FLOOD RISK ASSESSMENT AND SURFACE WATER DRAINAGE STRATEGY

Residential Adventure and Activity Centre

Ford Castle, Ford,

Berwick-upon-Tweed, TD15 2PX

Prepared for: PGL Travel Ltd

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SLR

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1.0 Introduction

1.1 Context

SLR Consulting Limited (SLR) has been appointed by PGL Travel Ltd (the client) to prepare a Flood Risk Assessment (FRA) and Surface Water Drainage Strategy (SWDS) to support a planning and listed building application at the existing residential activity centre for children, associated teachers and staff at Ford Castle, Berwick-Upon-Tweed, Northumberland, TD15 2PX (the Site).

In summary, the work relating to this report consists of the following, located within the application boundary:

Siting of activity equipment and associated access (including removal of existing activity equipment) involving:

- A zip wire
- A challenge course
- Two aero-balls
- Two air rifle ranges
- A linear course
- Re-instated historic gravel footpaths

Other work scheduled for the Site includes:

1. Construction of an activity pond within the Site (included within this application)
2. Refurbishment of existing ablution facilities, kitchen, and bedrooms within the Castle Buildings (being dealt with separately to this application)

This FRA has been prepared by SLR, under the direction of a Technical Director for Hydrology at SLR who specialises in flood risk and associated planning matters. Reporting has been completed in accordance with guidance presented within the National Planning Policy Framework[1] (NPPF) and its associated Planning Practice Guidance[2] (PPG), taking due account of current best practice documents relating to assessment of flood risk published by the British Standards Institution BS8533[3].

1.2 Administrative Context

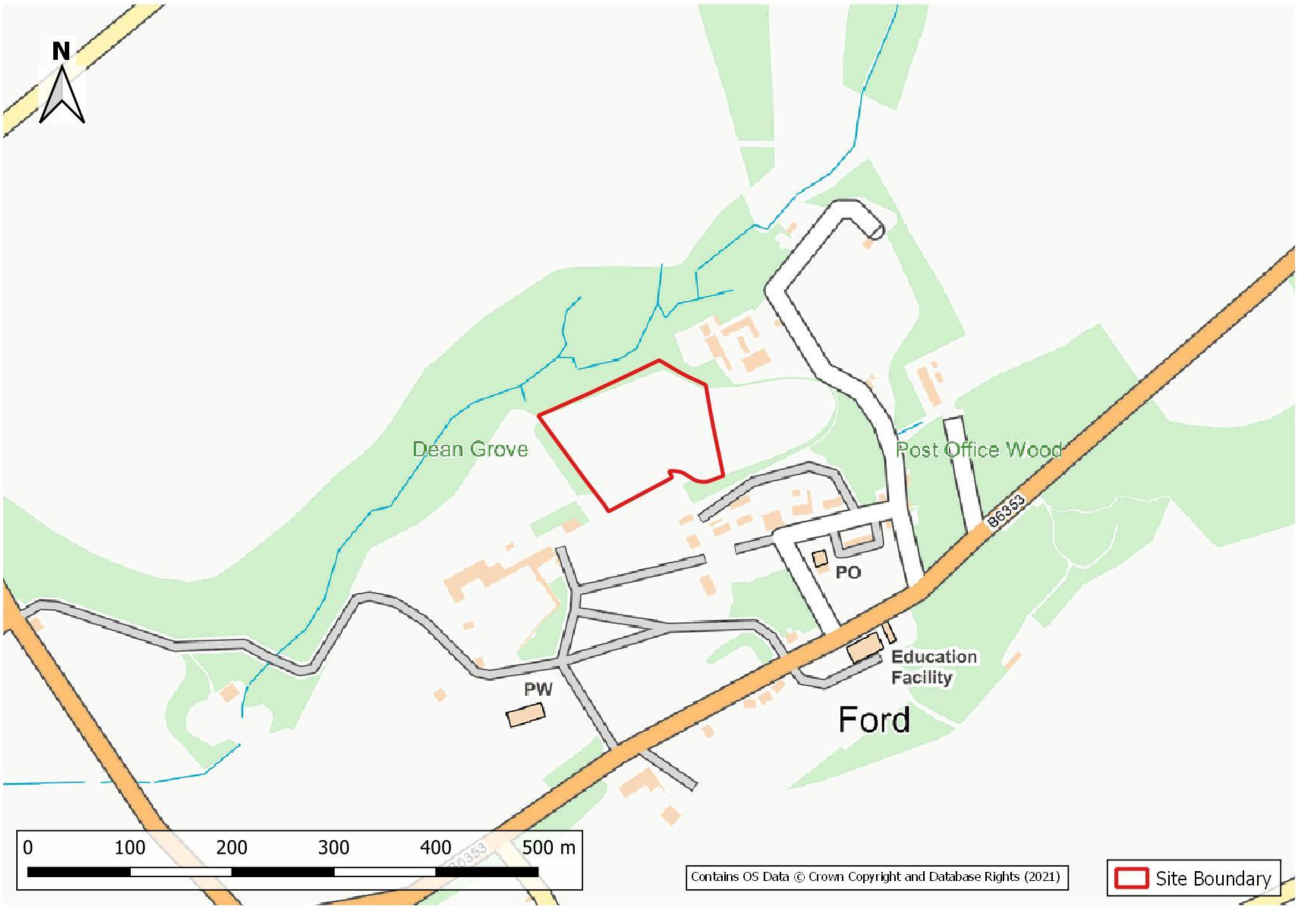
The proposed development falls completely within the planning jurisdiction of Northumberland County Council which also acts as the Lead Local Flood Authority (LLFA).

1.3 Site Location

The Site comprises an activity field, an existing part of the Ford Castle grounds, of which PGL are tenants. The site lies in the north western area of the village of Ford, approximately 16.0km south west of Berwick-Upon-Tweed and 10.2km east of the Scottish border at Coldstream. The Site area covers 1.47ha and is centred at National Grid Reference (NGR) NT 94581 37671, as shown on the Site location plan provided as Figure 1-1.

1 National Planning Policy Framework: Communities and Local Government (Updated July 2021)
2 Planning Practice Guidance: Communities and Local Government (Updated July 2021)
3 BS8533:2017, Assessing and managing flood risk in development: Code of Practice (December 2017)

Figure 1-1 Site Location Plan



The Site is accessed from the B6353 to the south or west of the Site. The village of Ford is situated in a wider rural area consisting of arable farming, well-established woodland areas, residential properties, and farm buildings.

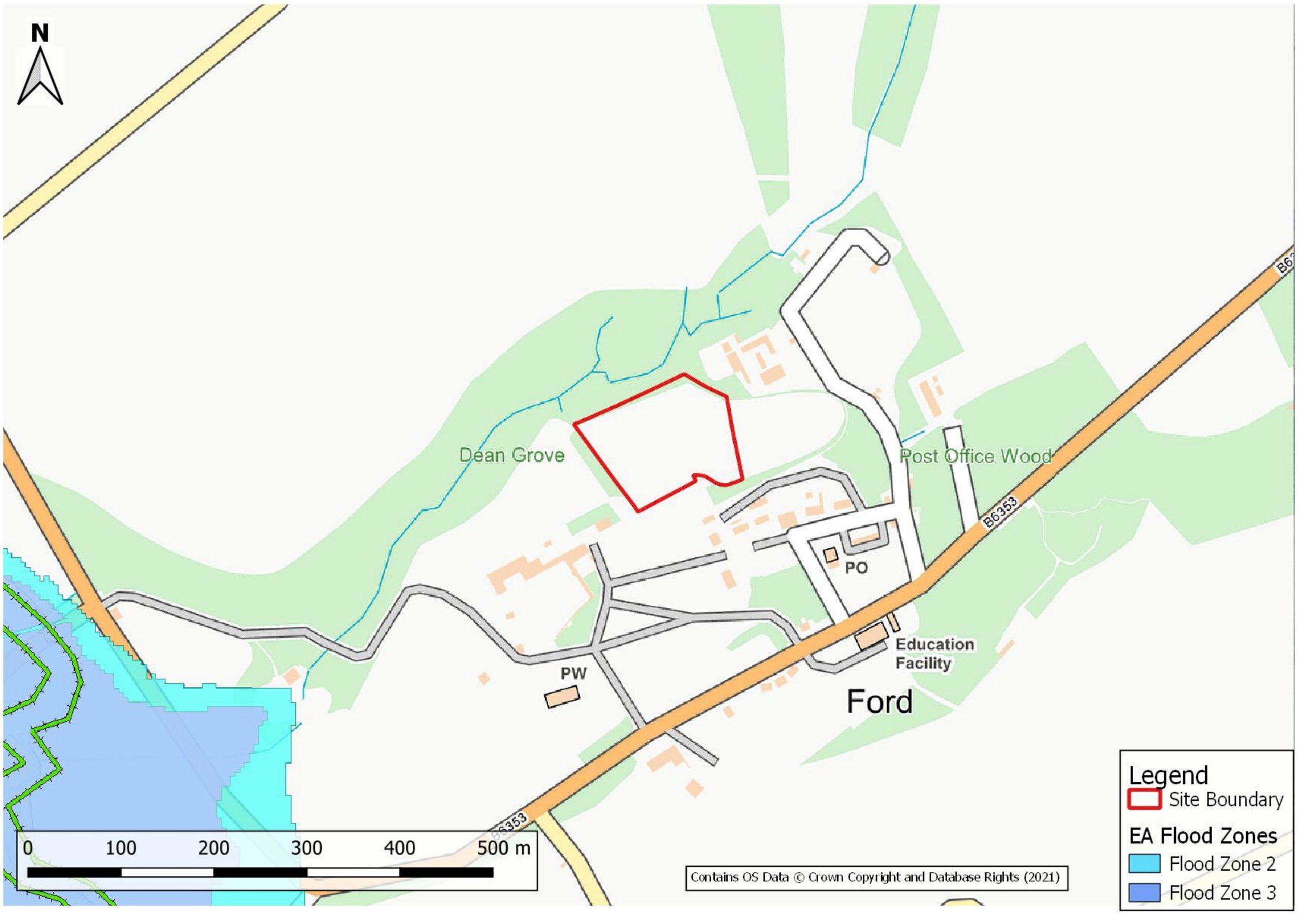
An indicative Site layout for the proposed activity field is included in **Appendix 01**.

1.4 Background and Aims

With reference to the *Flood Map for Planning (Rivers and Sea)*[4] , the Site lies entirely within Flood Zone 1 with respect to flooding from fluvial or tidal flooding. An extract of the *Flood Map for Planning* is provided as Figure 1-2.

4 Government Digital Service (Accessed on 29th October 2021) https://flood-map-for-planning.service.gov.uk/

Figure 1-2 Extract of the Flood Map for Planning



As the Site is greater than 1ha, with reference to footnote 55 of the NPPF[1], any planning application for proposed development needs to be accompanied by a site-specific FRA, despite being within Flood Zone 1.

2.0 Baseline Site Details

The Site comprises an activity field which is located within the grounds of Ford Castle, a 13th Century estate which was repurposed in the mid-20th Century as a residential activity centre. The Site is bordered to the north by the wooded valley of Dean Grove, Ford village to the east and south east, and the Ford Castle grounds to the west and south west.

Figure 2-1 Satellite Imagery of the Site

2.1 Topography

LiDAR topographic data for the Site and immediate locality has been downloaded from the Environment Agency open data website[5].

LiDAR data detailed in Figure 2-2 indicates that the topography of the Site falls from east to west. A maximum elevation of 72.85m AOD is recorded at the eastern Site boundary, and the minimum of 68.2m AOD is shown in the northeast corner, as the topography slopes downwards north of the Site, into the valley of the Dean Grove watercourse which flows past the Site in a south westerly direction.

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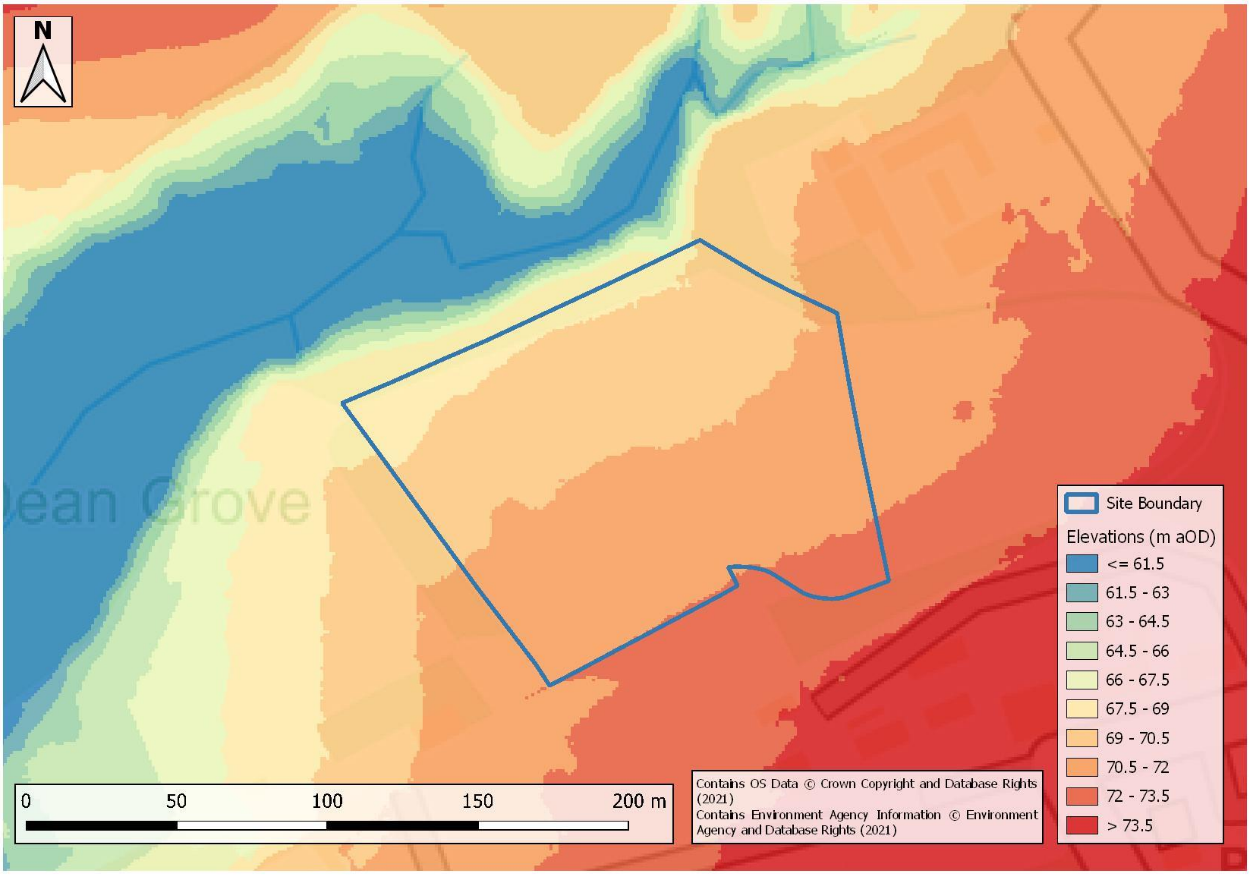
5 Environment Agency open data website, (Accessed on 1st November 2021) http://environment.data.gov.uk

Figure 2-2 LiDAR Imagery of the Site



2.2 Local Hydrology

As shown in Figure 2-3, Dean Grove and associated trees within the valley border the northern Site boundary. The channel rises approximately 400m northeast from the site and drains a very small upstream catchment, flowing south west before adjoining Bradford Burn around 680m west of the Site. Bradford Burn continues from this point approximately 40m further north westwards where it discharges into the River Till, an Environment Agency-designated ‘Main River’, which then continues north westwards. At its nearest point, the River Till lies around 360m west of the Site and drains an upstream catchment of 600km^2.

Figure 2-3 Surface Water Features

2.2.1 Existing Drainage Arrangement

There is no formal drainage strategy which serves the current activity field. Incidental rainfall is generally expected to drain via a combination of evaporation, infiltration into the underlying strata and overland flow into local surface water drainage channels, eventually draining into Dean Grove valley. Any excess overland flow is likely to follow the topography across the northern and western Site boundary, towards the Dean Grove watercourse.

2.3 Geology and Hydrogeology

2.3.1 Soils

The National Soils Resources Institute[6] indicates that the soils at the Site are *'slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils'*, with a *'loamy and clayey'* texture and *'impeded drainage'*.

2.3.2 Geology

Published British Geological Survey (BGS) geological mapping[7] indicates that the Site is entirely underlain by bedrock of the *Fell Sandstone Formation - Sandstone. Till, Devensian - Diamicton*. Superficial deposits are also

6 Soilscapes map (Accessed on 1st November 2021) http://www.landis.org.uk/soilscapes/
7 BGS Website (Accessed on 1st November 2021) http://mapapps.bgs.ac.uk/geologyofbritain/home.html

overlying much of the bedrock, apart from a small slither of land in the northwest where no superficial deposits are mapped as being present.

There are two boreholes present north of the Site, which lie a similar distance from the River Till as the Site does (BGS borehole references NT93NW4/5). These display approximately 0.5m of subsoil and reddish brown sandstone thereafter (3m depth). It is not clear if either borehole encounter water. The BGS mapviewer outlines that both boreholes lie in the same geology as the Site.

2.3.3 Hydrogeology

Review of the online MAGIC mapping[8] indicates that the *Fell Sandstone Formation* is classified as a Principal aquifer, defined as '*layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer*'.

The *Diamicton* is classified as a Secondary Undifferentiated aquifer, because *'it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type'.* The *Alluvium* is classified as a Secondary A aquifer, defined as *'permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers*'.

The Site does not lie within a groundwater Source Protection Zone (SPZ).

8 Defra, MAGIC Map, (Accessed on 1st November 2021) http://magic.defra.gov.uk/MagicMap.aspx

3.0 Policy Status for Proposed Development

3.1 Development Proposals

The proposed development type relevant to this application is for the construction of a new outdoor activity pond and activity facilities, which include a zipwire, challenge course, linear high ropes, air rifle shooting ranges, aeroball units and associated access in the form of gravel pathways.

With reference to Table 2: Flood risk vulnerability classification at PPG Paragraph 066, the activities areas are categorised within *'Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms'*, are classified as a *'water-compatible development'*. The activity pond is categorised as '*Water-based recreation'* and the pathways as '*Sand and gravel workings'* which are also both '*water-compatible development'.*

3.2 Flood Zone Classification

The definition of Environment Agency flood zones is provided in PPG *Table 1: Flood Zones*:

- *Zone 1 - Low Probability* (Flood Zone 1) is defined as land which could be at risk of flooding from fluvial or tidal flood events with less than 0.1% annual probability of occurrence (1:1,000 year) i.e. considered to be at 'low probability' of flooding.
- *Zone 2 - Medium Probability* (Flood Zone 2) is defined as land which could be at risk of flooding with an annual probability of occurrence between 1% (1:100 year) and 0.1% (1:1,000 year) from fluvial sources and between 0.5% (1:200 year) and 0.1% (1:1,000 year) from tidal sources i.e. considered to be at 'medium probability' of flooding.
- *Zone 3a - High Probability* (Flood Zone 3a) is defined as land which could be at risk of flooding with an annual probability of occurrence greater than 1% (1:100 year) from fluvial sources and greater than 0.5% (1:200 year) from tidal sources i.e. considered to be at 'high probability' of flooding.
- *Zone 3b - the Functional Floodplain* (Flood Zone 3b) is defined as land where water has to flow or be stored in times of flood. Local Planning Authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain in agreement with the EA. In the absence of definitive information, it is often defined as land that would flood with an annual probability of occurrence of 5% (1:20 year) or greater.

In assessing the boundary between flood zones 1, 2 and 3, the protection afforded by any flood defence structures, and other local circumstances, is not taken into account by the Environment Agency mapping.

Based upon the Environment Agency Flood Map for Planning[9] (Figure 1-2) the Site is wholly located in Flood Zone 1.

3.3 Planning Policy

This FRA report has been completed in accordance with the guidance presented in the NPPF[1]and with reference to PPG[2]. The NPPF states that Local Plans should be supported by a Strategic Flood Risk Assessment (SFRA) and develop policies to manage flood risk from all sources taking account of advice from the Environment Agency. It is crucial that Local Planning Authorities consider the risks posed by flooding within their boundary when determining planning applications.

9 Data.gov.uk website, https://data.gov.uk/ , accessed 13/09/2017

3.3.1 Local Planning Policy

The Northumberland Local Plan[10] is currently at the consultation stage and, when adopted, will supersede the Berwick-upon-Tweed Local Plan (1999). It sets out Northumberland County Council's visions and policies for future development.

The active Berwick-upon-Tweed Local Plan[11] includes the following policy regarding flood risk:

POLICY F16

In considering the acceptability of development proposals, regard will be had;

- *i) to the adequacy of available effluent treatment capacity;*
- *ii) to the avoidance of an unacceptable risk of flooding, or an unacceptable increase in the risk of flooding, or of the pollution of any watercourse or groundwater, whether on or off the site; and,*
- *iii) to the avoidance of any material adverse effect on the biodiversity of the water environment.*

The following policy has been developed as part of the emerging Northumberland Local Plan (2019) in order to manage sources of flooding and drainage:

Policy WAT 3

Flooding

1. *In assessing development proposals the potential for both on and off-site flood risk from all potential sources will be measured, taking into account the policy approach contained within: the relevant Catchment Flood Management Plan; the Northumberland Local Flood Risk Management Strategy; the Northumberland Outline Water Cycle Study; and the findings of Drainage Area Studies.*
2. *Development proposals will be required to demonstrate how they will minimise flood risk to people, property and infrastructure from all potential sources by:*
   - *a. Avoiding inappropriate development in areas at risk of flooding and directing the development away from areas at highest risk, applying the Sequential Test and if necessary the Exceptions Test, in accordance with national policy and the Northumberland Strategic Flood Risk Assessment. Site Specific Flood Risk Assessments will be required in accordance with national policy and guidance;*
   - *b. Ensuring that the development will be safe over its lifetime, taking account of climate change, will not increase flood risk elsewhere and where possible, reduce flood risk overall;*
   - *c. Assessing the impact of the development proposal on existing sewerage infrastructure and flood risk management infrastructure, including whether there is a need to reinforce such infrastructure or provide new infrastructure in consultation with the relevant water authority;*
   - *d. Ensuring that development proposals in areas at risk from flooding are made resistant and resilient, in terms of their layout, mix and/or building design, in accordance with national policy and the findings and recommendations of the Northumberland Strategic Flood Risk Assessment;*

10 Northumberland Local Plan – Publication Draft Plan (Regulation 19), Northumberland County Council, January 2019
11 Berwick-upon-Tweed Borough Local Plan Adopted April 1999.

e. Pursuing the full separation of foul and surface water flows as follows:

i. A requirement that all development provides such separation within the development; and

ii. Where combined sewers remain, the Council will work with statutory sewerage providers to progress the separation of surface water from foul;

f. Ensuring that built development proposals, including new roads, separate, minimise and control surface water run-off, with Sustainable Drainage Systems being the preferred approach, modified as necessary where minewater is present; in relation to this:

i. Surface water should be managed at source wherever possible, so that there is no net increase in surface water run-off for the lifetime of the development;

ii. Surface water should be disposed of in accordance with the following hierarchy for surface water run-off:

- *To a soakaway system, unless it can be demonstrated that this is not feasible due to poor infiltration with the underlying ground conditions;*
- *To a watercourse, unless there is no alternative or suitable receiving watercourse available;*
- *To a surface water sewer;*
- *As a last resort, once all other methods have been explored, disposal to combined sewers;*

iii. Where greenfield sites are to be developed, the surface water run-off rates should not exceed, and where possible should reduce, the existing run-off rates;

iv. Where previously developed sites are to be developed:

- *The peak surface run-off rate from the development to any drain, sewer or surface water body for any given rainfall event should be as close as reasonably practicable to the greenfield run-off rate for the same event, so long as this does not exceed the previous rate of discharge on the site for that same event; or*
- *Where it is demonstrated that the greenfield run-off rate cannot be achieved, then surface run-off rate should be reduced by a minimum of 50% of the existing site run-off rate;*

g. Full consideration should be given to solutions within the wider catchment area, including blue-green infrastructure based solutions and those providing ecosystem services, with wider solutions especially applied if local solutions could be harmful to biodiversity, landscape or built heritage;

3. In relation to flood alleviation schemes:

a. The early implementation of approved schemes will be supported through development decisions;

b. Any proposal for additional schemes should demonstrate that they represent the most sustainable solution and that their social, economic and environmental benefits outweigh any adverse environmental impacts caused by new structure(s), including increasing the risk of flooding elsewhere.

4. Any works relating to the above, which impact on natural water systems, should consider the wider ecological implications, applying the ecosystem approach, and link into green infrastructure initiatives wherever practicable.

<u>Policy WAT 4</u>

Sustainable Drainage Systems

1. *Water sensitive urban design, including Sustainable Drainage Systems (SuDS) will be incorporated into developments whenever necessary, in order to separate, minimise and control surface water run-off, in accordance with national standards and any future local guidance.*
2. *SuDS will be a requirement for any development where it is necessary to manage surface water drainage unless it can be clearly demonstrated:*
   a) *That SuDS are not technically, operationally or financially deliverable or viable and that any surface water drainage issues resulting from the development can be alternatively mitigated; or*
   b) *That the SuDS scheme will itself adversely affect the environment or safety, including where ponds could increase the risk of bird strike close to the airport or where existing minewater problems could be exacerbated.*
3. *SuDS or other water sensitive urban design schemes should be devised to take account of predicted future conditions and, where appropriate, efforts should be made to link them into wider initiatives to enhance the green infrastructure, improve water quality, benefit wildlife and/or contribute to the provision of an ecosystem service.*
4. *Arrangements must be put in place for the management and maintenance of SuDS over the lifetime of the development, with such arrangements taking account of the cumulative effectiveness of SuDs in the area concerned.*

3.3.2 Flood Risk Compatibility

As discussed in Section 3.1, the proposed developments are classified as *'Water-compatible'* and would be located within Flood Zone 1.

PPG *Table 3: Flood risk vulnerability and Flood Zone 'compatibility'* (reproduced as Table 3-1) confirms that this is acceptable.

Table 3-1
Flood Risk Vulnerability and Flood Zone 'Compatibility'

Flood Risk Vulnerability Classification (PPG Table 2)		Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Flood Zone (PPG Table 1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	Exception Test Required	✓	✓	✓
	Zone 3a	Exception Test Required	x	Exception Test Required	✓	✓
	Zone 3b (functional floodplain)	Exception Test Required	x	x	x	✓

Key: ✓ Development is appropriate x Development should not be permitted

3.4 Sequential Test

NPPF[1] Paragraph 164 advises that the aim the Sequential Test is to '*steer new development to areas with the lowest risk of flooding*'. Furthermore, it states:

> '*Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower risk of flooding*.'

As discussed in Section 3.2, the proposed development lies entirely within Flood Zone 1, and is therefore considered to pass the Sequential Test.

3.5 Exception Test

As outlined in Table 3-1, PPG identified that developments under all Flood Risk Vulnerability Classifications are appropriate when within Flood Zone 1. The Exception Test is therefore not applicable at the Site.

3.6 Climate Change

PPG requires that consideration of future climate change is included in FRA reporting and should be considered over the project development lifetime.

3.6.1 Anticipated Lifetime of Development

PPG and best practice both recommend that for consideration of industrial development, a 75-year development lifetime is assumed unless there is specific justification for considering a shorter period.

3.6.2 Climate Change Overview

In July 2021 the Environment Agency issued updated guidance on the impacts of climate change on flood risk in the UK[12] to support NPPF. This advice sets out that peak rainfall intensity, sea level, peak river flow, offshore wind speed and extreme wave heights are all expected to increase in the future as a result of climate change.

The guidance acknowledges that in relation to certain factors there is considerable uncertainty with respect to the absolute level of change that is likely to occur. As such, in these instances, the guidance provides estimates of possible changes that reflect a range of different emission scenarios.

PPG recommends that considerations for future climate change are included in FRAs for proposed developments. The consideration of climate change for this Site considers the possible changes in peak river flows and peak rainfall intensity. Peak river flows are considered due to the proximity of Dean Grove watercourse.

Table 3-2
Peak Rainfall Intensity Allowance in Small and Urban Catchments
(Use 1961 to 1990 baseline)

River Basin District	Allowance Category	Total potential change anticipated for 2015 to 2039	Total potential change anticipated for 2040 to 2059	Total potential change anticipated for 2060 to 2115
Applies across all of England	Upper End	10%	20%	40%
	Central	5%	10%	20%

Table 3-2 highlights that there is an anticipated uplift of 20-40% in peak rainfall allowance to account for climate change during the lifetime of the development. Guidance on climate change recommends assessing for both scenarios.

3.6.3 Peak River Flow Allowance

For peak fluvial flow rates the Environment Agency guidance notes that the effect of climate change will increase over time and acknowledges that there is uncertainty with respect to the absolute level of change that is likely to occur. Details from the Environment Agency's *Climate change allowances for peak river flow in England* map are summarised in Table 3-3 for the Till Management Catchment in the Solway Tweed River Basin District.

Table 3-3
Peak River Flow Allowance in Humber River Basin District (use 1961 to 1990 baseline)

Management Catchment	Allowance Category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2125)
Till	Central	31%	36%	52%

Table 3-3 highlights that there will be a 52% uplift in peak river flows to allow for climate change during the lifetime of the development. The central allowance has been used as the lowest possible allowance to account for the development types and the position of the Site in Flood Zone 1.

12 Guidance on Climate Change, Gov.uk. Accessed at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

4.0 Potential Sources of Flooding

4.1 Methodology & 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 published by the Construction Industry Research and Information Association (CIRIA)[13], and British Standard BS8533[3].

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
- Flood from infrastructure failure.

The flood risk from each of these potential sources is discussed below and summarised in Table 4-4.

4.2.1 Flooding from the Sea or Tidal Flooding

The Site is located remotely from the coast (14km inland) and is elevated to at least 68m aOD. For these reasons, tidal flooding or flooding from the sea is not considered to be significant to the Site. The Site is also located within Flood Zone 1 (Figure 1-2).

The risk of flooding from this source is not considered further.

4.2.2 Flooding from Rivers or Fluvial Flooding

The Site is located adjacent to Dean Grove, a tributary of the River Till. Despite the proximity of this source, the site remains wholly in Flood Zone 1, likely due to the nature of the small upstream catchment and all areas of the Site being elevated at least 5m above watercourse level.

Flood Zones 2 and 3 from the River Till are also located approximately 400m south west of the Site boundary, but the whole Site remains in Flood Zone 1.

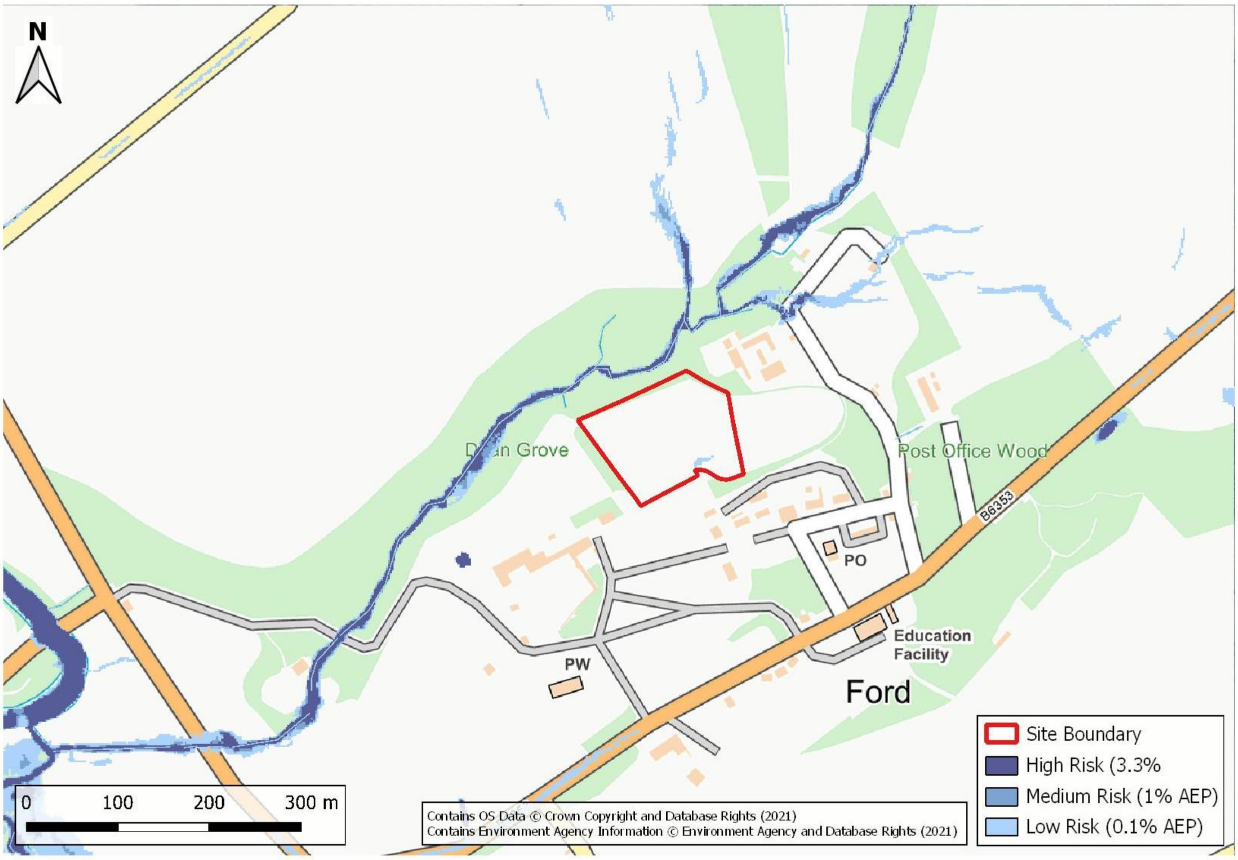
As such, the risk of fluvial flooding is not of significance to the site and is not considered further.

4.2.3 Flooding from Surface Water and Overland Flow

There is very limited potential for surface water flooding to affect the Site as lower lying ground is generally dominated by the local hydrology. Figure 4-4 highlights the extent of potential surface water flooding at the Site.

13 CIRIA Report C624, Development and flood risk: guidance for the construction industry

Figure 4-4 Environment Agency Surface Water Flood Map



The Environment Agency Surface Water Flood Map confirms that there is little to no risk at the Site from overland flow, only a small, isolated area of standing water is predicted to the southeast of the Site during an extreme event (1 in 1000 chance). Surface water flooding to the north of the Site is likely indicative of potential flooding from Dean Grove in times of high rainfall and this does not affect the Site.

The risk of surface water flooding to the Site is therefore not significant and not considered further.

4.2.4 Flooding from Groundwater

Regional mapping showing areas of elevated groundwater flood risk is contained within the Northumberland County Council Level 1 Strategic Flood Risk Assessment[14] (SFRA). This coarse mapping suggests that the Site sits on the edge of a Major Aquifer with High Vulnerability and a Minor Aquifer with Low Vulnerability. DEFRA Magic Mapping[8] places the Site in a Medium-High area of Groundwater Vulnerability with a small portion at the top of the Site within a region of High Vulnerability, which is likely due to the sandstone bedrock and lack of superficial deposits.

The SFRA also notes that the aquifers within the county largely vary in permeability and there have been occurrences of groundwater flooding, in Spittal and Darras Hall, neither of which are within proximity to the Site. This occurrence is also less likely at the Site where glacial till overlays the aquifer, as the permeability is variable.

Considering the proximity to the River Till and Dean Grove valley, it is likely that any high groundwater levels are in direct conjunction with peak fluvial flows. Considering the local topography and geology at the Site (section

14 Northumberland County Council Level 1 Strategic Flood Risk Assessment, Scott Wilson, September 2010

2.3.2) it is not foreseen that groundwater flooding would affect any areas of the Site. It is seen that the estimates within the SFRA and DEFRA Magic Mapping are likely coarse and not a robust measure of site-specific risk.

Flooding from this source is not significant and therefore not considered further.

4.2.5 Flooding from Sewers

Ford Castle and the wider estate is served by private drainage networks to manage surface water and foul flows. It is understood that the castle is served by its own package treatment plant to treat foul flow from the castle and associated buildings and Ford village to the south east is also served by a small package treatment plant.

Anecdotal evidence indicates that no drainage infrastructure lies beneath or in close proximity to the Site. Any risk of flooding from off-site sewers is unlikely given the local topography and any such risk would be limited in nature.

The risk of flooding to the Site from this source is assessed to be negligible and is not considered further.

4.2.6 Flooding from Reservoirs, Canals, and other Artificial Sources

A review of the local context indicates that there are no canals, reservoirs, or other significant artificial water bodies up gradient of the Site that could potentially cause flooding. As such, flooding from such features is not of relevance to this assessment.

4.2.7 Flooding from Infrastructure Failure

The Site is located in Flood Zone 1 and does not benefit from any formal flood defences, along the River Till or neighbouring tributaries.

4.3 Summary of Flood Screening

Table 4-4 summarises the flood screening assessment.

Table 4-4 Potential Risk Posed by Flooding Sources

Potential Source	Potential Significant Flood Risk at Site?
Sea or Tidal Flooding	No
Rivers or Fluvial Flooding	No
Surface Water and Overland Flow	No
Groundwater	No
Sewers and Water Mains	No
Reservoirs, Canals and other Artificial Sources	No
Infrastructure Failure	No

This concludes the flood screening assessment placing the entire Site at low risk of all types of flooding.

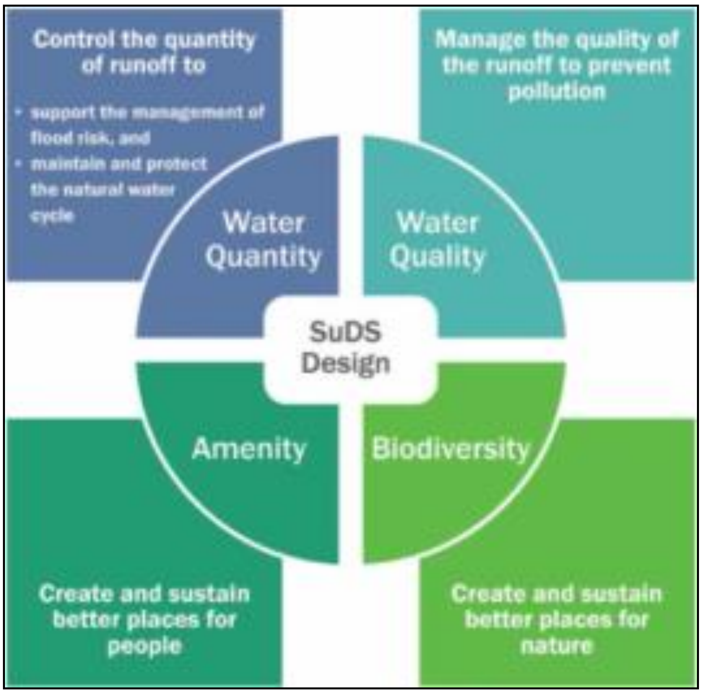
5.0 Surface Water Drainage Strategy

5.1 Key Principles of Surface Water Management

5.1.1 Overview

Current best practice guidance document; The Sustainable Drainage System (SuDS) Manual (CIRIA Report C753)[15], 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 5-5.

Figure 5-5
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).
- **Site Control** – management of water from several sub-catchments (including routing water from roofs and car parks to one/several large soakaways for the whole site).
- **Regional Control** – management of runoff from several sites, typically in a retention pond or wetland.

15 Report C753, The SuDS Manual; CIRIA (2015). Report C753, November 2015.

5.1.2 National Policy Context

Current national planning policy guidance and best practice, namely NPPF and PPG, require development proposals in all flood zones to seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of SuDS.

5.1.3 Local Policy Context

Northumberland County Council in their role as LLFA has published guidance relating to surface water drainage[16]. This guidance sets out recommended approaches and methodology for calculating appropriate runoff rates for new development, sustainable drainage solutions and the design events that should be worked to.

5.2 Existing Drainage Arrangements

There are no plans to change the existing surface water drainage system which serves the activity field as it is not relevant to the input of the impermeable surfaces. At present, there is no formal drainage strategy for the Site (see Section 2.2.1).

5.3 Constraints on the use of SuDS

5.3.1 Geology

As discussed in Section 2.3.2, BGS mapping indicates the Site is underlain by bedrock geology of the Fell Sandstone Group and overlain by Devensian Till – Diamicton drift deposits. These geologies have varying levels of permeability and could negatively affect the rate of infiltration.

5.3.2 Watercourses

As discussed in Section 2.2, an ordinary watercourse named Dean Grove borders the northern Site boundary. A direct connection to the watercourse would be possible, but runoff volumes are not projected to be great enough to make the connection feasible.

5.3.3 Topography

Site levels rise from the west to the east where development is sited by approximately 10m overall. Drainage features are to be sited downgradient of structures where possible to work with natural gradients. This may not be possible in some cases where the drainage feature encroaches on the entrance or exit to the structures.

5.3.4 Sewers

No sewers are noted to be within proximity of the Site and no connection to sewer is considered feasible for the management of surface water runoff.

5.4 Allowable Discharge Rates

5.4.1 Pre-Development Greenfield Runoff Rates

Greenfield runoff rates for the Site were estimated through application of the methodology outlined in IoH 124 as set out within the Interim Code of Practice for SuDS (ICP) for catchment areas of 50 hectares or less. IoH 124 is widely recognised as current best practice for estimation of catchment release rates for small rural catchments.

16 North East Lead Local Flood Authorities Sustainable Drainage Local Standards, July 2020.

The IoH 124 method can be used to estimate greenfield runoff release rates for a range of annual probability events, or return periods, by applying regional growth curve factors to the mean annual peak runoff.

The UK hydrological region for Ford is Region 3 therefore appropriate growth curve factors for this region have been incorporated into the analysis undertaken in the MicroDrainage (2020) software suite[17]. Results are presented in **Appendix 02** and are summarised in Table 5-5 for a range of AEP[18] storm events.

The following parameters have been incorporated into the runoff modelling.

- Average Annual Rainfall (SAAR): 700mm/year (as taken from WinDes); and
- Soil Index: 0.15 (as taken from WinDes)

Table 5-5
Greenfield Runoff: Rates

Annual Probability	Greenfield Runoff Rate (l/s/ha)	Site Greenfield Runoff Rate (l/s)
100%	0.5	0.8
50%	0.6	0.8
3.3%	1.1	1.5
1%	1.3	1.8

The only impermeable area being added within the Site boundary relates to the introduction of roofs over the standing area and target areas for the air rifle ranges and small activity shelters across the Site. Drainage for each of these items will be managed discretely local to each feature. The total impermeable area introduced within the Site boundary is very small (0.014ha) and does not warrant the development of a formal drainage system to manage runoff on a site-wide basis.

The total runoff rates for the Site will also be controlled at or below greenfield rates for the entire Site. This will mean peak discharge rates from the Site are maintained at or below 1.8l/s for all storms up to the 1 in 100 annual probability event with a 40% accommodation for climate change.

5.5 Conceptual Drainage Strategy

Many of the proposed activity structures are lightweight structures placed directly onto the existing ground surface, supported by heavy concrete footings, with no significant areas of hardstanding. Runoff from the actual structures will be minimal and will be allowed to drain onto the adjacent ground and there should be no net change in runoff rates.

The proposed footpaths will also comprise gravel workings which are permeable and will infiltrate water directly into the ground. The proposed activity pond is also not served by any formal drainage nor will be integrated into the wider site hydrology. It is assumed that the lake will accommodate any incidental rainfall by way of the freeboard allowed in construction. There are also two areas of hardstanding adjacent to the pond that do not require any formal drainage arrangements as any rainfall will runoff directly into the new pond feature.

17 Innovyze, Inc. MicroDrainage, Version 2020.1
18 Annual Exceedence Probability

The structures on Site that include impermeable areas as a result of their construction are the 12 activity shelters sited around the activity area (**Appendix 01**) and the air rifle roof areas.

Primary drainage arrangements for these structures will comprise of swales adjacent to the structures. It is proposed that most of the activity shelters will possess their own swale for runoff to enter, but these will connect where possible. It is possible for the air rifle sheds to share one larger swale, if there are no logistical constraints with this.

The strategy will be to make the swale feature drain by infiltration however it is noted that no infiltration test data is currently available to confirm the viability of this approach and this testing is therefore scheduled to be undertaken as part of the phase 2 intrusive investigation scheduled for Q4 2021/Q1 2022. Attenuation will be provided for infiltration up to the 1 in 100-year rainfall event plus a 40% accommodation for climate change.

In the event that attenuation is not viable, the swales will be designed as oversized, unlined features in order to maximise whatever limited infiltration is available locally. Any water collected during rainfall that does not infiltrate will disperse by a combination of vegetation uptake and evapotranspiration. Each feature will have capacity for twice the volume of runoff generated during a design event, ensuring that capacity would be available following wet antecedent conditions.

5.6 SuDS Attenuation

Volumes for infiltration required within the swales has been estimated using the Source Control function in the WinDes software, an appropriate methodology for planning and master planning purposes.

Full calculation results are presented in **Appendix 02** with the swale dimensions based on these calculations.

The Flood Estimation Handbook (FEH) rainfall model was used with a design standard return period of 1% AEP (1 in 100-year return period) plus an allowance for climate change as recommended within climate change guidance detailed in Section 3.6.2 (applied as a 40% uplift in peak rainfall intensity).

Runoff from the activity shelters and air rifle roofs will infiltrate into adjacent swales. Each structure is 5m x 2m with impermeable cover of 0.001ha (total 0.014ha).

The following parameters have been incorporated into the modelling:

- Contributing Catchment: 0.001 ha (for 1 shelter/roof)
- Infiltration Rate: 0.001 (as per MicroDrainage guidance cutoff point for most infiltration systems)
- Safety Factor: 1 (this is lower than the standard 2 as the infiltration rate is conservative)
- Porosity: 1
- Cover Level: 69m (aOD)
- Invert Level: 68.5m (aOD)
- Base Width: 1m
- Length: 6m
- Side Slope: 4m

The critical event for the attenuation requirements has been analysed as the 100-year event with 40% climate change uplift. The output for this event shows that the swales will not overtop in any storm event. Maximum volumes are summarised in Table 5-6.

Table 5-6 Singular Swale Performance

Name	Attenuation Type	Half Drain time (mins)	Maximum Depth (m)	Freeboard (mm)	Maximum Attenuation Volume (m^3)
Activity Shelters and Roof Areas	Infiltration Swales	3077	0.5	300	1.2

5.7 SuDS Operation and Maintenance

Long term management and maintenance responsibility for Site drainage arrangements will rest with the Site owners.

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 each proposed SuDS feature is provided below.

5.7.1 Swale

The anticipated maintenance and management for swales are associated with the surface water drainage system is outlined in Table 5-6:

Table 5-7
Typical Swale Maintenance Requirements

Maintenance Schedule	Required Action	Minimum Frequency
Regular Maintenance	Remove litter and debris	Monthly, or as required
	Cut grass – to retain grass height within specified design range	Monthly (during growing season), or as required
	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 infiltrations surfaces for ponding, compaction, silt accumulation, record areas where water is ponding for > 48 hours	Monthly, or as 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	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

Maintenance Schedule	Required Action	Minimum Frequency
Remedial Actions	Remove or control tree roots where they are encroaching the sides of the crates, using recommended methods (e.g. NJUG, 2007 or BS 3998:2010). Clear silt and debris from the ditch to ensure correct operation.	As required.
	Relevel uneven surfaces and reinstate design levels	
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface	
	Remove build-up of sediment on upstream gravel trench, flow spreader or at the top of filter strip	
	Remove and dispose of oils or petrol residues using safe standard practices	

5.8 Exceedance

In the event that rainfall exceeds the design criteria, the individual swale features will fill and then overtop with excess flow spilling downgradient following local topographical gradients. As each swale feature will be local to the feature generating runoff, this routing of exceedance flows will mirror current catchment hydrology and will not create any change in regime or increase in flow.

6.0 Conclusion and Recommendations

SLR Consulting Limited has been appointed on behalf of PGL Travel Limited to prepare a Flood Risk Assessment (FRA) and Surface Water Drainage Strategy (SWDS) to inform and support a planning application for the input of a new activity pond, activity structures and associated access paths at the existing residential activity centre for children, associated teachers and staff at Ford Castle, Berwick-Upon-Tweed, Northumberland, TD15 2PX.

6.1 Flood Risk

Environment Agency Mapping[4,5] indicates that the Site is wholly located wholly in Flood Zone 1 and is at very low risk of fluvial and surface water flooding. The flood screening assessment also concludes that the Site is not at risk from any other source of flooding.

6.2 SuDS Strategy

The preliminary drainage strategy has been developed to demonstrate that the requirements of national, regional, and local planning policy can be achieved at the Site given the nature and the quantum of development proposed. Currently there is no formal drainage system on the Site as there are no buildings or structures. The input of activity shelters and air rifle (amongst other equipment) prompts the requirement for consideration of a drainage system to compensate for the introduction of impermeable areas.

The new drainage strategy will infiltrate runoff the ground (dependent on infiltration testing to be carried out in the next few months). The method of attenuation comprises of swales sited around the contributing catchment area, adjacent to the structures generating runoff. The swales will infiltrate runoff up to the 1% AEP + 40% CC event.

Infiltration testing will commence in late 2021 to ascertain if this method is suitable for the geology. Because of the low area of impermeable surfaces and subsequent low volume of runoff, it is projected that this method is the most feasible and achievable for the Site.

In common with most drainage strategies put forward in support of planning applications, the strategy presented here will need to be subject to detailed design and relevant approvals before construction commences.

APPENDIX 01

Site Layout

KEY

(red line)	Site Boundary Line
(orange dashed line)	Line of Tree Route Protection
AS	Activity Shelter

Revision	Description	Date
C	Drawing updated to show now activity shelter locations	29.11.21
B	Updated to suit Zip Wire alterations	29.11.21
A	ISSUED FOR PLANNING	15.11.21

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Client PGL HOLIDAYS

Project FORD CASTLE BERWICK-UPON-TWEED

Drawing PROPOSED ACTIVITY FIELD

Drawing No. 2035\AF-003 Revision C

Scale 1:500@A1 Date 04.08.21 Drawn JWH

A1 Drawing

APPENDIX 02

MicroDrainage Calculations

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 3077 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	68.535	0.035	0.0	0.2	O K
30 min Summer	68.546	0.046	0.0	0.3	O K
60 min Summer	68.557	0.057	0.0	0.4	O K
120 min Summer	68.569	0.069	0.0	0.5	O K
180 min Summer	68.576	0.076	0.0	0.6	O K
240 min Summer	68.581	0.081	0.0	0.6	O K
360 min Summer	68.588	0.088	0.0	0.7	O K
480 min Summer	68.594	0.094	0.0	0.8	O K
600 min Summer	68.597	0.097	0.0	0.8	O K
720 min Summer	68.600	0.100	0.0	0.8	O K
960 min Summer	68.604	0.104	0.0	0.9	O K
1440 min Summer	68.609	0.109	0.0	0.9	O K
2160 min Summer	68.612	0.112	0.0	1.0	O K
2880 min Summer	68.614	0.114	0.0	1.0	O K
4320 min Summer	68.616	0.116	0.0	1.0	O K
5760 min Summer	68.617	0.117	0.0	1.0	O K
7200 min Summer	68.618	0.118	0.0	1.0	O K
8640 min Summer	68.618	0.118	0.0	1.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	126.812	0.0	19
30 min Summer	86.898	0.0	34
60 min Summer	57.172	0.0	64
120 min Summer	35.861	0.0	124
180 min Summer	27.204	0.0	184
240 min Summer	22.322	0.0	244
360 min Summer	16.834	0.0	362
480 min Summer	13.744	0.0	482
600 min Summer	11.726	0.0	602
720 min Summer	10.290	0.0	722
960 min Summer	8.358	0.0	962
1440 min Summer	6.216	0.0	1440
2160 min Summer	4.617	0.0	2056
2880 min Summer	3.746	0.0	2392
4320 min Summer	2.804	0.0	3156
5760 min Summer	2.299	0.0	3976
7200 min Summer	1.986	0.0	4824
8640 min Summer	1.770	0.0	5624

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
10080 min Summer	68.619	0.119	0.0	1.1	O K
15 min Winter	68.538	0.038	0.0	0.3	O K
30 min Winter	68.550	0.050	0.0	0.4	O K
60 min Winter	68.563	0.063	0.0	0.5	O K
120 min Winter	68.576	0.076	0.0	0.6	O K
180 min Winter	68.583	0.083	0.0	0.7	O K
240 min Winter	68.589	0.089	0.0	0.7	O K
360 min Winter	68.597	0.097	0.0	0.8	O K
480 min Winter	68.603	0.103	0.0	0.9	O K
600 min Winter	68.607	0.107	0.0	0.9	O K
720 min Winter	68.610	0.110	0.0	0.9	O K
960 min Winter	68.615	0.115	0.0	1.0	O K
1440 min Winter	68.620	0.120	0.0	1.1	O K
2160 min Winter	68.624	0.124	0.0	1.1	O K
2880 min Winter	68.625	0.125	0.0	1.1	O K
4320 min Winter	68.627	0.127	0.0	1.1	O K
5760 min Winter	68.627	0.127	0.0	1.2	O K
7200 min Winter	68.628	0.128	0.0	1.2	O K
8640 min Winter	68.628	0.128	0.0	1.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
10080 min Summer	1.613	0.0	6464
15 min Winter	126.812	0.0	19
30 min Winter	86.898	0.0	34
60 min Winter	57.172	0.0	64
120 min Winter	35.861	0.0	122
180 min Winter	27.204	0.0	182
240 min Winter	22.322	0.0	240
360 min Winter	16.834	0.0	358
480 min Winter	13.744	0.0	476
600 min Winter	11.726	0.0	594
720 min Winter	10.290	0.0	710
960 min Winter	8.358	0.0	942
1440 min Winter	6.216	0.0	1400
2160 min Winter	4.617	0.0	2072
2880 min Winter	3.746	0.0	2680
4320 min Winter	2.804	0.0	3332
5760 min Winter	2.299	0.0	4272
7200 min Winter	1.986	0.0	5192
8640 min Winter	1.770	0.0	6136

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m^3)	Status
10080 min Winter	68.627	0.127	0.0	1.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m^3)	Time-Peak (mins)
10080 min Winter	1.613	0.0	7056

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 394553 637599 NT 94553 37599
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 %	+40

Time Area Diagram

Total Area (ha) 0.001

Time From:	(mins) To:	Area (ha)
0	4	0.001

Model Details

Storage is Online Cover Level (m) 69.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00100	Length (m)	6.0
Infiltration Coefficient Side (m/hr)	0.00100	Side Slope (1:X)	4.0
Safety Factor	1.0	Slope (1:X)	0.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	68.500	Cap Infiltration Depth (m)	0.000
Base Width (m)	1.0		

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