater is considered to be relatively low, although specific mitigation is recommended to address any elevated risk in areas of higher groundwater.

4.5 Surface Water (Pluvial)

4.5.1 The risk of flooding from surface water has been mapped by the SEPA on a strategic scale to understand areas that may be susceptible to ponding of surface water during periods of extreme rainfall. An extract of the latest mapping is included for reference as **Figure 4.3**.

4.5.2 The mapping indicates that most of the site is at low risk of flooding from surface water. With a small area along the western boundary in medium to high risk, however, this small build-up is most likely caused by topographical depressions in the ground or where an un-named watercourse connects into the Gryfe Water.

4.5.3 Therefore, the risk of flooding from surface water to the development as a whole is low but remains a risk in certain parts of the site, which should adopt mitigation to avoid the area of risk.

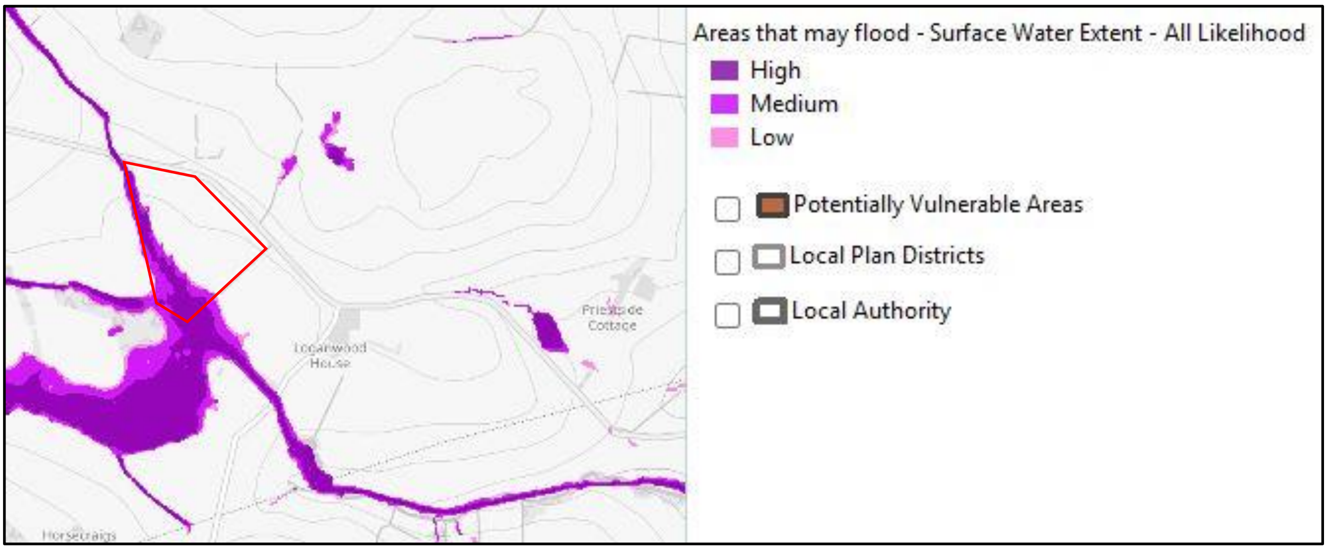


Figure 4.3 Surface Water Flooding

4.6 Sewers

4.6.1 Flooding from sewers typically results from the network capacity being exceeded or because of a blockage to key elements. Flooding usually occurs by way of surcharging manholes, gullies or other features that allow water from sewers to reach the surface, resulting in overland flows that can affect nearby properties.

4.6.2 Looking at the current usage of the land it is considered that the presence of sewers including private sewers is unlikely.

4.6.3 Therefore, the site is considered to be at low risk from flooding from surcharging of the local network.

4.7 Canals

4.7.1 There no canals present that pose a risk to the site and so the risk from this source is considered to be negligible.

4.8 Reservoirs

4.8.1 There are no reservoirs located within the vicinity of the site, therefore, the risk posed to the site is considered negligible.

5 Potential Flood Risk Mitigation

5.1 Sequential Arrangements

5.1.1 Energy generation and storage uses such as the one proposed are considered to comprise 'essential infrastructure' in accordance with SEPA's Land Use Vulnerability Classification. Essential infrastructure is generally permitted within most flood risk categories.

5.1.2 However, in line with the policy hierarchy of NPF4 and SPP, development should be encouraged towards areas of lowest flood risk and aim to avoid flood prone areas where possible.

5.1.3 Therefore, it is recommended that any installation battery storage is positioned within the areas at lowest flood risk. This would comprise most of the northern area of the site.

5.1.4 Where this is not possible, locating the installation within the floodplain would need to be justified to demonstrate why it cannot be in areas of lower flood risk, and additional mitigation would be required, as discussed below.

5.2 Development Levels

5.2.1 Where any proposed development is located within the floodplain, it should be designed to remain operational in times of flooding. Therefore, the finished floor level of any building should be elevated above the design flood event, including a suitable allowance for climate change.

5.2.2 Level changes within the floodplain would require a suitable provision of floodplain compensation to offset any loss of floodplain storage. This would be difficult to provide within the confines of the southern parcel due to changes in elevation.

5.3 Exceedance Flows

5.3.1 As a result of extreme rainfall events, it is inevitable that the capacities of sewers, watercourses, and other drainage systems will become exceeded on very rare occasions. Overland flow analysis should be undertaken at the detailed design stage using finished Site contours to determine where overland flows will be routed in extreme flood events when the pipe and manhole capacities within the network have been exceeded to ensure that all surface water flooding is contained on-site.

5.3.2 As the site is classified as Essential Infrastructure, consideration should be made for the 1 in 1000yr event, plus an allowance for climate change. The outline surface water drainage strategy included within this assessment demonstrates that the 1 in 200yr+CC event could be attenuated on site within the basin. Events larger than this would exceed the capacity of the basin, however the topography of the site is such that any over topping of the basin would mean that flows would route to the south and into the Gryfe Water, not impacting upon any third party properties.

6 Summary

6.1.1 This report and supporting appendices demonstrate that an appropriate surface water drainage strategy has been developed for the site based on sustainable drainage principles in line with the relevant local and national policy and standards.

6.1.2 This Sustainable Drainage Assessment and Flood Risk Assessment is intended to support an outline planning application and as such the level of detail included is commensurate with the nature of the proposals. **Table 5.6-1** provides a summary of key information included within this report.

Table 5.6-1 Summary of Key Information

Topic	Existing Site		Proposed Development
Site Area (hectares)	8.48		2.7
Impermeable Area (hectares)	-		2.57
Number of Sub-Catchments	-		1
Outfall Location(s)			1 (Gryfe Water)
Peak Runoff Rate (l/s/ha)	1 in 1-year	12.8	Peak Runoff Rate 11.54 l/s (4.5 l/s/ha)
	1 in 2-year	13.7	
	1 in 30-year	28.5	
	1 in 200-year + CC	44.7	
Proposed Storage Volume (m³)	-		2,960
SuDS Features	-		Attenuation basin Filter drains Swales
Maintenance Responsibilities	Landowner		Site owner/operator Scottish Water

6.1.3 To summarise the findings of Flood Risk Assessment

- Most of the site is at very low risk of flooding from rivers, with the south-western corner of site within medium and high likelihood floodplain are associated with the Gryfe Water.
- It is recommended that the development is prioritised in the northern area of the site, located within the areas at very low risk of flooding.
- In the event that structures need to be provided within the floodplain, battery storage is considered ‘essential infrastructure’ and so can be placed within the floodplain. However, additional mitigation would be needed to ensure its safety and to prevent an increase in flooding elsewhere.
- SEPA mapping places the site outside of any modelled extent of flooding from reservoirs or large waterbodies.
- It is assumed that the site is not underlain by any sewer’s therefore the site is assumed to be a low risk of flooding from sewers.
- Surface water runoff from the site is to be managed via a restricted outfall from the site to the Gryfe Water.

6.1.4 Therefore, it is considered that the Proposed Development meets the requirements of NPF4 and Scottish Planning Policy in respect to flood risk and surface water drainage. The Proposed Development may proceed without being subject to significant flood risk and will not result in an increase in flood risk elsewhere as a result of sustainable management of surface water runoff.

Appendix A Greenfield Runoff Rate

ICP SUDS Mean Annual Flood

Input

Return Period (years)	200	Soil	0.450
Area (ha)	1.000	Urban	0.000
SAAR (mm)	2000	Region Number	Region 2

Results	**l/s**
QBAR Rural	15.0
QBAR Urban	15.0
Q200 years	44.7
Q1 year	13.1
Q30 years	28.5
Q100 years	39.5

Appendix B Greenfield Runoff Volume

Greenfield Runoff Volume

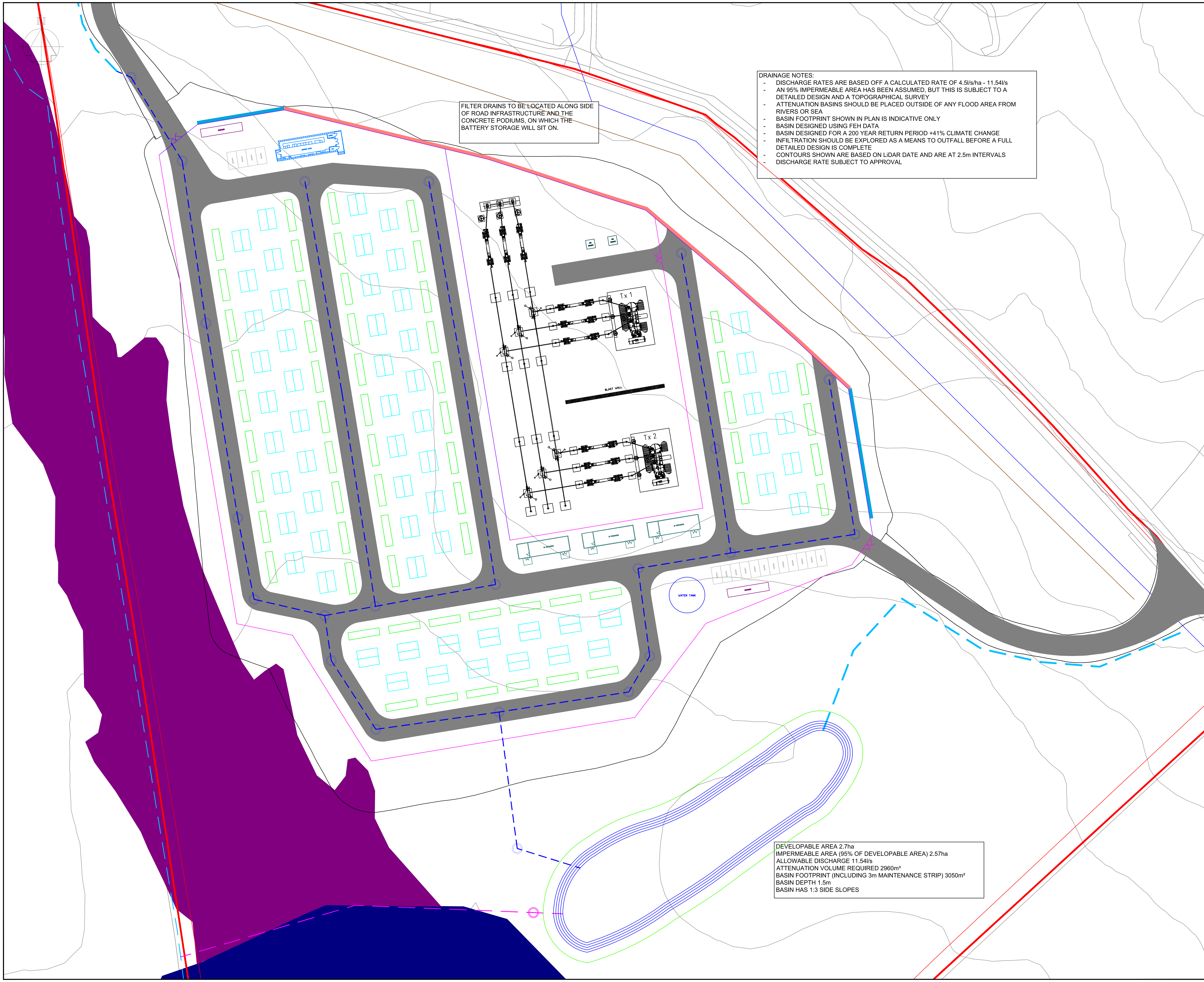
FEH Data

Return Period (years)	100
Storm Duration (mins)	360
FEH Rainfall Version	2013
Site Location	GB 232100 671399 NS 32100 71399
Data Type	Point
Areal Reduction Factor	1.00
Area (ha)	2.570
SAAR (mm)	2000
CWI	126.224
SPR Host	47.000
URBEXT (1990)	0.0000

Results

Percentage Runoff (%)	52.63
Greenfield Runoff Volume (m^3)	1002.566

Appendix C Indicative Drainage Strategy



GENERAL NOTES

G1. DO NOT SCALE THIS DRAWING.

G2. ANY DIMENSIONAL DISCREPANCIES SHOULD BE NOTIFIED TO THE ENGINEER IMMEDIATELY.

G3. ALL DIMENSIONS ARE IN MILLIMETRES - (mm) ALL LEVELS ARE IN METRES - (m) AND ARE ABOVE ORDNANCE DATUM AT NEWLYN, CORNWALL UNLESS NOTED OTHERWISE.

G4. NORTH SHOWN INDICATIVE ONLY

G5. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT; SPECIFICATIONS; DRAWINGS; DETAILS AND OTHER DESIGN INFORMATION.

G6. ALL DRAWINGS AND WRITTEN MATERIAL CONTAINED WITHIN, CONSTITUTE ORIGINAL AND UNPUBLISHED WORK OF THE ENGINEER AND MAY NOT BE DUPLICATED, USED, REPRODUCED OR DISCLOSED WITHOUT WRITTEN CONSENT OR EXPRESS PERMISSION FROM THE ENGINEER.

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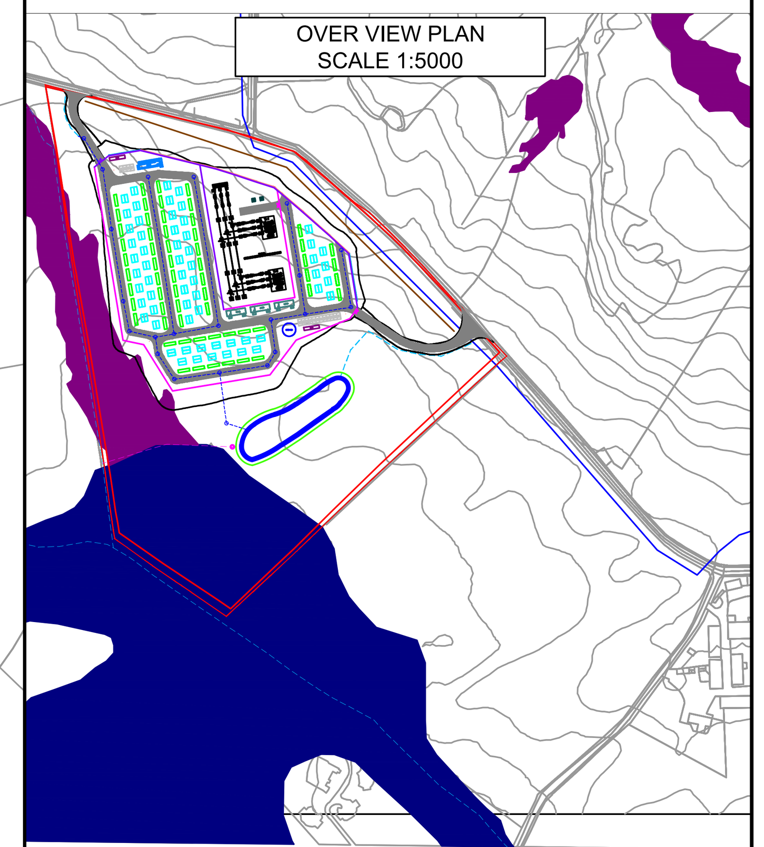

KEY:
- SITE BOUNDARY
- WATERCOURSE
- WATER MAIN
- POSSIBLE OUTFALL
- RIVER FLOODING 0.1% CHANCE
- SURFACE WATER FLOODING 0.1% CHANCE
- ATTENUATION BASIN
- INDICATIVE MANHOLE AND DRAIN LAYOUT
- INDICATIVE SWALE LOCATION
- INDICATIVE FRENCH DRAIN LOCATION

REV	DESCRIPTION	DRN	CHK	APP	DATE
P06	UPDATED IN LINE WITH CLIENT COMMENTS	DW	SM	SM	09.10.25
P05	UPDATED WITH REVISED SITE LAYOUT	DW	SM	SM	02.10.25
P04	UPDATED IN LINE WITH CLIENT COMMENTS	SP	HM	DAR	07.11.24
P03	UPDATED IN LINE WITH CLIENT COMMENTS	SP	HM	DAR	29.04.24
P02	UPDATED IN-LINE WITH MASTERPLAN	SP	DAR	DAR	13.03.24
P01	FIRST ISSUE	SP	DAR	DAR	22.12.23

Pell Frischmann

4th FLOOR, THE POYNT, WOLLATON STREET, NOTTINGHAM NG1 5FW
Telephone +44 (0)115 784 8960
Email: pfnottingham@pellfrischmann.com
www.pellfrischmann.com

Architect/Client/Contractor

HARMONY HM LTD

Project

HIGH MATHERNOCK BESS

Drawing Title

INDICATIVE ATTENUATION STRATEGY

Drawing Status

FOR INFORMATION

	Name	Date
Drawn	S. PAOLI	22.12.23
Designed	S. PAOLI	22.12.23
Eng Chk	D. ALLUM-ROONEY	22.12.23
Approved	D. ALLUM-ROONEY	22.12.23

Status Code: S2

Scale: 1:500

Revision: P06

Drawing No.

107529 - PEF - ZZ - XX - DR - C - 0500

Appendix D Attenuation Calculations

Summary of Results for 200 year Return Period (+41%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.460	0.460	11.5	794.6	O K
30 min Summer	0.643	0.643	11.5	1137.9	O K
60 min Summer	0.835	0.835	11.5	1512.6	O K
120 min Summer	0.934	0.934	11.5	1713.9	O K
180 min Summer	0.995	0.995	11.5	1841.2	O K
240 min Summer	1.040	1.040	11.5	1933.8	O K
360 min Summer	1.102	1.102	11.5	2065.0	O K
480 min Summer	1.145	1.145	11.5	2158.0	O K
600 min Summer	1.177	1.177	11.5	2228.0	O K
720 min Summer	1.202	1.202	11.5	2282.3	Flood Risk
960 min Summer	1.237	1.237	11.5	2359.0	Flood Risk
1440 min Summer	1.275	1.275	11.5	2442.4	Flood Risk
2160 min Summer	1.296	1.296	11.5	2489.6	Flood Risk
2880 min Summer	1.310	1.310	11.5	2521.4	Flood Risk
4320 min Summer	1.329	1.329	11.5	2564.0	Flood Risk
5760 min Summer	1.339	1.339	11.5	2585.9	Flood Risk
7200 min Summer	1.342	1.342	11.5	2592.8	Flood Risk
8640 min Summer	1.340	1.340	11.5	2588.5	Flood Risk
10080 min Summer	1.334	1.334	11.5	2575.2	Flood Risk
15 min Winter	0.512	0.512	11.5	891.2	O K
30 min Winter	0.715	0.715	11.5	1276.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	167.553	0.0	716.8	27
30 min Summer	120.165	0.0	941.2	41
60 min Summer	80.296	0.0	1482.2	72
120 min Summer	46.099	0.0	1674.9	130
180 min Summer	33.427	0.0	1771.0	190
240 min Summer	26.657	0.0	1800.2	250
360 min Summer	19.434	0.0	1777.7	368
480 min Summer	15.585	0.0	1747.2	488
600 min Summer	13.160	0.0	1719.3	606
720 min Summer	11.479	0.0	1695.2	726
960 min Summer	9.277	0.0	1656.4	964
1440 min Summer	6.929	0.0	1610.9	1442
2160 min Summer	5.230	0.0	3413.0	1888
2880 min Summer	4.312	0.0	3343.2	2284
4320 min Summer	3.319	0.0	3126.0	3080
5760 min Summer	2.774	0.0	5105.3	3928
7200 min Summer	2.422	0.0	5559.4	4768
8640 min Summer	2.172	0.0	5929.6	5624
10080 min Summer	1.982	0.0	5865.3	6464
15 min Winter	167.553	0.0	794.7	26
30 min Winter	120.165	0.0	962.8	41

Summary of Results for 200 year Return Period (+41%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.926	0.926	11.5	1698.7	O K
120 min Winter	1.036	1.036	11.5	1926.9	O K
180 min Winter	1.105	1.105	11.5	2071.2	O K
240 min Winter	1.154	1.154	11.5	2177.4	O K
360 min Winter	1.224	1.224	11.5	2329.7	Flood Risk
480 min Winter	1.274	1.274	11.5	2439.6	Flood Risk
600 min Winter	1.312	1.312	11.5	2524.0	Flood Risk
720 min Winter	1.341	1.341	11.5	2591.0	Flood Risk
960 min Winter	1.385	1.385	11.5	2689.6	Flood Risk
1440 min Winter	1.438	1.438	11.5	2810.0	Flood Risk
2160 min Winter	1.473	1.473	11.5	2890.7	Flood Risk
2880 min Winter	1.482	1.482	11.5	2912.1	Flood Risk
4320 min Winter	1.499	1.499	11.5	2951.9	Flood Risk
5760 min Winter	1.497	1.497	11.5	2948.7	Flood Risk
7200 min Winter	1.486	1.486	11.5	2921.2	Flood Risk
8640 min Winter	1.466	1.466	11.5	2876.5	Flood Risk
10080 min Winter	1.442	1.442	11.5	2820.2	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	80.296	0.0	1642.1	70
120 min Winter	46.099	0.0	1797.7	128
180 min Winter	33.427	0.0	1806.2	188
240 min Winter	26.657	0.0	1789.3	246
360 min Winter	19.434	0.0	1755.0	362
480 min Winter	15.585	0.0	1728.5	480
600 min Winter	13.160	0.0	1708.7	596
720 min Winter	11.479	0.0	1694.1	712
960 min Winter	9.277	0.0	1678.3	942
1440 min Winter	6.929	0.0	1690.1	1396
2160 min Winter	5.230	0.0	3490.3	2044
2880 min Winter	4.312	0.0	3406.2	2596
4320 min Winter	3.319	0.0	3305.4	3292
5760 min Winter	2.774	0.0	5713.9	4264
7200 min Winter	2.422	0.0	6209.1	5192
8640 min Winter	2.172	0.0	6443.0	6136
10080 min Winter	1.982	0.0	6172.9	7056

Rainfall Details

Rainfall Model	FEH
Return Period (years)	200
FEH Rainfall Version	2013
Site Location	GB 232100 671399 NS 32100 71399
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+41

Time Area Diagram

Total Area (ha) 2.567

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.856	4	8	0.856	8	12	0.855

Model Details

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	1626.8	1.000	2084.0	1.500	2333.8

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0148-1150-1500-1150
Design Head (m)	1.500
Design Flow (l/s)	11.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	148
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.500	11.5
Flush-Flo™	0.439	11.5
Kick-Flo®	0.939	9.2
Mean Flow over Head Range	-	10.0

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

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	5.3	1.200	10.3	3.000	16.0	7.000	24.0
0.200	10.4	1.400	11.1	3.500	17.2	7.500	24.8
0.300	11.2	1.600	11.9	4.000	18.3	8.000	25.6
0.400	11.5	1.800	12.5	4.500	19.4	8.500	26.3
0.500	11.5	2.000	13.2	5.000	20.4	9.000	27.0
0.600	11.3	2.200	13.8	5.500	21.3	9.500	27.8
0.800	10.6	2.400	14.4	6.000	22.2		
1.000	9.5	2.600	14.9	6.500	23.1		

Appendix E Water Quality Assessment – Simple Index Approach

SUMMARY TABLE		DESIGN CONDITIONS			
		1	2	3	4
Land Use Type	Low traffic roads (e.g. residential roads and general access roads, < 300 traffic movements/day)				
Pollution Hazard Level	Low				
Pollution Hazard Indices					
TSS	0.5				
Metals	0.4				
Hydrocarbons	0.4				
SuDS components proposed					
Component 1	Detention basin	SuDS components can only be assumed to deliver these indices if they follow design guidance with respect to hydraulics and treatment set out in the relevant technical component chapters of the SuDS Manual. See also checklists in Appendix B			
Component 2	None				
Component 3	None				
SuDS Pollution Mitigation Indices					
TSS	0.5				
Metals	0.5				
Hydrocarbons	0.6				
Groundwater protection type	None				
Groundwater protection Pollution Mitigation Indices					
TSS	0				
Metals	0				
Hydrocarbons	0				
Combined Pollution Mitigation Indices					
TSS	0.5	Reference to local planning documents should also be made to identify any additional protection required for sites due to habitat conservation (see Chapter 7 The SuDS design process). The implications of developments on or within close proximity to an area with an environmental designation, such as a Site of Special Scientific Interest (SSSI), should be considered via consultation with relevant conservation bodies such as Natural England			
Metals	0.5				
Hydrocarbons	0.6				
Acceptability of Pollution Mitigation					
TSS	Sufficient				
Metals	Sufficient				
Hydrocarbons	Sufficient				