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Red John Pumped Storage Hydro Scheme

Volume 5, Appendix 9.1: Flood Risk Assessment

ILI (Highlands PSH) Ltd.

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Quality information

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Revision History

Revision	Revision date	Details	Authorized	Name	Position
1	November 2018	Submission	CA	Catherine Anderson	Associate Director

Distribution List

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Appendix 9.1 Flood Risk Assessment

9.1 Introduction

9.1.1 This Flood Risk Assessment (FRA) provides the detailed analysis of flood risk as a result of the construction and operation of the Development.

Objectives

9.1.2 The objective of this FRA is to assess five main issues in relation to flood risk:

- Acceptability of the Development in accordance with planning policy;
- Risk to the Development from all forms of flooding;
- Risk of increasing flooding elsewhere due to the Development (resulting from increased surface water run-off, changes in flood routing through the Development and loss of floodplain storage);
- Risk of increasing flooding elsewhere due to the operation of the Development; and
- Appropriate mitigation measures to reduce the impact of flooding on the Development and off-site to an acceptable level.

Sources of data

9.1.3 To inform this study, information has been obtained from the following sources:

- River Ness Flood Scheme - Details of Hydraulic Modelling undertaken for Development of Preferred Scheme - The Highland Council / Mott MacDonald October 2011;
- Guidance to risk assessment for reservoir safety management - Volume 2: methodology and supporting information Report - SC090001/R2- Department for Environment, Food and Rural Affairs (Defra);
- Water Control Manual - Caledonian Canal - Version 9.0 - Scottish Canals;
- Flood Risk & Drainage Impact – Supplementary Guidance Jan 2013 – The Highland Council;
- Dochgarroch Lock water levels - Scottish Canals;
- River Ness flow data - National River Flow Archive;
- Elevation Discharge curve for Loch Dochfour – extract from Loch Dochfour Reservoirs Act Section 10 Inspection 1987;
- Scottish Environment Protection Agency (SEPA) flood risk mapping (https://www.sepa.org.uk/environment/water/flooding/flood-maps/).

Flood risk terminology

9.1.4 In this appendix, flood events are defined according to their likelihood of occurrence. The term Annual Exceedance Probability (AEP) is used, meaning the chance of a particular flood event occurring or being exceeded in any given year. The 100-year flood has an AEP of 1 %; a 1 % chance of occurring or being exceeded in any given year.

Flood Risk

9.1.5 Flood risk takes account of both the probability and the consequences of flooding. Probability is usually interpreted in terms of the return period, e.g. 1 in 100 and 1 in 200-year event etc. In terms of probability, there is a 1 in 100 (1 %) chance of one or more 1 in 100 year floods occurring in a given year. The consequence of flooding depends on how vulnerable a receptor is to flooding. The components of flood risk can be considered using the source-pathway-receptor model.

9.1.6 Sources constitute flood hazards, which are anything with the potential to cause harm through flooding e.g. rainfall, extreme sea levels, river flows and canals. Pathways represent the mechanism by which the flood hazard would cause harm to a receptor e.g. overtopping and failure of embankments and flood defences, inadequate drainage and inundation of floodplains. Receptors comprise of the people, property, infrastructure and ecosystems that could potentially be affected should a flood occur.

9.2 Legislation, Policy and Guidance

9.2.1 A summary of the legislation and planning policy relevant to the assessment of impacts of the Development is provided in this section.

Scottish Planning Policy

9.2.2 Clauses 254 to 268 of the Scottish Planning Policy 2014 (SPP) address flood risk issues. SPP provides a Risk Framework (Clause 263) that characterises areas for planning purposes by their AEP of flooding and gives the following planning response:

- Little or no risk area – less than 0.1 % (1:1000 event) – no general constraints;
- Low to medium risk area - 0.1 % to 0.5 % (1:1000 – 1:200) – suitable for most development but not essential civil infrastructure such as hospitals, fire stations, emergency depots, schools, ground based electrical and telecommunications equipment; and
- Medium to high-risk area - 0.5 % (1:200) or greater – in built up areas with flood prevention measures most brownfield development should be acceptable for essential civil infrastructure; undeveloped and sparsely developed areas are generally not suitable for most development.

9.2.3 SPP requires that the planning system promotes a precautionary approach to flood risk from all sources, including taking account of the predicted effects of climate change (Clause 255). When considering proposed developments, the potential effects of climate change should be taken into account and an allowance is made for freeboard (Clause 264).

9.2.4 In terms of planning policy principles, Clause 255 stipulates that the planning system should promote: "A precautionary approach to flood risk from all sources, including coastal, watercourse (fluvial), surface water (pluvial), groundwater, reservoirs and drainage systems (sewers and culverts), taking account of the predicted effects of climate change;

- *Flood avoidance: by safeguarding flood storage and conveying capacity, and locating development away from functional floodplains in medium to high-risk areas;*
- *Flood reduction: assessing flood risk and, where appropriate, undertaking natural and structural flood management measures, including flood protection, restoring natural features and characteristics, enhancing flood storage capacity, avoiding the construction of new culverts and opening existing culverts where possible; and*
- *Avoidance of increased surface water flooding through requirements for Sustainable Drainage Systems (SuDS) and minimising the area of impermeable surface*"

9.2.5 A FRA will be required for proposed developments within medium to high risk areas as shown by SEPA flood maps, although in some cases, a FRA will be required in areas at low to medium risk.

SEPA guidance

9.2.6 The SEPA publishes guidance covering all aspects of water and environmental management and best practice.

9.2.7 Their *Technical Flood Risk Guidance for Stakeholders* (2018) sets out the requirements for a FRA. The functional floodplain is defined as land with a greater than 0.5 % probability of flooding each year, corresponding with SPP designation of Medium to High risk. AFRA, with appropriate mitigation measures must be undertaken for areas that fall under this designation.

9.2.8 It also outlines that any development that falls under the 'Most Vulnerable Use', as defined in SEPA's *Land Use Vulnerability Guidance*, should be assessed up to the 1 in 1000yr (0.1 % AEP) event, and in the case of civil infrastructure, avoided. This classification covers development such as nurseries, hospitals and schools.

The Highland Council – Local Development Plan

9.2.9 The Highland Council (THC) has a number of Supplementary Guides (SG) to support the delivery of their Local Development Plan. The Flood Risk & Drainage Impact guidance (Ref 5) sets out the guidance on carrying out FRAs. The relevant policies are outlined below.

9.2.10 Policy 64 Flood Risk

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

9.2.12 Development proposals within or bordering medium to high flood risk areas, will need to demonstrate compliance with SPP through the submission of suitable information which may take the form of a FRA.

9.2.13 Development proposals out with indicative medium to high flood risk areas may be acceptable. However, where:

- better local flood risk information is available and suggests a higher risk;
- a sensitive land use, as specified in the risk framework of Scottish Planning Policy, is proposed, and / or;
- the development borders the coast and therefore may be at risk from climate change; a FRA or other suitable information which demonstrates compliance with SPP will be required.

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

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

Policy 66 Surface Water Drainage

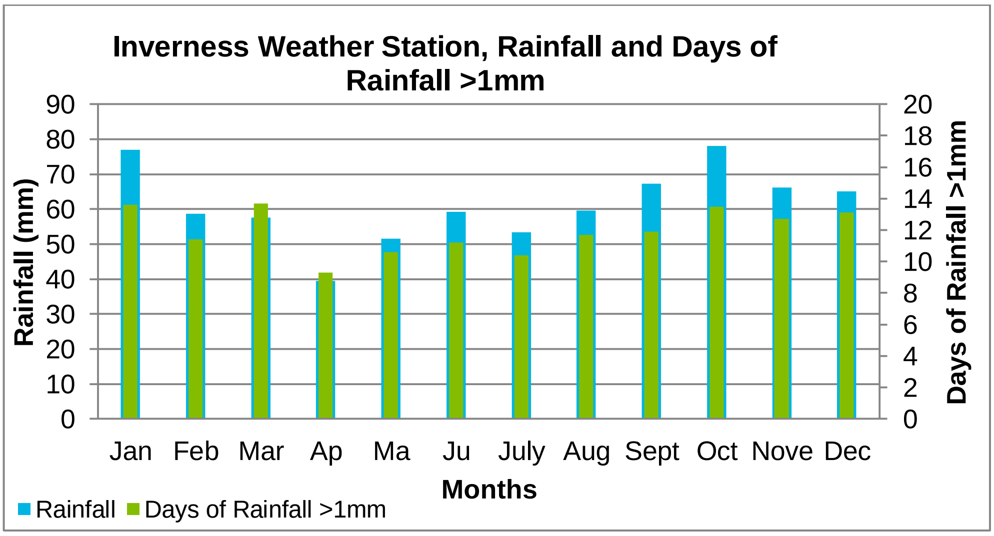
9.2.16 All proposed developments must be drained by Sustainable Drainage Systems (SuDS) designed in accordance with The SuDS Manual (CIRIA C697) and, where appropriate, the Sewers for Scotland Manual 2nd Edition. Planning applications should be submitted with information in accordance with Planning Advice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

9.3 Existing Site

9.3.1 The Development Site is situated between the River Ness and River Nairn water catchment areas. The Development Site lies on Ashie Moor, a ridge of land between Loch Ness to the north-west, Loch Duntelchaig to the south-west (including the connected small Loch nan Geadas basin and the upstream Loch Ceo Glais), and Loch Ashie to the north-east. In the south-east of the Development Site, there are two small lochs, Loch na Curra and Lochan an Eoin Ruadha. The location of the Development is shown in Figure 9.1 (Volume 3).

9.3.2 Loch Ness is the lowest point of the Development Site at approximately 16 metres (m) Above Ordnance Datum (AOD). The terrain climbs steeply from the banks of Loch Ness and then gradually plateaus towards the C1064, which runs southwest to northeast through the Development Site, with a high point of 262 m AOD. From the C1064 the land dips down again to the shore of Loch Duntelchaig at approximately 217 m AOD. There are three small peaks at the southern and eastern side of the Development Site, the highest of which is 278 m AOD.

9.3.3 A review of the Meteorological Office website shows there is a weather station at Inverness, NH668452, 11 km north of the Development but close to sea level. Based on the available data from this weather station it is estimated that the Development experiences an average of only 733 mm of rainfall per year, with it raining more than 1 mm on around 143 days per year. Insert 9.1 illustrates this data to show how the average rainfall varies throughout the year, with it being wettest in the autumn-winter period and driest in the spring and early summer.



Insert 9.1 Inverness Weather Station, Rainfall and Days of Rainfall >1 mm for the period 1981-2010 (source, Met Office)

9.3.4 Rainfall is generally high, with more than 60 mm expected each month between September and January, and 50-60 mm per month the rest of the year, except in April (where average rainfall totals are about 40 mm).

9.3.5 On the National River Flow Archive website, the nearest catchment with rainfall statistics is the Ness at Ness Castle Farm (NH639410), approximately 7 km north of the Site. Standard Annual Average Rainfall (SAAR) for the period 1961-1990 is 1779 mm per year, considerably greater annual average rainfall than the Met Office. This could be due to the difference in elevations of the Site and the Met Office weather station at Inverness. Overall, it is likely that the Met Office weather station in Inverness underestimates the rainfall expected at the Site.

Surface Water Bodies

9.3.6 The following descriptions of water bodies around the Development are based on the field observations made during a site walkover survey on the 9th May and online data sources. The main water bodies surrounding the Development are:

- Loch Ness;
- Loch Duntelchaig; and
- Loch Ashie.

Loch Ness

9.3.7 Loch Ness is a large glacially eroded freshwater loch covering approximately 55.33 km^2. It lies close to sea level (water level is around 16 m Above Ordnance Datum (AOD)) and is approximately 22.5 km long with a northeast to southwest axis along the Great Glen Fault. It is very deep with a maximum depth of around 230 m.

9.3.8 Loch Ness is a water source for the northern section of the Caledonian Canal and provides a location for various recreational activities. During drought conditions, Scottish and Southern Energy (SSE) is required to release water from upstream catchments and reservoirs to provide minimum ‘compensation’ flows and maintain minimum navigational depths over lock upstream cills. A minimum pass forward flow must be maintained to the River Ness over the Ness Weir and a minimum water level must be maintained at the Ness Weir.

9.3.9 Loch Ness and its upstream catchment feeds flood water into a Potentially Vulnerable Area (PVA) with regard to flood risk – PVA 01/21 Inverness and the Great Glen. Significant flooding has been experienced in Inverness from the River Ness. This has resulted in THC constructing the recently completed River Ness Flood Protection Scheme to protect low lying areas of Inverness from both tidal and fluvial flooding.

9.3.10 Since 1999 the 600 m long gravel / sandy beach at Dores has been designated as bathing water under the original Bathing Waters Directive (76/160/EC) and the current Revised Bathing Waters Directive (2006/7/EC). According to SEPA’s online Bathing Water Profile for Dores, the beach is very popular with tourists, particularly in the summer season. SEPA monitor the quality of water (for faecal indicator organisms) throughout the bathing water season (May to September) from NH 59671 35000 and the current bathing water quality at Dores is ‘Good’ (period 2017/18). The Bathing Water Profile also shows the location of a small sewage treatment works discharging to Loch Ness to the south of Dores at approximately NH 59640 34450, including a sewage outfall, combined sewer and emergency overflows. It also states that algal blooms have occurred on the loch, including those formed of cyanobacteria i.e. blue-green algae, which can be toxic, although the loch is not considered sensitive to an overproduction of filamentous algae or phytoplankton.

9.3.11 Other activities on Loch Ness include various recreational water sports such as kayaking, there is an important kayak route through the loch, bank and boat fishing, and loch cruises. In addition, water is abstracted from the loch for bottled water by Loch Ness Water Ltd. Scottish Water is currently developing a scheme to transfer water from Loch Ness to Inverness Water Treatment Works as part of their resilience measures. This is a project with capital commitment. Finally, there are also two existing large-scale hydro-electric schemes in operation on Loch Ness, located at the south western end of the loch nearer to Fort Augustus – Foyers and Glendoe.

Loch Duntelchaig

9.3.12 Loch Duntelchaig (NH 61122 30774) is a freshwater loch approximately 5 km long and approximately 1.75 km wide at its widest point, with a surface area of approximately 5.55 km^2. According to Ordnance Survey data, Loch Duntelchaig has a maximum depth of around 60 m, which despite being significantly shallower than Loch Ness is still considered deep and seasonal stratification is expected.

9.3.13 Loch Duntelchaig forms part of the upper catchment of the River Nairn. Loch Duntelchaig feeds into an area that is classed as being a Potentially Vulnerable Area with regard to flood risk – PVA 01/18 Nairn Central. Loch Duntelchaig is at the upper part of the catchment and the contributing area feeding the reservoir is small relative to the surface area of the loch resulting in significant attenuation of any flood flows from the upper catchment.

9.3.14 Loch Duntelchaig in conjunction with Loch Ashie, both Drinking Water Protected Areas (DWPA), is the main potable water supply reservoir for Inverness. The current arrangement is under pressure to meet future demand and any impact on current yield as a result of this proposal will, therefore, exacerbate this. The loch is also likely important for local recreational activity and water sports.

Loch Ashie

9.3.15 Loch Ashie forms part of the upper catchment of Big Burn, a tributary of the River Ness that joins at the upstream end of Inverness. Loch Ashie feeds into an area that is classed as being a Potentially Vulnerable Area with regard to flood risk – PVA 01/21 Inverness and the Great Glen. Loch Ashie is at the upper part of the catchment and the contributing area feeding the reservoir is small relative to the surface area of the loch, which is likely fed from groundwater, resulting in significant attenuation of any flood flows from the upper catchment.

9.3.16 Loch Ashie is included within a Drinking Water Protected Zone and provides a secondary supply to Inverness. A water treatment works is located at the bottom of the loch close to the overflow to Allt Mor. Loch Ashie is principally fed from Big Burn, a WFD watercourse (ID 20261).

9.4 Drainage Assessment

9.4.1 The drainage assessment seeks to demonstrate that the Development is able to discharge foul and surface wastewater flows without increasing the flood risk both on and off-site. A drainage strategy will need to be confirmed by the Construction Contractor at the detailed design stage and prior to construction. This assessment considers the following:

- Existing drainage arrangements;

- Potential foul and surface water drainage arrangements;
- Climate change; and
- The mitigation measures needed for surface water and foul water disposal.

9.4.2 No formal drainage strategy has been produced at this time. However, potential methods of wastewater management and disposal have been considered as part of this study. All details and proposals will be reconsidered at detailed design stage and agreed with THC, SEPA and / or Scottish Water (SW) as appropriate to ensure the most appropriate drainage strategy for the Development is in place.

Surface Water Drainage

Existing Surface Water Drainage

9.4.3 The Development site is an undeveloped area. With the possible exception of the houses within the Development Site boundary, no existing surface water drainage arrangement therefore exists.

9.4.4 The Development Site sits on the catchment boundary between Loch Ashie and Loch Ness (as shown on Figure 9.2, Volume 3). Surface water and groundwater flows in the area around the Headpond towards Loch Ashie and Loch Ness. Surface water flows drain towards existing natural ditches and watercourses and then on to the two main water bodies.

Proposed Surface Water Drainage

9.4.5 In order to ensure that the Development Site is adequately drained, a suitable surface water management strategy for the Development is required. In addition to local rainfall, the surface water drainage design must consider the potential for overland flow paths from permeable and impermeable areas outside of those areas which are to be formally developed, including from outside of the Development Site. Potential groundwater flows must be considered if they may be expected to break ground.

9.4.6 A sub-lining drainage system may be incorporated into the Headpond design to remove any water from below the Headpond lining. The details and capacity of any sub-lining drainage system would be subject to detailed design. The flow from the sub-lining drainage system would be subject to monitoring for leakage detection purposes, but should then be discharged into the appropriate surface water drainage system for safe disposal.

9.4.7 The drainage design must be particularly robust in more vulnerable areas such as potential points of entry to below ground infrastructure, in order to protect personnel and equipment from flooding.

Methods of Surface Water Disposal

9.4.8 Surface water disposal for the development will be designed to SEPA regulatory method on SuDS (Ref 9), The Highland Council Supplementary Guidance (Ref 5). Further detail is included in the Surface Water Management Plan located in Appendix 10.5.

9.4.9 The information provided by the hydrogeological desk study gives an indication that infiltration is unlikely to be feasible as a method of surface water disposal. Assuming infiltration will not be feasible; there are a number of likely options for the disposal of surface water drainage into local watercourses / bodies.

9.4.10 The site is in close proximity to a number of watercourses which naturally drain the local catchments. These may provide the most appropriate point of surface water drainage disposal.

9.4.11 Based on the principle that surface water drainage should follow the natural catchments, it is likely that a number of separate surface water systems, each with at least one separate point of discharge will be required. Any surface water drainage in the area around the Headpond that drain towards Loch Ashie and is within the catchment of Loch Ashie should be discharged to Loch Ashie.

9.4.12 Any surface water drainage in the Development site which naturally drains to the west and Loch Ness should be discharged to the small watercourses that drain into Loch Ness.

9.4.13 Temporary surface water management arrangement will be constructed to take account of construction stage increased hardstanding.

Attenuation Requirements

9.4.14 If surface water drainage from the Development is to be discharged to local watercourses, there may be a requirement to restrict the discharge of surface water to an appropriate rate, to be agreed with THC and SEPA. Any requirement for attenuation from a new development is normally based on the principle that the development should not create additional run-off to the watercourse, compared to the existing situation, and therefore does not lead to an increase in flood risk elsewhere.

9.4.15 Due to the nature of the site, careful consideration of the natural catchments, likely existing run-off, and likely change in run-off would be required to establish an appropriate limit for each discharge. Discussion with the SEPA should be undertaken at the detailed design stage to agree on the most appropriate method of assessment.

9.4.16 Un-attenuated discharge to Loch Ashie and Loch Duntelchaig would not be acceptable. This should be agreed in full with the THC and SEPA at detailed design.

Storage Requirements

9.4.17 Surface water should be stored within the drainage system either below ground or in formal above ground systems for the 1 in 30 year storm event with an allowance for climate change. In excess of this up to the 1 in 200 year plus climate change event, ponding is tolerated above ground on the site. Any ponding would need to be contained in areas such as formal landscaping or car park areas.

9.4.18 The volume of storage required will depend on the final impermeable area within the Development and the hydraulic characteristics of the drainage system, including whether attenuation of the discharge is required. The volume should be confirmed at the detailed design stage when an accurate assessment of the impermeable area has been made, and further discussions with the SEPA and THC regarding the requirements for attenuation have taken place.

9.4.19 Attenuation storage could be in the form of a detention basin, retention basin, geo-cellular storage modules, a formal concrete tank or other appropriate SuDS systems.

Climate Change

9.4.20 According to Defra guidance (Table 2 of Ref 2), rainfall intensity is projected to increase by up to 20% until 2085 due to climate change. Beyond this, it is expected there will be up to 30% increase in rainfall intensity. The minimum lifetime of the Development is taken as 125 years; the drainage system for the Development should be designed to account for at least a 30% increase in rainfall intensity over its lifetime. However, this should be reviewed after the publication of UKCIP2018, expected release December 2018. The mitigation measures provided within section **Error! Reference source not found.** are based on levels within Loch Ness and therefore the conclusions and proposed mitigation measures are resilient to Climate Change, regardless of the outcome of UKCIP2018.

Sustainable Drainage Systems (SuDS)

9.4.21 SPP and Part H of the Building Regulations direct developers towards the use of SuDS wherever possible. SEPA encourages the use of SuDS where practicable, and THC encourages their use in their local Planning Supplementary Planning Guidance document

9.4.22 In order to protect the receiving aquifer, watercourse or sewer from pollution, CIRIA Report C753 (The SuDS Manual) suggests an approach for setting the level of treatment that surface water run-off will pass through before being discharged based on treatment indices.

9.4.23 If utilised these systems must be maintained correctly to ensure their safe operation and that flood risk to the site or off-site is not increased. Design guidance for SuDS is currently provided by CIRIA Report C753 (The SuDS Manual).

9.4.24 Table 9.1 outlines the type of SuDS that could potentially be used on the Site. It should be noted that not all SuDS methods are suitable or necessary for all developments. Many factors, such as available space and ground conditions, will influence the choice of methods for a particular development.

Table 9.1 SuDS Techniques (Extract from CIRIA, Table 1.7 Ref 1)

Technique	Description	Management Train Suitability						Water Quantity				Water Quality								Environmental Benefits		
		Prevention	Conveyance	Pre-treatment	Source control	Site Control	Regional Control	Conveyance	Detention	Infiltration	Water Harvesting	Sedimentation	Filtration	Adsorption	Biodegradation	Volatilisation	Precipitation	Uptake by plants	Nitrification	Aesthetics	Amenity	Ecology
Water butts, site layout and management	Good housekeeping and design practices.	■	▲		■			▲	▲	■	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Pervious pavement	Allow infiltration of rainwater into underlying construction/soil.	■			■	▲			■	■	▲	■	■	■	■	■				▲	▲	▲
Filter drain	Linear drains/ trenches filled with a permeable, often with a perforated pipe at the base of the trench.		■		■	▲		■	■				■	■	■	■						
Filter strips	Vegetated strips of gently sloping ground designed to drain water from impermeable areas and filter out silt and other particulates.			■	■			▲	▲	▲		■	■	■	■					▲	▲	▲
Swales	Shallow vegetated channels that conduct and/or retain water (and can permit infiltration when underlined). The vegetation filters particulates.		■		■	■		■	■	▲		■	■	■	■			▲		▲	▲	▲
Ponds	Depressions used for storing and treating water. They have a permanent pool and bankside emergent and aquatic vegetation.					■	■		■	▲	■	■	■	■	■	■	■	■	■	■	■	■
Wetlands	As ponds, but the run-off flows slowly but continuously through aquatic vegetation that attenuates and filters the flow. Shallower than ponds.		▲			■	■	▲	■	▲	■	■	■	■	■	■	■	■	■	■	■	■
Detention Basin	Dry depressions designed to store water for a specified retention time.					■	■		■			■	▲	▲	■			■		▲	▲	▲
Soakaways	Sub-surface structures that store and dispose of water via infiltration.				■					■			■	■	■							
Infiltration Trenches	As filter drains, but allowing infiltration through trench base and sides.		▲		■	■		▲	■	■			■	■	■	■						
Infiltration basins	Depressions that store and dispose of water via infiltration.					■	■		■	■			■	■	■	■				▲	▲	▲
Green roofs	Vegetated roofs that reduce run-off volume and rate.	■		■	■				■				■	■	■	■	■	■	■	■	■	■
Bioretention areas	Vegetated areas for collecting and treating water before discharge downstream, or to the ground via infiltration.				■	■			■	■		■	■	■	■	■	■	■	■	■	■	■
Sand filters	Treatment devices using sand beds as filter media.			■		■	▲		■	▲			■	■	■	■	■					
Silt removal devices	Manhole and/or proprietary devices to remove silt.			■								■										
Pipes, subsurface storage	Conduits and their accessories as conveyance measures and/or storage. Water quality can be targeted using sedimentation and filter media.		■			■		■	■			▲	▲	▲								

Key	
■	Recommended
▲	Some opportunities, subject to design

Design Standard and Approval

9.4.25 Surface water drainage systems for the development shall be designed in accordance with The Building Regulations Part H1.

9.4.26 The surface water drainage strategy shall be confirmed at the detailed design stage and shall ensure that the site is adequately drained without posing a risk of flooding on-site or off-site. The drainage scheme shall be approved by THC and should be agreed with the SEPA also.

Foul Drainage

Existing Foul Drainage

9.4.27 There is no known foul drainage system on the existing site, with the possible exception of the houses within the Development boundary.

Proposed Foul Drainage

9.4.28 The following elements of the Development are expected to generate an element of foul flow:

- Staff welfare facilities within the main turbine building and offices; and
- Some surface water drainage sources if the risk of contamination is high.
- Foul wastewater is either to be discharged to the public sewerage infrastructure off-site, or stored temporarily on site in a cesspit for appropriate disposal.
- For disposal to the public sewer, the drainage designer should undertake a more detailed assessment of the foul drainage requirements and agree the allowable foul discharges and suitable points of connection with SW at the detailed design stage.
- Disposal of contaminated surface water may require trade effluent consent, and this should be discussed and agreed with SW at the detailed design stage.

9.4.29 At this stage the requirement for a pumping station to convey foul flows from the Development cannot be ruled out. A pumping station may also be required to serve below ground elements of the Development. Emergency storage and telemetry to warn of high levels / pump failure should be included for in any pumping station design.

9.4.30 Foul drains for the development should be designed to Building Regulations Part H.

9.4.31 All foul drainage proposals should be agreed in full with The Highland Council and SW at the detailed design stage.

Summary

9.4.32 The above assessment demonstrates that the provision of safe and effective surface water and foul drainage systems for the Development is possible, provided any proposed systems are designed and managed appropriately.

9.4.33 A more detailed drainage strategy will need to be developed at the detailed design stage. The strategy should be agreed in full with the SEPA, SW and THC as appropriate to ensure all flow rates, storage volumes, and points of discharge are satisfactory to all parties.

9.5 Flood Risk Assessment

9.5.1 In accordance with Flood Risk & Drainage Impact, supplementary guidance by THC, flood risk must be assessed for all sources of flooding. It should also be demonstrated that the development will not increase the risk of flooding elsewhere.

9.5.2 This section identifies all other potential sources of flooding and assesses the flood risk associated with each source of flooding and what impact the development will have on flood risk elsewhere.

Tidal Flood Risk

9.5.3 The local watercourses and water bodies are not tidally influenced, and the Development Site and surrounding area are at an elevation of at least 15mAOD. The risk of tidal flooding affecting the development or of the development having any influence on tidal flooding is therefore low and acceptable.

Fluvial Flood Risk

Direct Fluvial Flood Risk to the Development

9.5.4 The Development Site extends from the banks of Loch Ness up to the higher ground on Ashie Moor. A review of the SEPA flood risk maps shows that the Tailpond Inlet / Outlet at Loch Ness by its nature falls within an area of high flood risk. However, this element of the Development is water compatible and needs to be within this zone. The remaining area of the Development is regarded as being of a lower risk than the 1 in 1000 year (low flood risk).

9.5.5 The SEPA flood maps do not give any indication of flood risk from smaller watercourses; therefore further consideration should be given to the watercourses in close proximity to the site. The watercourses around the site are relatively small and are close to their upstream source with relatively small catchments; therefore the flows are not expected to be large under normal flow conditions.

9.5.6 The watercourses are likely to have a quick response to rainfall events which may lead to a rapid rise in flow, but the likelihood of this causing flooding on the steeply graded sloped around the site is considered low.

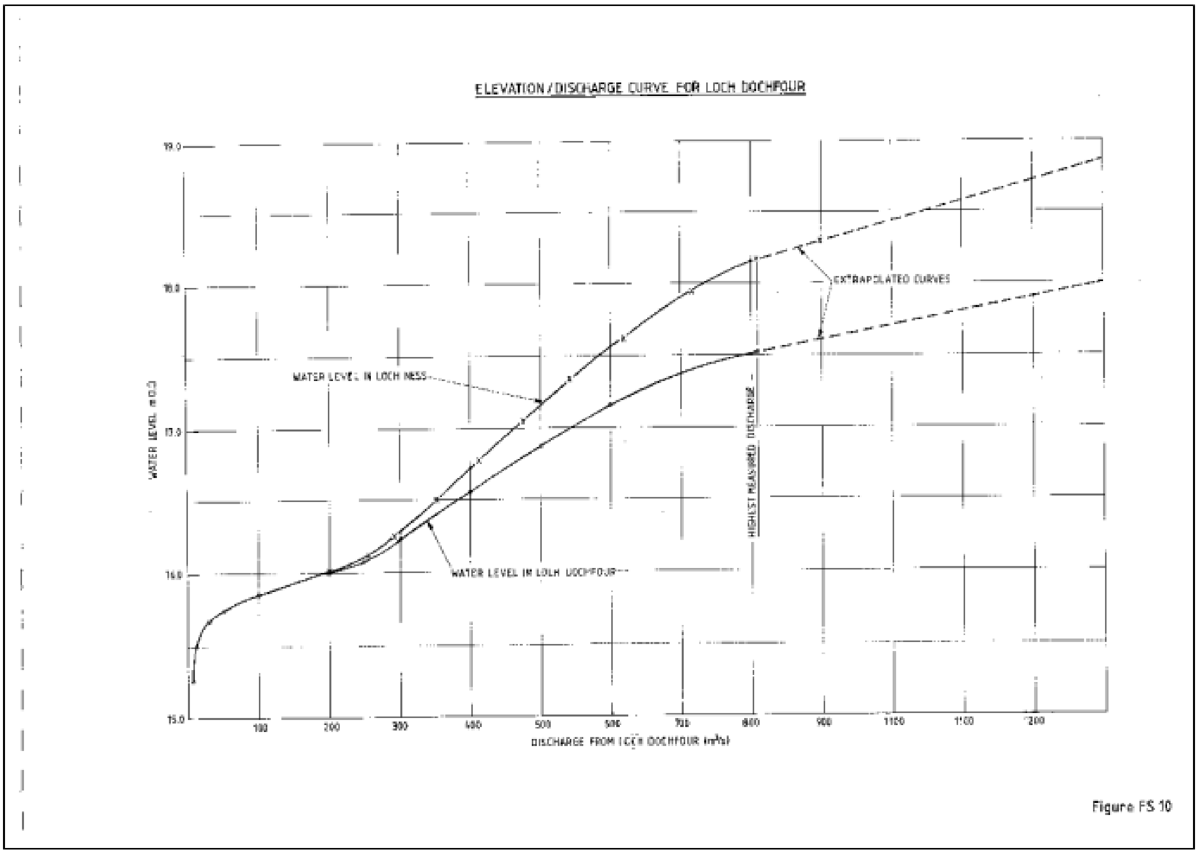
9.5.7 Based on the above, direct risk of fluvial flooding to the Development is considered low and acceptable.

Loch Ness Inlet / Outlet

9.5.8 The proposed Tailpond Inlet / Outlet at Loch Ness is located between the B852 and the shore of Loch Ness. The arrangement will consist of a roofed structure protected by wave walls containing the Waterways Inlet / Outlet and the Spillway Outlet and a Screen together with a control building. The minimum ground levels at the Development Site are to be set at 19.64 m AOD.

9.5.9 A review of the River Ness Flood Scheme shows the peak flows at Ness side to be 954.2 m^3/s and 1283.6 m^3/s during the 1 in 200 and 1 in 1000 year event, respectively. These increase to 1145 m^3/s and 1540 m^3/s with a 20% climate change allowance. Based on the Loch Dochfour and Loch Ness stage discharge curves (Insert 9.2) the flood flows in the River Ness relate to the flood levels in Loch Ness stated in Table 9.2.

9.5.10 The Inlet / Outlet is partially located within the loch. The Screen is water compatible and therefore is not vulnerable to flood risk. Any mechanical or electrical equipment will be located a minimum of 600 mm above the 1 in 1000 year flood level with an allowance for climate change. The access road is set at 19.64 m AOD, this is above the 1 in 1000 year plus climate change level and therefore is operational at all times.



Insert 9.2 Ness Weir stage discharge curve- Figure FS 10 of Loch Dochfour Reservoir Report (Ref 10)

Table 9.2 Return Period and Historic Flood Level in Loch Ness

Flood event	Discharge (m³/s)	Loch Ness level (m AOD)	Loch Dochfour level (m AOD)
1 in 200yr	954.20	18.30	17.64
1 in 200yr + climate change	1145.00	18.65	17.83
1 in 1000yr	1283.60	18.80	18.00
1 in 1000yr + climate change	1540.30	19.20	18.20
1989 flood event	-	-	17.50
1849 flood event	-	-	17.60

9.5.11 A wave wall will be located around the water side of the Inlet / Outlet. This will deflect any wind generated waves back towards the loch and minimise and wave carryover. In summary, the risk of flooding to the Inlet / Outlet Screen and the consequences of this flooding are considered to be low and acceptable.

Risk of Development Increasing Fluvial Flood Risk Downstream

9.5.12 The Development will discharge into Loch Ness. No operational discharges are proposed to Loch Ashie or Loch Duntelchaig as the Development is a closed loop system. The area downstream of Loch Ness is classified as a PVA under the Local Flood Risk Management Strategy and Plan ‘Inverness and the Great Glen (PVA 01/21)’.

9.5.13 Extensive works have been undertaken to reduce flood risk within the City of Inverness through the construction of the River Ness Flood Scheme. This has increased the standard of protection from the River Ness downstream of Ness Bridge. Areas between the Ness Bridge and Ness Islands remain at risk.

9.5.14 The detailed modelling carried out as part of the River Ness Scheme show that the area currently has a standard of protection of between 1 in 10 and 1 in 25 years.

9.5.15 As part of this FRA a flood routing model of Loch Ness and Loch Dochfour has been constructed to assess the impact of generation discharge during a flood event.

9.5.16 Loch Ness spans from Fort Augustus to the Bonnar Narrows at Lochend where it becomes Loch Dochfour. At the downstream end of Loch Dochfour, the watercourse splits with the Caledonian Canal continuing east towards Dochgarroch and the River Ness passing over the Ness Weir and flowing parallel to the canal towards Inverness. The weir was constructed during the works to construct the Caledonian Canal and effectively controls the level of Loch Dochfour and subsequently Loch Ness. During low flows the level of Loch Ness and Loch Dochfour are equal, but when discharges from Dochfour over the weir exceed 200 m^3/s the Bonnar Narrows become a control point and the level of Loch Ness rises quicker than Loch Dochfour. This is shown in the rating curve for Loch Dochfour, as shown above in Insert 9.2.

9.5.17 In addition to generation discharge, spill from the Headpond and scour discharge will result in potentially increased flows from the Spillway Outlet. These flows are however low and do not have a material impact on flood risk from Loch Ness.

Discharge under Normal Operating Conditions

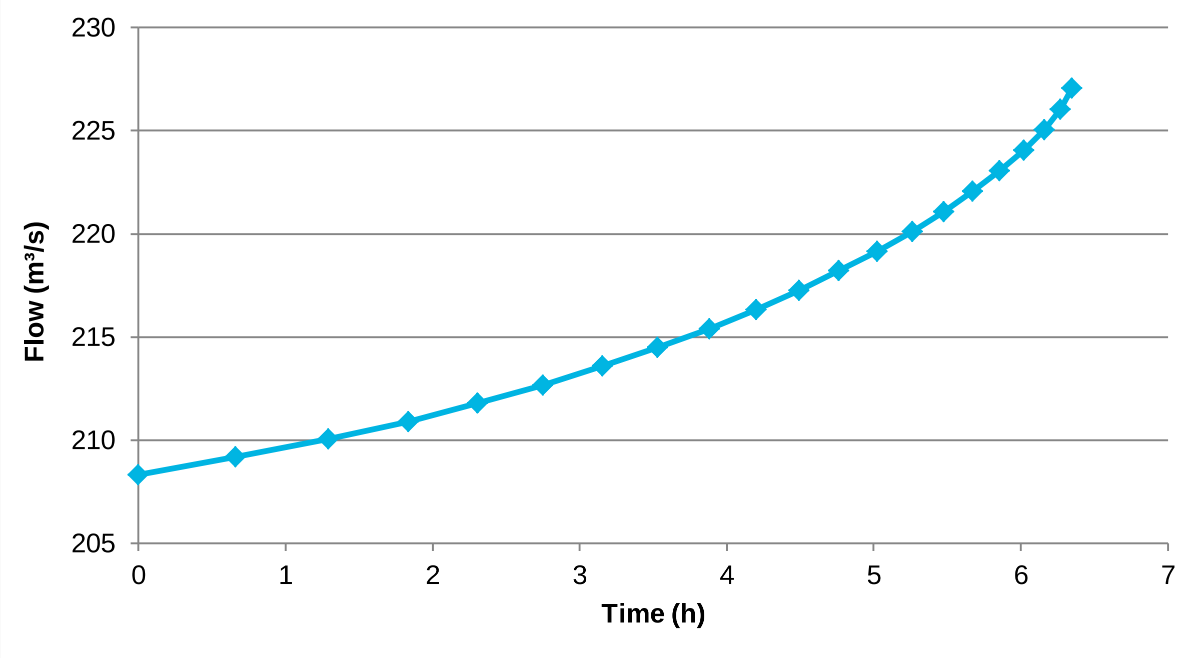
9.5.18 The normal generation discharge was investigated for ‘day to day’ low flows entering Loch Ness from its catchment, and for flood conditions.

9.5.19 For the purpose of assessing the maximum potential impact a full discharge cycle is assumed. The operational discharge rates over a full cycle are summarised in Insert 9.2.

Hydrodynamic modelling of discharge into Loch Ness

9.5.20 Flood Modeller was used to set up 1-D models to route catchment and generation inflows into Loch Ness and downstream to Loch Dochfour and over the Ness Weir. The low flows condition was first investigated with one storage node representing the combined storage of Loch Ness and Loch Dochfour, and secondly the storm conditions where the lochs are expected to split in level.

9.5.21 The normal operation discharge profile is shown in Insert 9.3 and a further detail in Chapter 2: Project and Site Description (Volume 2). The discharge profile represents the flows necessary for a constant power generation as the water level in the Headpond reduces from top water level down to a bottom water level, at which point generation ceases. This flow profile was routed into the Loch Ness storage node.



Insert 9.3 Operational discharge (full cycle)

<u>**Operational Discharge During Low Loch Levels**</u>

9.5.22 The Q90, Q50 and Q10 events were modelled and were input in to Loch Ness within the routing model as a constant flow rate. These are the flows which are exceeded 90 %, 50 % or 10 % of the time during the course of a year. The Q90 is, therefore, a very low flow and the Q10 relatively high. Annual averages for each low flow event were obtained from the National River Flow Achieve (NFRA) (Ref 7). The results of the low flows modelling are presented in Table 9.3.

9.5.23 Initial conditions were established by running the model with the catchment inflows alone and the operational discharge set to zero.

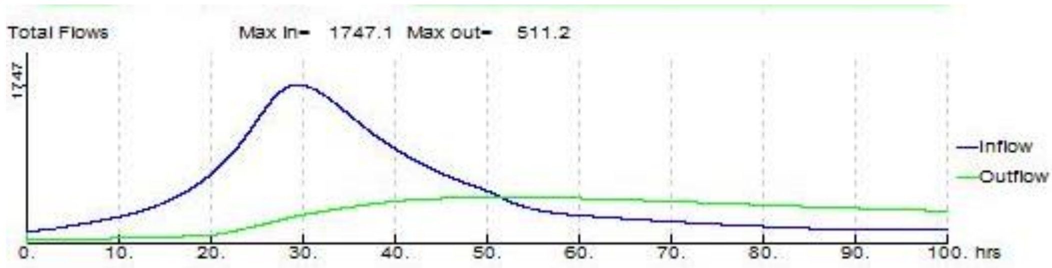
Table 9.3 Effect of the Development discharge during low flow conditions

Event	Catchment Inflow (m³/s)	Peak Outflow at Ness Weir (m³/s)	Max Stage at Ness Weir (m AOD)	Change in level (mm) at Loch Ness
Q90	14.22	14.924	15.361	81
Q50	44.21	59.268	15.714	78
Q10	159.1	165.317	16.214	79

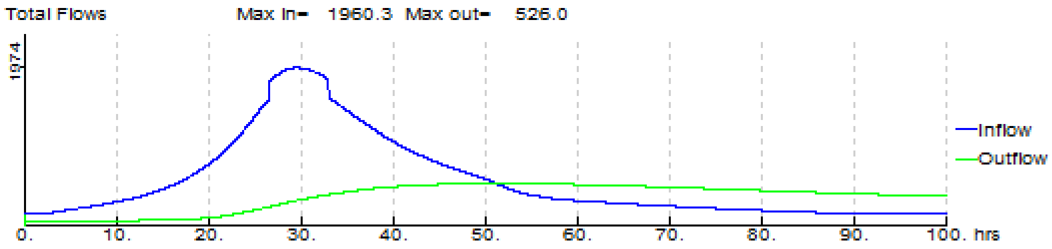
Operational Discharge during Storm Flows

9.5.24 The effect of the discharge from the Development on Ness Weir conditions during return period flood conditions was also investigated. The 1 in 10 year return period rainfall event was simulated by replacing the hydrograph node with a ReFH2 (Revitalised Rainfall-Runoff) node which was used to generate the 1 in 10 year inflow hydrograph. The ReFH2 node model allows hydrographs and peak flows to be generated. The River Ness Flood Protection Scheme hydraulic modelling assessment concluded that flows in the region of 500-600 cumecs were sufficient to cause flooding downstream of the Ness Weir. The critical 48.5

hour duration was selected for the 1 in 10 year storm. The hydrograph is shown in Insert 9.4. The Development discharge was released to coincide with the peak of the hydrograph at 26.5 hours. The effect of the discharge on the inflow hydrograph can be seen in Insert 9.5



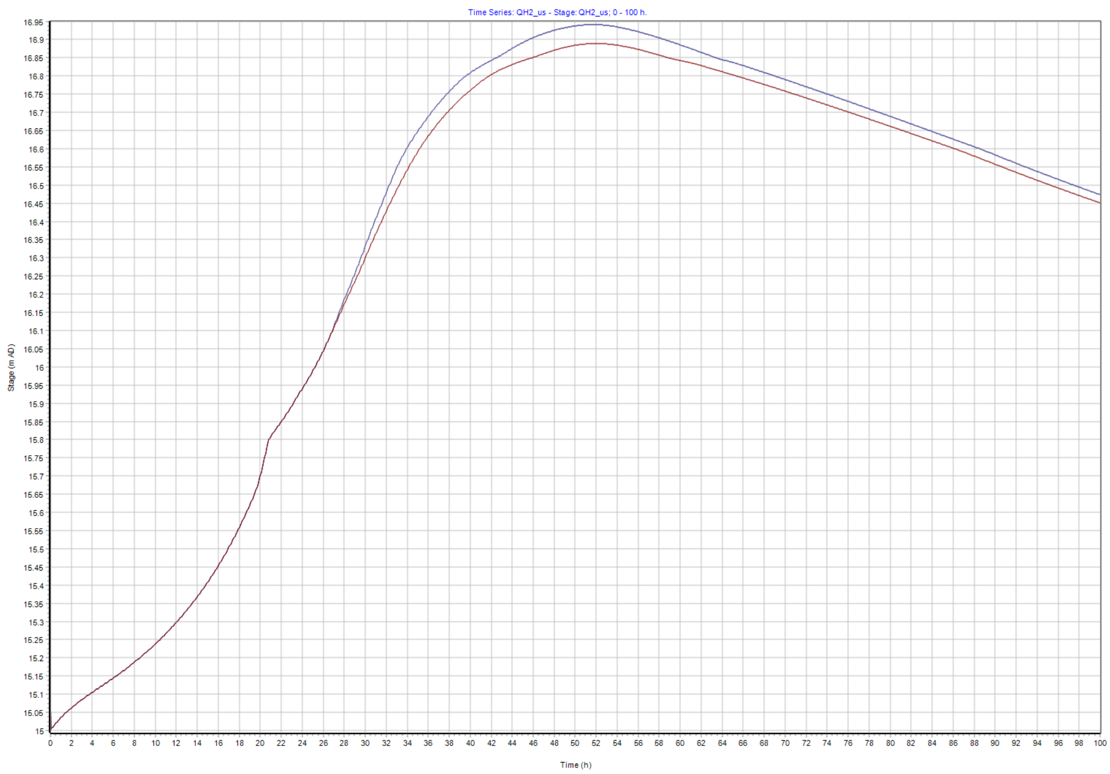
Insert 9.4 1 in 10 Year Inflow Hydrograph



Insert 9.5 1 in 10 Year Inflow Hydrograph Including Development Discharge

9.5.25 Insert 9.4 and Insert 9.7 illustrate respectively the change in flow and stage of the waters at Ness Weir during the baseline event including only 1 in 10 year flood flows, and generation event where the Development is discharging during the 1 in 10 year event.

Insert 9.6 Change in Flow Over Ness Weir During Generation (Baseline = Pink; Generation = Red)



Insert 9.7 Change in stage at Ness Weir during generation (Baseline = Brown; Generation = Blue)

Table 9.4 Conditions at Ness Weir with and Without Development Operation

Scenario	Stage (m)	Flows (m^3/s)
Baseline	16.89	511
Full Generation cycle	16.94	526
Difference	0.05	15

Discharge from Headpond Overflow and Scour

9.5.26 The Development includes an overflow from the Headpond into Loch Ness. The spill flows are small relative to the overall inflows into Loch Ness. Confidential Annex 9.1.1 assesses the flood lift in the Headpond and the risk of overtopping. Flood routing modelling calculated the discharge rate in the Probable Maximum Precipitation (PMP) event to be 10 m^3/s. The scour rate has been estimated to be approximately 11.8 m^3/s. Both the PMP and scour equate to less than 0.1 % of the inflow into Loch Ness during such an event. Therefore, the overflow and scour from the Headpond does not have a material impact on flood risk downstream and therefore has a negligible impact.

Risk of Development from Existing Reservoirs

9.5.27 SEPA published a Reservoirs flood risk map to show the largest area which would be flooded in the event of existing reservoir failure. From the map it can be seen that the Development Site itself (with the exception of the proposed Inlet / Outlet Screen) is not currently in an area which would be at risk of flooding in such an event but that there are significant local areas which are considered to be at risk in the unlikely event of reservoir failure.

9.5.28 Interrogation of the online map reveals that there are currently ten potential sources of reservoir flood risk in the vicinity of the site, with varying degrees of downstream influence. The reservoirs are as follows:

- **Cluanie Reservoir:** Hydro-electric reservoir operated by SSE located upstream of Loch Ness. Maximum Cubic Capacity of Reservoir at Top Water Level 203,000,000 m^3.
- **Quoich Reservoir:** Hydro-electric reservoir operated by SSE located upstream of Loch Ness. Maximum Cubic Capacity of Reservoir at Top Water Level 382,000,000 m^3.
- **Invergarry Reservoir:** Hydro-electric reservoir operated by SSE located upstream of Loch Ness. Maximum Cubic Capacity of Reservoir at Top Water Level 38,000,000m^3.
- **Loch a' Chrathaich :** Hydro-electric reservoir operated by SSE located upstream of Loch Ness. Maximum Cubic Capacity of Reservoir at Top Water Level 2,700,000 m^3.
- **Loch ma Stac Reservoir:** Hydro-electric reservoir operated by SSE located upstream of Loch Ness. Maximum Cubic Capacity of Reservoir at Top Water Level 3,500,000 m^3.
- **Loyne Reservoir:** Hydro-electric reservoir operated by SSE located upstream of Loch Ness. Maximum Cubic Capacity of Reservoir at Top Water Level 45,500,000 m^3.
- **Loch Dundreggan:** Hydro-electric reservoir operated by SSE located upstream of Loch Ness. Maximum Cubic Capacity of Reservoir at Top Water Level 1,640,000 m^3.
- **Loch Mhor:** Hydro-electric reservoir operated by SSE located upstream of Loch Ness. Maximum Cubic Capacity of Reservoir at Top Water Level 14,500,000 m^3.

- **Bhlaraidh Reservoir:** Hydro-electric reservoir operated by SSE located upstream of Loch Ness. Maximum Cubic Capacity of Reservoir at Top Water Level 300,000 m^3.
- **Liath Reservoir:** Hydro-electric reservoir operated by SSE located upstream of Loch Ness. Maximum Cubic Capacity of Reservoir at Top Water Level 1,620,000 m^3.
- **Loch Oich:** Raised natural reservoir that feeds the Caledonian Canal. Operated by Scottish Canals. Cubic Capacity of Reservoir at Top Water Level 25,000,000 m^3.
- **Loch Ashie**: Raw water supply for the Inverness WTW. Operated by Scottish Water. Cubic Capacity of Reservoir at Top Water Level 2,727,000 m^3. Loch Ashie falls to the east of the proposed Headpond. The proposed development is not at risk in the event of a breach. However, the reservoir could fall within a cascade in the event of a breach form the proposed Headpond.

9.5.29 There is negligible risk of flooding from these reservoirs impacting on the safety of the Development. Although the Inlet / Outlet Screen may be at risk in the event of flooding from the upstream reservoirs feeding into Loch Ness the likelihood of such an event is considered unlikely and would not impact on the safe operation of the Development.

9.5.30 The risk of existing reservoir flooding to the Development is considered low and acceptable.

Risk of Development from the Headpond

9.5.31 The Development will include the creation of a new Headpond. As this structure will impound a significant volume of water, there is an inherent risk of flooding associated with it. However, the probability of flooding from such as Headpond occurring is considered extremely low due to the high standard of design, management, and maintenance required under law (Ref 4) and provided by any responsible operator.

9.5.32 This section details the assessments which have been made to determine the risk associated with the Headpond and its associated Embankment, and to provide a balanced assessment of the flood risk associated with the Development.

Reservoirs (Scotland) Act 2011

9.5.33 The Reservoirs (Scotland) Act 2011 applies to reservoirs that hold more than 25,000 m^3 of water. When fully implemented, the Floods and Water Management Act 2010 will update the Reservoirs (Scotland) Act 2011 by reducing the capacity beyond which a reservoir will be regulated to 10,000 m^3.

9.5.34 This act sets out a legal framework with regards to responsibilities and requirements for inspection and maintenance of reservoirs, in order to ensure the risk presented by such structures is acceptable.

9.5.35 Under The Act reservoir owners have ultimate responsibility for the safety of reservoirs. Reservoir owners must appoint a Panel Engineer to supervise the design and construction of the reservoir and to supervise inspection and maintenance of the reservoir, which is the Headpond for this Development.

9.5.36 The Headpond will be of a volume by which it is regulated under the Reservoirs (Scotland) Act 2011. The proposed Embankments will be designed in accordance with the requirements of the Act. When in operation, inspection and maintenance will be undertaken in accordance with the requirements of the Act. An assessment of the areas at risk from the Headpond indicates it would be categorised as Category A reservoir and therefore would be subject to the most stringent design standard with the capability to convey safely the Probable Maximum Flood (PMF) as a design flood.

9.5.37 Design, inspection and maintenance in accordance with the legislative framework of the Reservoirs (Scotland) Act 2011 will ensure that the risk of failure of the proposed Headpond remains low throughout its working life.

Wave Action

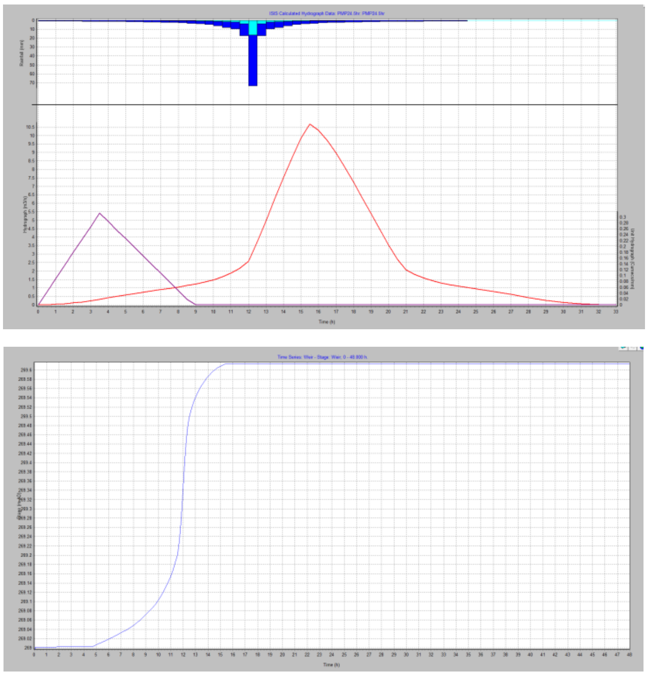
9.5.38 Consideration will be given to the potential effects of wave action upon the Headpond and its Embankment. If unmitigated, significant wave action due to wind can cause damage to the Embankment wall, particularly the top of the Embankment, and potential overtopping if the water level is high enough.

9.5.39 The design freeboard within the Headpond mitigates the potential for wave action on the Embankment top and potential overtopping by waves, by ensuring water levels are below the top level of the Embankment. The normal top water level in the Headpond will be 4m below the Embankment top.

9.5.40 The top of the Embankment is also to have a wave wall to dissipate the energy of any waves which reach the Embankment top.

Risk of Overtopping

9.5.41 A routing model of the Headpond has been undertaken based on PMP condition to determine the critical flood lift for various durations. The 24 hour event with a design rainfall depth of 245 mm routed through the Headpond was shown to be the critical condition. The flood lift was calculated to be approximately 0.5 m resulting in a peak water level of approximately 269.5 m AOD. This has a freeboard of approximately 3.5 m freeboard below the embankment top level of 273 m AOD.



Insert 9.8 PMP flood lift at the Headpond

9.5.42 The risk of the Headpond overtopping and resulting in flood risk is considered low and acceptable.

Breach Analysis and Flood Routing

9.5.43 A breach analysis was undertaken due to the proximity of human receptors (Confidential Annex 9.1.1, Volume 6). During consultation with Scottish Water it was identified that the need for a breach analysis of the Headpond was also required based on the risk to the Scottish Water assets immediately downstream. Upon review of the potential breach scenarios it was identified that two potential breach locations should be investigated; a breach of the northern Embankment into the Loch Ashie catchment and a breach of the western Embankment into the Loch Ness catchment. Due to the local topography and the fact that no raised embankment holds water levels above the spill level into the Loch Duntelchaig catchment spill into the Duntelchaig catchment has not been considered.

9.5.44 In the unlikely event of a breach of the Headpond at the northern and western sections of the Embankment, significant areas are at risk of inundation. However, a combination of the spread of these flows over a large area and attenuation provided by the local topography reduce the impact during a breach. The methodology set out by DEFRA in the Guide to risk assessment for reservoir safety management was followed to assess the fatality rate and hence the risk posed from the Headpond.

9.5.45 Based on the estimated annual probability of failure of the embankments the fatality rates are classed as being within a ‘Broadly Acceptable’ number. The likelihood of such an event is extremely low.

Pluvial Flooding

9.5.46 Due to the steeply graded and semi-impermeable nature of the Development Site and surrounding area, it should be expected that local storm events produce rapid surface water run-off. The addition of hardstanding areas and new tracks, as part of the Development, also has the potential to change natural flow paths and increase surface water run-off from these areas. It is also recognised that during the winter, surface water run-off could be increased by melting snow.

9.5.47 This will need to be considered in the planning of an effective drainage strategy for the Development’s developed areas such as the permanent Compounds, permanent access tracks and around the above ground buildings. Without appropriate design, there is a significant risk that this will cause an unacceptable flow of surface water through the Development Site (adversely affecting the Development), off-site (adversely affecting areas outside of the Development Site) and potential ponding in lower areas.

9.5.48 Overland flow paths from permeable and impermeable areas outside of those areas which are to be formally developed must be considered when planning the layout of the Development and capacity of the proposed surface water drainage systems. Landscaping and drainage of the site should be designed to intercept and dispose of any run-off which will mitigate any increase in risk to on-site or off-site areas from this source of flooding.

9.5.49 It is envisaged that the use of SuDS components would be the most appropriate method of providing interception of overland flows whilst ensuring flows are conveyed in a controlled manner which mimics the natural response of the area.

9.5.50 Threshold levels of any proposed buildings should be located 150 mm above external ground levels to ensure any excess pluvial flows cannot enter properties.

9.5.51 Assuming design in accordance with the above, the risk of flooding on-site and off-site from pluvial flooding is considered to be low and acceptable.

Groundwater Flooding

9.5.52 No groundwater flooding has been reported as being experienced at the Development Site.

Below Ground Infrastructure

9.5.53 The groundwater flows in the sub-surface may potentially affect the below ground infrastructure such as that within the Power Cavern and Tunnels.

9.5.54 Potential groundwater flows will be considered in the design of the below ground infrastructure and appropriate lining and / or drainage provided to ensure the inflow does not pose a risk to users of the below ground areas during construction and operation.

9.5.55 It is currently proposed that a pumped system will serve the below ground areas of the Power Cavern complex to ensure that any groundwater inflows do not cause flooding. In the event of failure of the pumping system groundwater inflows could pose a flood risk to the below ground area. Any pumping system will be a fundamental part of the overall operation and is expected to be linked by telemetry to the control room, to warn of high levels / pump failure. Regular inspection and maintenance should ensure the pumped systems remains in a suitable condition, thereby mitigating the risk of this area becoming flooded.

9.5.56 Based on the above, the risk to the below ground areas being inundated is considered to be low and acceptable.

Flooding from Surface Water Drainage

9.5.57 The Development may increase the impermeable areas on-site. Additionally, a predicted increase in rainfall intensity by 20 % over the lifetime of the development is likely to increase surface water run-off from the Development Site over its lifetime.

9.5.58 In addition to proposed impermeable areas, the surface water drainage system will also need to consider potential pluvial flows from within and outside the site and any expected groundwater flows above ground. The design must be particularly robust in the provision of drainage to areas for which the consequences of surface water inundation would be greater, such as locations where flows could enter below ground infrastructure.

9.5.59 Surface water drains for the Development will be designed to SEPA regulatory method on SuDS (Ref 9), The Highland Council Supplementary Guidance (Ref 5) and in accordance with other current good practice and legislation. It was demonstrated in Section 9.4 that safe discharge of surface water is possible, with the implementation of SuDS where practicable.

9.5.60 The volume and location of surface water attenuation storage needs to be carefully assessed at the detailed design stage. If proposals for storage above ground are introduced, careful consideration needs to be given to protecting buildings from flooding by the use of appropriate containment and appropriate landscaping across the Development Site. Consideration also needs to be given to suitable access and egress routes from the areas to be used to accommodate flood storage. These details should be agreed with the THC and SEPA before construction takes place.

9.5.61 Assuming that the drainage system will be designed and constructed to these standards, the risk of flooding on-site and off-site from surface water drains is considered to be low and acceptable.

9.5.62 A residual risk remains from blockage of the drainage system or exceedance of its capacity. Mitigation, as described in Section 9.6 reduces the impact of these risks further.

Flooding from Foul Drains and Sewers

Existing Foul Drainage

9.5.63 No existing drainage in the area, except from that which may serve the residential house with the development.

Proposed Foul Drainage

9.5.64 Foul wastewater may be discharged to the public sewerage infrastructure off-site, or stored temporarily on-site in a cesspit for appropriate disposal.

9.5.65 Any system for disposal to the public sewer will be designed in accordance with the requirements of SW to ensure that there is no detrimental impact on the existing public sewer system. The drainage designer should undertake a more detailed assessment of the foul drainage requirements and agree on the allowable foul discharges with SW at the detailed design stage.

9.5.66 Foul drains for the Development will be designed in accordance with SW. Assuming that the drainage system will be designed and constructed to these standards; the risk of flooding on-site and off-site from foul drains is considered to be low and acceptable.

9.5.67 A residual risk remains from blockage of the drainage system or exceedance of its capacity. Mitigation, as described in Section 9.6 reduces the impact of these risks further.

9.6 Mitigation Measures

9.6.1 This section demonstrates that it is possible to mitigate the flood risks identified in Section 9.5. The mitigation measures outlined below are designed to protect both the people and property on-site and off-site from the effects of flooding.

Operational Regime

9.6.2 An effective operational regime is required to ensure the Development continues to operate effectively whilst ensuring that flood risk is not increased elsewhere.

9.6.3 Whilst extensive areas next to the River Ness in Inverness benefit from an increased standard of flood protection as a result of the recent River Ness Flood Protection Scheme, properties further upstream remain at risk during lower return period events. Properties are shown to be at risk during events between the 1 in 10 year and the 1 in 25 year event based on current conditions.

9.6.4 Any increase in flood flows in the River Ness during extreme flood events will exacerbate the flood risk. In order to avoid such increase discharge into Loch Ness should be limited to periods when water levels are below the current 1 in 10 year flood level. This equates to 17.2 m AOD at Loch Dochfour and 17.6 m AOD at Loch Ness.

9.6.5 Setting the operational regime based on water levels will ensure that it is robust and is resilient to climate change.

Emergency Planning

9.6.6 Although it has been demonstrated that the flood risk from the Headpond and its associated Embankment will be low, effective local emergency planning will need to be implemented to ensure an appropriate response in the unlikely event of a failure. An appropriate emergency plan will be developed in conjunction with the SEPA and THC to ensure that an effective and coordinated response to any emergency can be implemented to further mitigate the potential consequences of such an event.

Residual Risk of Flooding from On-Site Drainage Systems

9.6.7 There is a residual risk of flooding from blockage of the proposed drainage systems, including any SuDS components, if poorly maintained. Regular inspection and maintenance should be undertaken to ensure drainage infrastructure, including SuDS, remains in a suitable condition.

9.6.8 There is a residual risk of flooding to the Developments buildings if the capacity of the surface water drainage system is exceeded. Finished floor levels for buildings on the Development could be located at least 150 mm above external ground levels in accordance with standard practice, to ensure any such flows cannot enter buildings.

9.6.9 Assuming implementation of the above, the residual risk of flooding from the proposed drainage systems is therefore considered to be low and acceptable.

9.7 Conclusion and Recommendations

Conclusions

9.7.1 The FRA has assessed the flood risk and consequences associated with the Development.

9.7.2 All the potential sources of flooding to the Development have been considered, including sea, river, groundwater, land drainage, overland flow, artificial sources, water mains and foul and surface water drainage arrangements. In accordance with the requirements of SW, a detailed analysis of the risk of a breach has been undertaken as part of the assessment. Climate change has also been considered, which is expected to increase the peak rainfall intensity by up to 30 % and peak river flow by up to 20 % over the lifetime of the Development in line with River Ness Flood Protection Scheme.

9.7.3 With the exception of the Tailpond Inlet / Outlet at Loch Ness, the SEPA flood maps show that Development is located in area of low flood risk. The FRA has demonstrated that the risk of the Development increasing fluvial flooding locally is considered to be low and acceptable with the implementation of the operational regime set out based on a peak water level for discharge.

9.7.4 In the unlikely event of a breach of the Headpond at the northern and western sections of the Embankment, significant areas are at risk of inundation. However, a combination of the spread of these flows over a large area and attenuation provided by the local topography reduce the impact during a breach. The methodology set out by DEFRA in the Guide to risk assessment for reservoir safety management was followed to assess the fatality rate and hence the risk posed from the proposed Headpond. Based on the estimated annual probability of failure of the embankments the fatality rates are classed as being within a 'Broad Acceptable' number. The likelihood of such an event is extremely low.

9.7.5 The report has demonstrated that disposal of foul and surface water from the Development is possible provided any proposed systems are designed and managed appropriately. Any detailed drainage design for the Development should be developed in accordance with the recommendations of the FRA, and the proposed drainage arrangements agreed in full in advance of construction with THC, Scottish Water and SEPA as necessary. Additionally, wherever possible the development will use SuDS to manage surface water run-off. The suitability of the Development for the use of SuDS should be determined fully from the results of site investigations and infiltration testing at the detailed design stage. The maximum discharge rates to watercourses from surface water systems, and any required attenuation volumes should be discussed with and agreed in full with the SEPA at the detailed design stage.

9.7.6 The report demonstrates that it is possible to mitigate the identified risks through the application of appropriate design principles at the detailed design stage and appropriate system management principles in operation. The mitigation measures outlined within this report are designed to protect the users of the Development, the Development itself, and off-site properties from the effects of flooding.

9.7.7 The report has set out the guiding principles by which the design will be undertaken to ensure that there is no unacceptable increase in flood risk from the Development. The FRA is based on the available information at the time of writing and should be revisited at the detailed design stage, taking into account any further information on site conditions, drainage, or iterations of the design to ensure all flood risks have been adequately mitigated in the final design.

Recommendations

9.7.8 It is recommended that the following are incorporated or considered in the design for the Development to ensure that it is subject to a low and acceptable risk of flooding:

- Attenuation of surface water flows may be required. Discharge limits and locations to be discussed and agreed in full with THC at detailed design, and appropriate storage to be provided within drainage design if necessary.
- Storage, to account for attenuated surface water, should be accommodated within the drainage system either below ground or informal above ground systems for the 1 in 30 year storm event with an allowance for climate change. In excess of this up to the 1 in 200 year plus climate change event, surface water should be stored in controlled areas such as car parks and landscaped features to ensure the residential buildings do not flood. Use of the reservoirs for storage may be acceptable.
- The drainage strategy for the Development should incorporate SuDS where practicable.
- The surface water drainage design should consider the potential for overland flow from outside of the site and any groundwater flows which are expected to break ground.
- Landscaping and drainage of the site should be designed to route flood flows away from the proposed buildings, towards the less vulnerable open areas or to drainage systems.
- Finished floor levels on the Development could be located 150 mm above external ground levels in accordance with standard practice, to ensure residual flows cannot enter buildings.
- Regular inspection and maintenance of drainage systems should be undertaken during operation of the site.
- FRA to be revisited at the detailed design stage to ensure all available information is taken into account and further mitigation included if necessary.

9.8 References

Ref 1. CIRIA, (2007) The SuDS Manual (C753).

Ref 2. Guidance to Flood Risk assessments: climate change allowances. (2016) -Department for Environment, Food and Rural Affairs (Defra).

Ref 3. UK Climate Projections (UKCP09) website. [Online]. Available: http://ukclimateprojections.metoffice.gov.uk/21678 Accessed 01/10/2018.

Ref 4. Reservoir (Scotland) Act, 2011, Scottish Government.

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