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Balliemeanoch Pumped Storage Hydro

Environmental Impact Assessment Report

Volume 5: Appendices
Appendix 12.2: Flood Risk Assessment

ILI (Borders PSH) Ltd

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Quality information

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Revision History

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1	July 2024	Submission	DL	David Lee	Technical Director

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1 Introduction

1.1 Objectives

This report presents the finding of the Flood Risk Assessment (FRA) for a proposed 1500 MW pumped storage hydro scheme (hereafter referred to as “the Development”). The Development is described in *Chapter 2: Project and Site Description,* of this EIAR *(Volume 2: Main Report)*. The above-ground elements of the Development consist of buildings and Access Tracks located on the eastern side of Loch Awe, near Balliemeanoch, as well as an intake structure on the bank of the Loch. The Site location is shown in *Figure 1.1 Location Plan (Volume 3: Figures)*.

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.

1.2 Sources of data

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

- Site information and development proposals;
- Scottish Environment Protection Agency (SEPA) flood risk mapping[1];
- Ordnance Survey (OS) mapping; and
- Loch Awe Water Levels – Drax Ltd.;
- The FRA for the proposed expansion of the Cruachan PSH scheme.

1.3 Flood risk terminology

In this document, 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 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. There is a 1 in 200 (0.5 %) chance of one or more 1 in 200-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. Sources constitute flood hazards, which are anything with the potential to cause harm through flooding e.g. rainfall, extreme sea levels, and river flows. 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.

[1] https://www.sepa.org.uk/environment/water/flooding/flood-maps/

2 Legislation, Policy and Guidance

2.1 National Planning Policy

This assessment is based upon the planning advice set out in the National Planning Framework 4[2].

"*Policy 22*

i. *Development proposals at risk of flooding or in a flood risk area will only be supported if they are for:*
   - *essential infrastructure where the location is required for operational reasons;*
   - *water compatible uses;*
   - *redevelopment of an existing building or site for an equal or less vulnerable use; or.*
   - *redevelopment of previously used sites in built up areas where the LDP has identified a need to bring these into positive use and where proposals demonstrate that long term safety and resilience can be secured in accordance with relevant SEPA advice.*

ii. *In such cases, it will be demonstrated by the applicant that:*
   – *all risks of flooding are understood and addressed;*
   – *there is no reduction in floodplain capacity, increased risk for others, or a need for future flood protection schemes;*
   – *the development remains safe and operational during floods;*
   – *flood resistant and resilient materials and construction methods are used; and*
   – *future adaptations can be made to accommodate the effects of climate change.*

c) *Development proposals will:*
   i. *not increase the risk of surface water flooding to others, or itself be at risk.*
   ii. *manage all rain and surface water through sustainable urban drainage systems (SUDS), which should form part of and integrate with proposed and existing blue green infrastructure. All proposals should presume no surface water connection to the combined sewer;*
   iii. *seek to minimise the area of impermeable surface.*

The National Planning Framework 4 defines the flood risk area as the area with an annual probability of being flooded greater than 0.5%, including an appropriate allowance for climate change.

2.2 Local Policy

The Argyll and Bute Local Development Plan 2 contains policies relevant to flooding as outlined below.

Policy 55 - Flooding

Development on the functional flood plain (land with greater than 0.5% (1 in 200) probability of flooding in any year) will be considered contrary to the objectives of this plan, except in the limited circumstances set out in part c) of this policy. Development elsewhere will be subject to assessment as set out in parts a) and b) of this policy, as relevant. Where redevelopment of existing sites within built up areas at risk from flooding is proposed, the planning authority will take into account the impact on flood risk elsewhere and the resilience and adaptation measures proposed. In all cases development proposals will be subject to assessment using Flood Risk Management Plan: Highland and Argyll Local Plan District; Flood Risk Management Plan: Clyde and Loch Lomond Local Plan District; and The River Basin Management Plan for Scotland 2021-2017 (see LDP2 T16 Technical Working Note: Flood Risk Framework).

The type of development that will be generally permissible taking into account the probability of flooding is set out below. However, it should be noted that in all cases where the potential for flooding is highlighted, the planning authority will exercise the 'precautionary principle' and refuse development proposals where such proposals do not comply with parts a), b), c) or d) of this policy and/or on the advice of the Scottish Environment Protection Agency (SEPA).

[2] Scottish Government, 2023, *National Planning Framework 4*. Available as: https://www.gov.scot/publications/national-planning-framework-4/

a) All types of development within areas with a probability of flooding of less than 1:1000 annual probability of flooding are acceptable in terms of this policy unless local circumstances and/or the nature of the development dictate otherwise;

b) All types of development, excluding essential civil infrastructure, within areas with a probability of flooding between 1:1000 and less than 1:200 annual probability of flooding are acceptable in terms of this policy unless local circumstances dictate otherwise;

c) Within flood risk areas (1:200 or greater annual probability of flooding) only those categories of development indicated in criteria i), ii) or iii) of this policy may be acceptable.

> *i) Redevelopment of residential, commercial and industrial development and which are of an equally or less vulnerable use within built-up areas providing flood prevention measures to a 1:200 year plus climate change standard already exist or are under construction. Water resistant materials/ construction together with a suitable freeboard allowance as appropriate;*
>
> *ii) Development on undeveloped and sparsely developed areas within the functional flood plain and compromising:*
>
>> *• Essential development such as navigation and water based recreation use and essential transport and some utilities infrastructure; and an alternative lower risk location is not achievable;*
>>
>> *• Essential infrastructure which should be designed and constructed to remain operational during floods;*
>>
>> *• Certain water compatible recreational, sport, amenity and nature conservation uses providing adequate evacuation procedures are in place.*
>
> *iii) Development, which is in accord with flood prevention or management measures as specified in association with a Local Development Plan 2 Allocation or development brief.*

d) All development proposals at risk of flooding or in a flood risk area shall demonstrate that:

> *i) All risks of flooding are understood and addressed;*
>
> *ii) There is no reduction in floodplain capacity, increased risk for others, or a need for future flood protection schemes;*
>
> *iii) The development would remain safe and operational during floods;*
>
> *iv) Flood resistant and resilient materials and construction methods are used, and*
>
> *v) Future adaptations can be made to accommodate the effects of climate change.*

Policy 61 – Sustainable Drainage Systems (SUDS)

Where appropriate developers should incorporate existing ponds, watercourses or wetlands as positive environmental features in development schemes. The Council will also require that canalisation or culverting, which can increase the risk of flooding and also greatly reduce the ecological and amenity value of watercourses are avoided wherever practicable and designed sensitively where unavoidable. Sustainable Drainage Systems (SUDS) (see Glossary) provide benefits in terms of flood avoidance, water quality, habitat creation and amenity. Development proposals will manage all rain and surface water through sustainable urban drainage systems (SUDS), which should form part of and integrate with proposed and existing blue-green infrastructure. All SUDS features should be in accordance with the Principles of The SUDS Manual (C753).

Policy 62 – Drainage Impact Assessments

The Council will require developers to demonstrate that all development proposals incorporate proposals for SUDS measures in accordance with technical guidance. Developers will be required to submit a Drainage Impact Assessment (DIA) with the following categories of development: • Development of six or more new dwelling houses; • Non-householder extensions measuring 100 square metres or more; AND, • Other non-householder developments involving new buildings, significant hard standing areas or alterations to landform. Developments excluded from the above three categories might also require a DIA when affecting sensitive areas such as areas affected by flooding, contamination or wildlife interest. In all cases the Council will encourage the use of sustainable options for waste and surface water drainage.

2.3 SEPA Guidance

SEPA has published guidance documents to provide planning advice related to flood risk. These guidance documents are currently being reviewed and updated in response to the National Planning Framework 4. As a result, this information - while useful - is potentially out of date.

SEPA's Land Use Vulnerability Guidance[3] classifies developments into five classes - Most Vulnerable, Highly Vulnerable, Least Vulnerable, Essential Infrastructure and Water Compatible - based on the recognition that the damages and knock-on effects from flooding will vary between land uses. Following this guidance, the Development into the category of **essential infrastructure.** Following the National Planning Framework 4, essential infrastructure may be located in a flood risk area if required for operational reasons, provided the risks of flooding to the site are assessed and no additional flood risk to others is generated.

The modelling approach in this FRA is in line with SEPA's *Modelling Guidance for Responsible Authorities*.

[3] SEPA, 2018, *Flood Risk and Land Use Vulnerability Guidance*. Available at: https://www.sepa.org.uk/media/143416/land-use-vulnerability-guidance.pdf

3 Site Description

The Development site is a pumped storage hydro proposed within the bounds of Argyll and Bute council. The site area expands from the southern border of Loch Awe along the A85, east, to Inveraray by the construction of a new wharf to the northwestern side of Loch Fyne.

3.1 Proposed development

The proposed Development is a 1.5 GW hydro scheme that utilises Loch Awe as it's lower reservoir and to instate a headpond to be used as the upper reservoir. The study area of the Development is reliant on the location of the Development, and subsequent construction of new infrastructure.

A brief outline of the proposed infrastructure (above and below), is described below:

- An inlet/outlet structure (tailpond) to Loch Awe at Balliemeanoch
- The Headpond, higher reservoir located in proximity of Loch Airigh
- New Access Tracks extending from the Tailpond to the top of the Headpond at Glenbrantar Forest,
- Tunnels will be constructed below ground, to transport water (for abstraction and generation purposes),
- Temporary construction areas.

Please see Chapter 2: Project and Site Description (Volume 2 Main Report) for further details on the Development.

3.2 Topography

A full topological assessment of the site is outlined in *section 2.2.2* within *Chapter 2: Project and Site Description (Volume 2: Main Report)* of the EIAR. A brief synopsis of the relevant ground elevations of the infrastructure, mentioned above, will be defined. The main Development Site sits from the summit of Cruach na Gearr-choise at 571 mAOD, along the eastern boundary of the Headpond, towards Loch Awe to the west.

The Headpond structure is located at the Lochan Airigh waterbody, with an elevation of 360 mAOD.

The main structure at the Tailpond is at the edge of Loch Awe. This is to be used for abstraction and generation purposes. By its nature it needs to be located next to the waterbody and is water compatible. Higher vulnerability elements will be set at a higher elevation in line with the findings of this study.

3.3 Catchment Area

Loch Awe is a freshwater loch with an expansive water catchment area, spanning approximately 40 km in length. Loch Awe is connected to the River Awe at the northeastern end. An assessment of the catchment area was conducted for the Water Resource Assessment *(Appendix 12.1 (Volume 5: Appendices))*, to assess the baseline environment of Loch Awe. It was calculated that the catchment was 815 km^2 based on an assessment of inflows (gauged and ungauged). The sub-catchments within the wider catchment are expressed in a tabular form below:

Table 0-1 Balliemeanoch Sub-catchments

Gauged/ ungauged catchment	Name	Area (km^2)	Gauged Years
Gauged	Orchy @ Glan Orchy	251.2	47
Gauged	Strae @ Glen Strae	36.2	47
Gauged	Lochy @ Inverlochy	47.7	46
Gauged	Avich @ Barnaline Lodge	32.1	44
Gauged	Abhain a Bhealaich @ Braevallich	24.1	43
Ungauged	Headpond catchment	5.4	N/A
Ungauged	Loch Awe	38.5	N/A
Ungauged	Remainder catchment modelled	380.7	N/A

3.4

3.5 Existing Infrastructure

Loch Awe is dammed by the Awe Barrage which is located on the River Awe (NGR: NN04520 286890), this is operated by Scottish and Southern Electric (SSE). The Barrage is used to feed a small run of river hydroelectric system at the Barrage together with a larger run of river scheme that diverts flows further downstream to the Inverawe Power station.

Loch Awe is also used as the tail water pond for the Cruachan Pump storage Hydro Scheme. In addition, three smaller hydro schemes are located on tributaries into Loch Awe. These are located on the following water courses of; Allt Beaochlich, River Avich and Loch Nant.

Water levels in Loch Awe are controlled by the barrage with target water levels for both the summer and winter months. The target levels are summarised in *Table 3-2*.

Table 3-2. Target water levels

Period	Target minimum (mAOD)	Target maximum (mAOD)
April-November (Summer)	36.27	37.06
December-March (Winter)	35.96	36.57

It is understood that when water level in Loch Awe exceeds a level of 37 mAOD the flood gates are opened. The flood risk assessment has been carried out on the basis of this assumption.

4 Fluvial Flood Risk Assessment

In accordance with flood risk guidance, the flood risk has been assessed for all sources of flooding. Fluvial flood risk is the greatest risk for the Development and downstream areas. Modelling has been used to assess the fluvial flood risk through calculating the peak level in Loch Awe and peak flow at the Loch Awe Barrage.

Model schematisation

Peak water levels in Loch Awe depend upon the maximum inflow into the Loch, from the surrounding catchment area, as well as the outflow from the Loch through the Loch Awe Barrage into the River Awe.

The arm of Loch Awe leading to the Barrage and River Awe is approximately 4 km long. Bathymetry data from a bathymetric survey in 1904 indicates that the channel is over 30 m deep until 2 km upstream of the Barrage. This point was chosen as the upstream extent of the model, assuming a level water surface upstream of this point, represented as a storage area in the model which receives the calculated inflow.

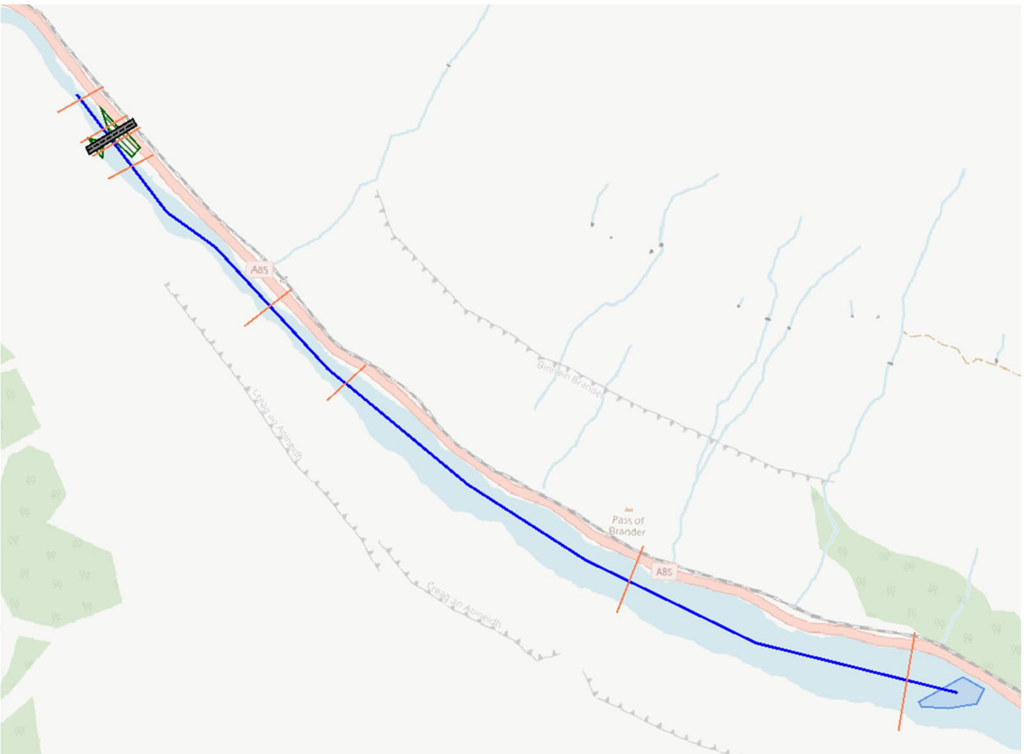

Figure 1: HEC-RAS model geometry.

There are a large number of watercourses flowing into Loch Awe. The largest of these, including the rivers Strae and Orchy have SEPA gauges with several decades of flow recordings. The gauges however are not regarded as being suitable for pooling group analysis. Given the uncertainties of the Loch Awe Barrage dimensions (see below), a minimal and conservative approach to flow estimation for the entire Loch Awe catchment was used.

Inflow estimates were produced from FEH catchment characteristics and the ReFH2 rainfall-runoff model. Inflow calculations were produced using both the ReFH2 model and a WINFAP pooling group analysis. The default pooling group produced flow estimates within 4% of the ReFH estimates for a critical duration of 24 hours.

Storm durations of 24, 48 and 72 hours were checked to determine which gave the highest peak water level at the upstream boundary. 72 hours was the maximum duration modelled due to FEH guidance about applicability of single-peak storm profiles over extended durations. The 72-hour event gave the highest water level. The total volume of flow over the storm event was the major determinant of the peak flood level due to the barrage downstream. The peak flow was less important. Because of the requirement to adjust the critical duration, the ReFH model was used instead of the statistical method to calculate the inflow for the model. The ReFH model was regarded as being a good representation of the catchments based on the correlation between the pooling group and the ReFH model for the critical duration event for the receiving water courses. The model was run for between 3 and 4 days, matching the length of the inflow hydrographs.

SEPA published 'Climate change allowances for flood risk assessment in land use planning' guidance in 2022. The document outlines the approach to climate change uplifts based on geographic location and catchment size. Catchments under 30 km^2 should have uplift applied to peak rainfall, whereas catchments over 50 km^2 should have uplifts applied to peak flow. Catchments in between these values should undertake both assessments and apply the greater of the two. A range of uplifts are provided based on a west/ east split for rainfall and by river basin regions for flow. The Loch Awe catchment is more than 50 km^2 and located in the Argyll Basin Region. On reviewing the guidance, peak flow for the Loch Awe Catchment was uplifted by 59%.

The geometry of the Loch Awe barrage is unknown. Conversations with SSE suggest that the Awe Barrage has two undershot radial flood gates and one overshot freshet gate, however, the geometry of these gates is unknown. For this assessment, the dimensions and levels for the outflow gates were taken from the Flood Risk Assessment Report for the Cruachan expansion[4], which also modelled Loch Awe flood levels. The modelled arrangement here is three gates 9 m wide and 5 m high, with a base invert level of 31 mAOD (modelled as sluices rather than radial or overshot gates due to unknown geometry). These gates are set to open when the water level is 37 m AOD. There is a fourth gate of 3m width and 1.5m height, with an invert of 34.9 mAOD. This gate remains open throughout the simulation. Ineffective flow areas were set for the areas of the barrage cross-section outside of the gate width, to represent flow constriction in the upstream channel. Downstream cross sections and boundary condition were set based on an assumed cross section and slope to allow unconstructed flow from the Barrage.

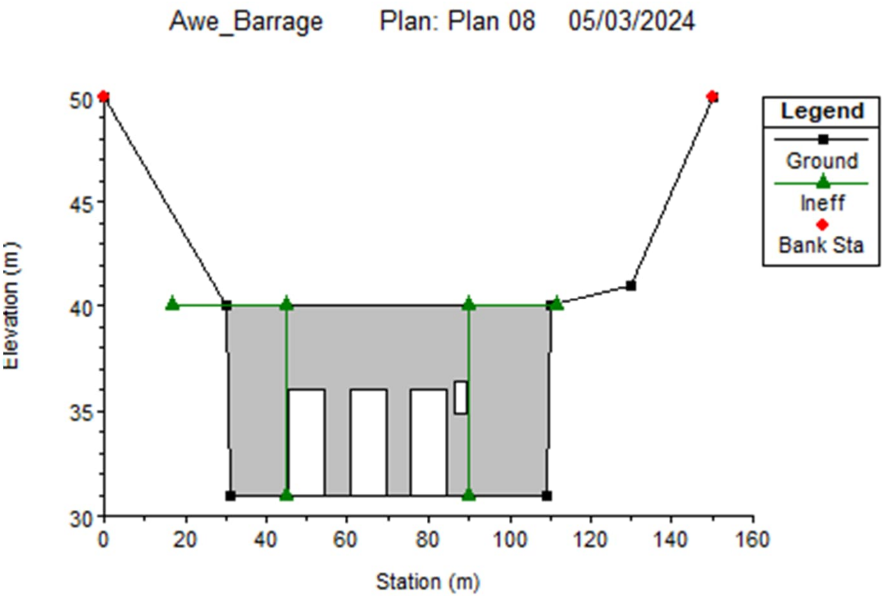

Figure 2: Loch Awe Barrage assumed geometry.

Initial water level in Loch Awe was set at 37 mAOD. The model results are sensitive to the assumed operation of the radial gates, as opening the gates fully at 37 mAOD decreases the water level unless inflows are high enough to match or exceed the outflow from Loch Awe with the gates open. To evaluate the potential additional impact of the Developmemt operation, increasing the water level to the proposed maximum allowed level at the critical time early in the storm event was tested.

The peak water level at the upstream end of the model, corresponding to levels in the main area of Loch Awe, for the 0.5% AEP plus climate change event is 39.8 mAOD.

A sensitivity assessment of the model results was conducted by running two additional scenarios:

- Increase of inflow by 20%
- Reduction of outflow capacity, by reducing the width of the gates by 20%

Direct Fluvial Flood Risk to the Development

[4] Available at https://www.cruachanexpansion.com/s36-application/

The Development Site is required to be protected up to and including the 0.5% AEP + climate change (CC) event based on SEPA's land use vulnerability guidance. The Development Site extends from the banks of Loch Awe up to the higher ground around the Headpond.

The Tailpond inlet/outlet on Loch Awe by its nature is within the flood risk zone, as shown on the SEPA flood maps, and in model results. The approximate top level of the intake structure is 38.6 mAOD. This would be submerged during the 0.5%AEP + climate change flood event. However, this element of the Development is water compatible. The intake will still be operational while fully submerged.

The existing B840 road will be diverted and then reinstated during the construction works. Two gate houses for the intake, as well as a permanent office, plant and equipment storage area and car park will be located on the landward side of the road adjacent to the intake. Road levels for the reinstated road will be 40.8 mAOD. The gate house and associated buildings and storage area will be at approximately the same level and are located on the opposite side of the road to the Loch. Scheme layouts that show the location of this infrastructure are on the following Figures within Volume 3:

- *Figure 2.15: Indicative Tailpond Inlet / Outlet Structure (Operational) (Volume 3 Figures)*
- *Figure 2.16 Indicative Tailpond Inlet / Outlet Cross Section (Volume 3 Figures)*

An increase in the 0.5% AEP + climate change flows by 20% increases the peak flood level to 40.8 mAOD. Decreasing the outflow capacity by reducing the gate dimensions increases the peak flood level to 40.2 mAOD. These results suggest that the 1m of freeboard between the 0.5%AEP + climate change flood level and the buildings at the inlet/outlet structure is appropriate. The flood risk to the Development as a result is **Low to Medium** and considered acceptable based on the nature of the Development.

In summary, the risk of flooding impacting the inlet/outlet structure and nearby scheme elements is low and acceptable.

Access Tracks to the Headpond may intersect the flood risk area at crossings over Allt Beochlich and other watercourses. SEPA flood risk maps indicate that the flood risk area is generally constrained within the channel. The Headpond and existing reservoir upstream in the catchment will attenuate flood flows, so the risk to the access track from flooding is low and acceptable. Any additional culverts / crossing along the access track will be designed to convey the design flows in the 1 in 200 year event with climate change and ensure that access to the Headpond is maintained during flood events.

Risk of Development Increasing Fluvial Flood Risk Downstream

Downstream receptors that may be impacted by flooding are:

- Road and rail infrastructure around Loch Awe, particularly the A85 running through the Pass of Brander. The minimum level of this road is approximately 40 mAOD. Flood events in late 2023 led to closure of this road.
- Taynuilt Potentially Vulnerable Area, this is at the mouth of the River Awe, downstream of Loch Awe.

The proposed hands-off level for generation is 37.67 mAOD, corresponding to a 50% AEP flood event. If generation increases the water level in Loch Awe to this level immediately prior to a flood event, the resulting peak flood level would be 40.0 mAOD. The increase in flow downstream is minimal (less than 2%), though the exact increase depends on the configuration of the Loch Awe Barrage, which is only assumed for this model.

The potential increase in Loch Awe levels leads to an increased risk of flooding to infrastructure around Loch Awe. The increase to flood risk at the Taynuilt PVA is assessed as minimal.

To mitigate the increased flood risk around Loch Awe, an addition to the operating regime for the Development will be made. Where forecasted rainfall amounts for the next three days exceed 150 mm (approximately equivalent to a 10% AEP event), the hands-off level will be reduced to 37.0 mAOD. A flood event with this initial water level results in a flood level of 39.8 mAOD, equal to the peak level without the Development operating.

5 Other Flood Risk Sources

Tidal Flood Risk

The local watercourses and water bodies are not tidally influenced, and the Development Site and surrounding area are at an elevation of at least 35.5 mAOD. The risk of tidal flooding affecting the Development or of the Development having any influence on tidal flooding is therefore **low** and acceptable.

Discharge from Headpond Overflow and Scour

The flow from the Headpond during a flood event will not exceed the flow that would have occurred in the existing catchment. Scour pipe discharges will also be limited to less than previous flood flows. Therefore, the flood risk from these sources is negligible.

Design of the Headpond Embankments will be based on the requirements under the Reservoirs Act 1975, as a Category A reservoir. Ongoing observations and maintenance following this legislation will ensure that the breach risk is **negligible**.

Pluvial Flooding

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.

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 would be 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.

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.

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

Assuming design in accordance with the above, the risk of flooding on-site and off-site from pluvial flooding is **Little to None** and therefore is acceptable.

Groundwater Flooding

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

Below Ground Infrastructure

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

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.

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.

Based on the above, the risk to the below ground areas being inundated is **Little to None** and therefore is acceptable.

Flooding from Surface Water Drainage

The Development may increase the impermeable areas on-site. A predicted increase in rainfall intensity by 46 % over the lifetime of the Development is likely to increase surface water run-off from the Development Site over its lifetime.

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.

Surface water drains for the Development will be designed to SEPA regulatory method on SuDS[5], Argyll and Bute Council guidance, and in accordance with other current good practice and legislation. 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 ABC and SEPA before construction takes place. Assuming that the drainage system will be designed and constructed to these standards, the risk of flooding on-site and off-site from is **Little to None** and therefore is and acceptable.

Flooding from Foul Drains and Sewers

There is no existing drainage in the area. Farmhouses in the surrounding area are assumed to be connected to septic tank or soakaway systems. Foul drainage arrangements for the Development will be designed according to ABC and SEPA requirements. The risk to flooding from the proposed drainage system is therefore inundated is **Little to None** and therefore is acceptable.

[5]Regulatory Method (WAT-RM-08): Sustainable Urban Drainage Systems (SUDS or SUD Systems). Available at: https://www.sepa.org.uk/media/219048/wat-rm-08-regulation-of-sustainable-urban-drainage-systems-suds.pdf

6 Mitigation measures

Operational Regime

To ensure that the operation of the scheme does not create flood risk downstream, the operational regime will be set so that no discharge of water can occur when the water level in Loch Awe is above the 1 in 2-year flood level of 37.67 mAOD. This level does not create flood risk to receptors.

In order to ensure that the scheme is not increasing flood risk during a flood event, an additional mitigation measure will be implemented. Where forecasted rainfall amounts at the site for the next three days exceed 150 mm (approximately equivalent to a 10% AEP event), the hands-off level will be reduced to 37.0 mAOD.

Residual Risk of Flooding from On-Site Drainage Systems

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.

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.

Assuming implementation of the above, the residual risk of flooding from the proposed drainage systems is considered **Little to None** and therefore is acceptable.

7 Conclusions

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

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. Climate change has also been considered, which is expected to increase the peak rainfall intensity by up to 46 % and peak river flow by up to 59 % over the lifetime of the Development.

With the exception of the Tailpond inlet / outlet at Loch Awe, 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.

This Flood Risk Assessment together with the Environmental Impact Assessment demonstrates 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 ABC, 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 SEPA at the detailed design stage.

This Flood Risk Assessment together with the Environmental Impact Assessment 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 offsite properties from the effects of flooding.

This Flood Risk Assessment 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.

Annex

SEPA Checklist