10 FLOOD RISK

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10.1 Introduction

10.1.1 This chapter presents the assessment of flood risk undertaken following guidelines set out in the IEMA publication "Guidelines for Environmental Impact Assessment" and TAN15: Development and Flood Risk (Welsh Government; 2004). The chapter sets out the baseline hydrological setting of the area as well as the hydrology, hydrogeology, drainage and existing flood risk at the site.

10.1.2 It also sets out the legislative and planning policy context, the scope of the assessment, the methodology followed in the assessment of environmental effects and describes the existing conditions at and adjacent to the Development. It then identifies construction and operational effects of the Development on flood risk.

Summary of 2012 Environmental Statement Chapter

10.1.3 A Flood Consequences Assessment (FCA) and Breach Analysis report were submitted within the 2012 ES. The FCA demonstrated that there are potential risks during construction and operation from groundwater flooding, pluvial flooding and flooding from existing drainage which requires consideration within the detailed design of the site, the buildings, the surface water drainage systems and the reservoirs.

10.1.4 Combined with the results of these two reports, the 2012 ES chapter concluded that it was possible to mitigate the identified risks through the application of appropriate site management at the construction stage, appropriate design principles at the detailed design stage, and appropriate system management principles in operation.

10.1.5 The mitigation measures are designed to protect the users of the approved scheme, the approved scheme itself, and off-site properties from the effects of flooding.

Scope of 2015 Environmental Statement Chapter

10.1.6 In the Scoping Letter submitted to NRW on the 12th November 2014, it was considered that the FCA and the results of the Breach Analysis remained valid and therefore would be submitted again for the benefit of the DCO Application. In their informal response dated 16th December 2014, NRW noted the submission of the FCA and Breach Analysis and recommended that the requirements of the Reservoir Act be incorporated into "Other Consents and Licenses Statement" of the DCO. These Appendices have subsequently been updated in relation to the increase in reservoir volume to 1,300,000m^3 and information on the modelling of the Nant Y Betws to support the operational discharge consents.

10.1.7 The chapter demonstrates that there are potential flooding risks during construction and operation from groundwater flooding, pluvial flooding and flooding from existing drainage. These risks require careful consideration during detailed design. The various risks can be mitigated by the application of appropriate site management at the construction stage, appropriate design principles at the detailed design stage, and appropriate system management principles in operation. Overall it is considered that, if appropriate mitigation measures are implemented, the residual impacts will be of negligible impact and not significant

10.1.8 The chapter should be read in conjunction with the Flood Consequence Assessment (FCA) report which is included as Volume 3, Appendix 10.1and also Chapter 9 Water Resources.

10.1.9 This chapter has been updated in the following sections:

- Relevant Planning Policy updates (Section 9.3);
- Consultation (Section 9.4); and
- Construction and operational impacts in relation to the requirements of the Reservoirs Act (Sections 9.8) with the addition of the summary Table 9-5 which replaces the previous construction (Table 9-5) and operation (Table 9-6) effects tables.

10.1.10 Additional information regarding operational discharges and an update to the increased reservoir capacity to 1,300,000m^3 has also been undertaken.

10.2 Scope of Assessment

Scope of Assessment

10.2.1 The scope of the assessment has been defined through a combination of experience of other similar developments and professional judgement. The assessment includes a qualitative assessment of potential effects on flood risk from construction works and during the operational phase.

10.2.2 The geographic scope of the appraisal considers surface water resources and flood risk sources or receptors both upstream and downstream of the Development.

10.2.3 The scope of appraisal has been determined through consultation with statutory consultees including Environment Agency Wales (EAW) for the previous assessment, Natural Resources Wales (NRW) more recently, and Gwynedd Council. It considers the potential temporary and permanent effects of the Development on flood risk (from all sources) during construction and operation of the Development.

10.2.4 Decommissioning of the Development will not be assessed as this will involve draining the quarries at an agreed rate. Water will be discharged from Q1 to Q6, and then finally into Llyn Padarn under the appropriate licensing regime.

10.2.5 Details of the Development are as described in Chapter 4 Project Description. Further specific details in relation to flood risk are summarised in the FCA report (Volume 3, Appendix 10.1).

Assessment Guidelines

10.2.6 The assessment methodology follows the guidance given in the Institute of Environmental Management and Assessment (IEMA) publication "*Guidelines for Environmental Impact Assessment*". Effects are assessed by predicting the changes that would be caused by the construction and operation of the Development in relation to the existing conditions of the water environment.

10.2.7 The assessment of flood risk during the operational stage was undertaken in accordance with Technical Advice Note 15: Development and Flood Risk (Welsh Government; 2004) (TAN 15), which provides a framework to guide planning decisions for new developments in relation to flood risk. The assessment is reported in full in the FCA report (AECOM, 2012). Whilst not addressed in the FCA, this chapter also considers potential flood risk during construction. The FCA report includes a more detailed introduction to flood risk and the relevant planning policy, and a more detailed assessment of the drainage requirements for the site.

10.3 Legislation and Policy Framework

10.3.1 This section presents legislative and planning context relevant to this assessment.

Legislation

10.3.2 The Development will comply with the following legislation in relation to flood risk:

- The Flood and Water Management Act 2010;
- The Water Resources Act 1991 (as amended); and
- The Land Drainage Act 1991 (as amended);

10.3.3 The Reservoirs Act 1975 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 Act 1975 by reducing the capacity beyond which a reservoir will be regulated to 10,000m^3. During consultation, the EAW confirmed that dams should be designed in accordance with Reservoirs Act 1975.

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

10.3.5 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.

10.3.6 Both Q1 and Q6 will be of a volume by which they are regulated under the Reservoirs Act 1975. The proposed dams 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 of both reservoirs indicates that both reservoirs would be categorised as Category A reservoirs and therefore would be subject to the most stringent design standards with the capability to convey the Probable Maximum Flood (PMF) as a design flood.

10.3.7 Design, inspection and maintenance in accordance with the legislative framework of the Reservoirs Act 1975 will ensure that the risk of failure of the proposed dams remains low throughout their working life.

National Planning Policy

10.3.8 The Overarching National Policy Statement for Energy (EN-1) sets out national policy for energy infrastructure. Section 5.7 gives guidance on flood risk assessments, stating that:

Applications for energy projects of 1 hectare or greater in Flood Zone 1 in England or Zone A in Wales and all proposals for energy projects located in Flood Zones 2 and 3 in England or Zones B and C in Wales should be accompanied by a flood risk assessment (FRA).

10.3.9 The National Policy Statement for Fossil Fuel Electricity Generating Infrastructure (EN-2), in addition to EN-1, provides the primary basis for decisions made by the Planning Inspectorate for nationally significant fossil fuel electricity generating stations and as such is a material consideration for this proposed development. Section 2.3.13 covers climate change adaptation and states that:

10.3.10 As fossil fuel generating stations are likely to be proposed for coastal or estuarine sites and climate change is likely, for example, to increase risks from flooding or rising sea levels, applicants should in particular set out how the proposal would be resilient to:

- coastal changes and increased risk from storm surge;

- effects of higher temperatures, including higher temperatures of cooling water; and
- increased risk of drought leading to a lack of available cooling water.

10.3.11 The National Policy Statement for Electricity Networks Infrastructure (EN-5) states that as climate change is likely to increase risks to the resilience of some of this infrastructure due to flooding, applicants should in particular set out to what extent the proposed development is expected to be vulnerable, and, as appropriate, how it would be resilient to flooding (particularly for substations that are vital for the electricity transmission and distribution network) and earth movement or subsidence caused by flooding or drought (for underground cables).

Regional Planning Policy

10.3.12 Planning Policy Wales (PPW) (Chapter 13, sections 13.2 – 13.4) sets out current national planning policy in respect to flood risk in Wales. It states that proposed development should not increase the risk of flooding elsewhere by loss of flood storage or flood flow route and should not increase the problem of surface water run-off. Additionally, planning authorities should work closely with NRW, drainage bodies, sewerage undertakers and any other relevant authorities when determining applications for proposed development, and advice given by NRW should be given due weight as a material consideration.

10.3.13 Technical Advice Note 15 (TAN 15) provides guidance to planners on how to consider flood risk issues in relation to proposed development, and provides guidance for developers on how to evaluate sites with respect to flood risk.

10.3.14 TAN 15 states that the prime objectives of an assessment of flood consequences is to gain a full appreciation of:

- The consequences of flooding on the development;
- The consequences of the development on flood risk elsewhere; and

- Whether appropriate mitigation measures can be incorporated within the design of the development to minimise risk to life, property and disruption to people living on the site and in the local community.

10.3.15 TAN 15 requires that all possible sources of flooding be considered in assessing the consequences of flood risk. This could include: flooding from rivers and the sea, flooding from land, flooding from groundwater, flooding from sewers and flooding from reservoirs, canals and other artificial sources.

10.3.16 TAN 15 makes it a planning requirement to account for climate change in the assessment of flood risk and in the proposed design. In the UK, climate change is expected to lead to increased rainfall intensities, increased peak river flows, and sea level rise.

10.3.17 NRW advise that the guidance given in the Defra document FCDPAG3 Economic Appraisal Supplementary Note to Operating Authorities Climate Change Impacts (October 2006) should be applied to the assessment of flood risk in Wales.

10.3.18 The key planning objectives of TAN 15 are to appraise, manage and where possible, reduce flood risk. Sustainable Drainage Systems (SuDS) provide an effective way of achieving some of these objectives, TAN 15 and Part H of the Building Regulations (DTLR, 2002) direct developers towards the use of SuDS wherever possible.

Local Planning Policy

10.3.19 The Gwynedd Unitary Development Plan (UDP) is the current adopted plan for Gwynedd Local Planning Authority Area, and this is supplemented by Supplementary Planning Guidance (SPGs).

10.3.20 The UDP has been prepared by Gwynedd Council to provide a framework to guide local land use planning decisions, with a focus on sustainable development. The following policies are relevant to the assessment of flood risk from the Development:

<u>Developments Which Create Risk - Strategic Policy 5</u>

10.3.21 This strategic policy states that developments which create a risk of 'unacceptable' damage to people, property or the environment will not be acceptable.

Policy B29 - Development on Land at Risk from Flooding

10.3.22 This policy enforces the acceptability criteria set out in TAN 15, and implies that development proposals in low flood risk areas (Zone A) will be approved provided that they do not present an 'unacceptable' risk of flooding on or off the site, or impair flood management or maintenance schemes.

Policy B32 - Increasing Surface Water

10.3.23 This policy places a requirement on developers to manage surface water effectively to ensure that runoff rates to receiving water bodies are not increased and do not lead to an increase in flood risk.

Policy C6 - Glyn Rhonwy Redevelopment Site

10.3.24 This policy deals specifically with the allocated development site into which part of the Development falls. The policy does not specifically include any drainage or flood risk clauses, but requires that development must not adversely affect the local environment and that Llyn Padarn must be 'protected and maintained'.

Policy C7 - Building in A Sustainable Manner

10.3.25 This policy states that to reduce the effect of a development on the environment, it must incorporate drainage systems which will not to increase flood risk or cause significant effect on local hydrological conditions.

Policy C18 - Availability of Infrastructure

10.3.26 This policy states that adequate provision of sewerage and surface water disposal infrastructure is a requirement for new development.

Supplementary Planning Guidance

10.3.27 Gwynedd Council has published a number of Supplementary Planning Guidance documents to support the delivery of development in accordance

with the UDP. The document 'Supplementary Planning Guidance: Planning for Sustainable Development' (April 2010) contains advice regarding the use of SUDS in new development, and highlights that SUDS can offer significant environmental/ecological benefits whilst managing and reducing surface water runoff. The document makes clear that consideration of climate change effects must be included in new development.

10.4 Consultation

10.4.1 In addition to the desk-top study, the results of previous consultation with EAW and Gwynedd Council informed the 2012 assessment. Relevant information and direction from consultation is included as appropriate within the baseline information or assessment section.

10.4.2 Whilst informal consultation was undertaken with NRW on the scoping letter in December 2014, a formal scoping report was submitted to PINS on the 5th January 2015. The response from the SoS was received on the 15th February 2015 with the following comments related to flood risk:

- In sections 3.55 – 3.57, the SoS welcomed the addition of the Flood Consequences Assessment (FCA) and breach analysis, and requested that these be reviewed in light of any changes to the reservoirs.
- The SoS also requested that consideration be given to NRW's comments on sudden releases whilst water levels are high within Llyn Padarn and the Seiont catchment; and
- Public Health England requested information on flood risk to be submitted.

10.4.3 A meeting was held with NRW on the 30th March 2015 where the following was discussed and agreed:

- NRW agreed that the spillway design could be a DCO Requirement;
- NRW agreed that an Excess Water Management Strategy would be formulated through detailed design and also be made a DCO Requirement;
- Contact with the Reservoirs team would be made to discuss their requirements for reservoir and dam design; and

- The Applicant could provide information on the operational discharges especially on the likelihood of discharges to the Nant Y Betws from Q1.

10.4.4 Additional consultation has also been undertaken with the NRW Reservoirs team. They have confirmed that the Development will be subject to detailed design and that the Applicant intends to maintain regular liaison with them on Reservoir Act matters. The Applicant confirmed that a Panel Engineer has been involved with the design of the Development to date but that formal notification under the Act would be required 30 days prior to the commencement of the construction phase.

10.4.5 Further to consultation responses were received asking why the breach analysis was confidential, clarification was sought from NRW regarding their requirements for it to remain confidential. Detailed modelling results from the work carried out by NRW are classed as “Restricted” and are only released to Local Resilience Forums for the emergency planning purpose. Therefore in keeping with publically available data on all other reservoirs the breach analysis mapping was considered to remain confidential on the basis of national security and protection of public safety. The data has been made available to NRW for their consideration.

10.4.6 A further meeting and site visit was held on the 15th July 2015 where the following was discussed:

- NRW asked for further details of the operational discharges, specifically those from Q1 to the Nant Y Betws in terms of frequency, rate, volume and duration and also queried the requirement for a relief valve at Q1;
- Requirement for a hydrological assessment of the Nant Y Betws to ensure that there would be no downstream effects from any releases; and
- Requirement for discharge consents for construction dewatering and operational discharges.

10.4.7 A technical briefing note was submitted to NRW on the 18th September 2015 providing additional information and clarification on the operational discharges from Q1 during normal, unlikely and extreme operational events.

The scope of the discharge consents was also contained in this technical note for NRW comment. At the point of submission, comments were awaited from NRW on the technical note.

10.5 Methodology

Desk Study

10.5.1 A qualitative assessment has been undertaken considering the potential interactions between the Development and existing baseline conditions.

10.5.2 Baseline conditions have been established by a desk study of published information and consultation with relevant statutory bodies. The desk study included the following:

- Ordnance Survey (OS) mapping to identify surface water bodies and topography;
- EAW On-line Flood Maps (accessed May 2012, December 2014 and again in July 2015);
- Welsh Government Development Advice Map (DAM);
- Dŵr Cymru Welsh Water (DCWW) public sewer and water mains records;
- Landmark Envirocheck Reports;
- Glyn Rhonwy Hydrogeological Desk Study (ESI Ltd, June 2011);
- Glyn Rhonwy Preliminary Pollution Risk Assessment Report (Eryri Consultancy, September 2011);
- Glyn Rhonwy Quarry Works report (AECOM, March 2012); and
- North West Wales Catchment Flood Management Plan; EAW; January 2010.

Assessment Criteria

10.5.3 The information collated during the desk based study has been used to inform a qualitative effect assessment. The assessment has been undertaken in accordance with the requirements of TAN 15.

10.5.4 Potential effects that may result from the construction and operation of the Development will be assessed using a methodology based broadly on the Highway Agency's Design Manual for Roads and Bridges (DMRB) for effects to the water environment (HD 45/09). Although developed for the assessment of water quality effects, the method to evaluate effects can be equally applied to other potential risks and provides a robust and accepted method for assessing the significance of effects. The following sections describe the approach in more detail.

10.5.5 Potential effects have been assessed qualitatively and evaluated with reference to statutory legislation, planning policy and in liaison with NRW. Effects have been determined by predicting the changes that would be caused by the construction and operation of the Development.

10.5.6 Where there are limitations in data and information, this has been explained in the effect assessment section.

10.6 Assessment of Significance

10.6.1 The assessment of significance of effects follows the guidance set out in HD 45/09. In assessing the significance of potential effects of the Development, three key factors have been taken into consideration:

- the likelihood of that effect occurring;
- the sensitivity or importance of the receiving environment; and
- the potential magnitude of effect.

10.6.2 The environmental value of the different features within the water environment is characterised by analysing their different attributes.

10.6.3 The sensitivity or importance of the receiving environment (i.e. its ability to absorb an effect without perceptible change) as suggested in DMRB HD45/09 is defined in Table 10-1.

Table 10-1: Water Features: Attributes and Indicators of Quality			
Feature	**Attribute**	**Indicator of Quality**	**Possible Measure**
Flood Plain	Conveyance of flow	Presence of floodplain Flood flows	Developed area within extent of floodplain affected, as determined from hydraulic modelling Flood risk Mean annual flood

Source: Amended from Table A4.1 from HD 45/09

10.6.4 The magnitude of effects considers the scale of the predicted change to baseline conditions resulting from a given potential effect and takes into account the duration of an effect (i.e. temporary or permanent and whether it is direct or indirect).The magnitude has been identified independently of importance or sensitivity using the criteria in Table 10-2.

Table 10-2: Criteria to Determine the Importance of Receptors		
Importance of feature/ attribute	**Criteria**	**Example**
Very High	Attribute has a high quality and rarity on a regional or national scale	Flood plain or defence protecting more than 100 residential properties from flooding.
High	Attribute has a high quality and rarity on a local scale	Flood plain or defence protecting between 1 and 100 residential premises from flooding.
Medium	Attribute has medium quality and rarity on a local scale	Flood plain or defence protection 10 or fewer industrial properties from flooding.
Low	Attribute has low quality and rarity on a local scale	Flood plain with limited constraints and a low probability of flooding of residential properties.

Source: Amended from Table A4.3 from HD 45/09.

10.6.5 Effects can be **beneficial, adverse** or **negligible.** Beneficial effects will be defined as reduction in peak flood level (1% annual probability) of >10 mm.

10.6.6 The significance of effects has been then determined using the matrix presented in Table 10-3.

Table 10-3: Criteria to Determine the Magnitude of effect		
Magnitude of Effect	**Criteria**	**Examples**
High	Results in loss of attribute and/or quality and integrity of the attribute	Increase in peak flood level (1% annual probability) >100mm (Hydrological Assessment of Design Floods and Hydraulic Assessment, Methods E and F, Annex I)
Medium	Results in effect on integrity of attribute, or loss of part of attribute	Increase in peak flood level (1% annual probability) >50mm
Low	Results in some measurable change in attributes, quality or vulnerability	Increase in peak flood level (1% annual probability) >10mm
Negligible	Results in effect on attribute, but of insufficient magnitude to effect the use or integrity	Negligible change in peak flood level (1% annual probability)<+/-10 mm

Source: Amended from Table A4.4 from HD 45/09

10.6.7 The significance of a given effect is based on a combination of the sensitivity or importance of the receptor and the magnitude of a given potential effect in shown in Table 10-4.

Table 10-4: Significance of effect				
Magnitude	**Importance**			
	Very High	**High**	**Medium**	**Low**
High	Major	Moderate	Moderate	Minor
Medium	Moderate	Moderate	Minor	Minor
Low	Moderate	Minor	Negligible	Negligible
Negligible	Minor	Minor	Negligible	Negligible

10.6.8 Effects have been initially assessed without taking mitigation measures into account but following good practice. Effects that remain following mitigation

measures are taken into consideration are residual effects. Temporary effects are considered in the construction period whilst permanent effects are discussed in the operational phase, albeit that the effect may first occur during construction (e.g. morphological changes). Effects of **moderate** significance or higher are considered to be **significant**.

10.7 Baseline Conditions

10.7.1 The following information is a summary of the key points from the full baseline information contained within the FCA report.

General Hydrological Setting

10.7.2 In the valley to the east of the site, Llyn Peris (the lower reservoir for the Dinorwig hydro-electric pumped storage scheme) is dammed at its north western end to function as a reservoir. In addition to the flows from Dinorwig, Llyn Peris is fed at its south eastern end by high flows from the Afon Nant Peris. It is understood that under low flow conditions the Afon Nant Peris flows via a diversion tunnel directly to Llyn Padarn.

10.7.3 At the north western end of Llyn Peris the excess water from the reservoir flows into Llyn Padarn, along with flows from the Afon Nant Peris diversion tunnel. The Afon Hwch (which flows from the mountainside to the south west of Llyn Peris) also flows into the south western end of Llyn Padarn.

10.7.4 A number of smaller watercourses from both the north and south sides of the valley flow into Llyn Padarn, including the Afon Goch and Afon Glyn which flow through Llanberis itself. At the downstream end of Llyn Padarn the Afon Rhythallt forms the outlet from the lake, before becoming the Afon Seiont.

10.7.5 To the south of the site the Nant y Betws flows from its source to the south of the site, in a south westerly direction before joining with the Afon Gwyrfai in the valley to the south west of the site and eventually discharging into the sea. A number of smaller tributaries to the Nant y Betws also rise on the slopes to the south west of the site.

Hydrology, Hydrogeology and Drainage of the Site

10.7.6 A detailed description of the geology, hydrology and hydrogeology of the site is given in Chapter 8 Geology and Soils, Chapter 9 Water Resources and also within the FCA report (Volume 3, Appendix 10.1). In summary:

- Surface water and groundwater flows in the area around Q1 are likely to drain towards the Nant y Betws in the south west. There are no known details of any drainage systems within the quarry itself, but like many of the other quarries it is considered possible that buried or obscured historical drainage features may be present, which continue to drain the quarry.
- Surface water from the Q2 area drains to Llyn Padarn via a small surface water system to the north west of the site. More details can be found in Chapter 9 Water Resources.
- The area around the lower quarries (Q3 – Q8) is located within the natural catchment of the Afon Glyn which flows into Llyn Padarn. However, is considered possible that a more direct flow route to Llyn Padarn exists, with drainage adits and culverts possibly providing a chain of drainage through subsequently lower quarries to the lake. More details can be found in Chapter 9 Water Resources.
- Groundwater flows through the slate spoil on the surface are expected to have a flashy' response to rainfall events, with the sub-surface material being largely impermeable except through fractures in the material.
- There is a manhole to the north east of Q8 adjacent to the car park between Llyn Padarn and the A4086 road which contains a pipe which appears to come from the direction of Q8. It is not clear from the investigations to date whether the pipe within the manhole conveys drainage from Q8 or only groundwater flows. It is assumed that water passing through the manhole flows towards Llyn Padarn but the discharge point has not been located.
- There are a number of small watercourses rising in the vicinity of the site and flowing down the mountainsides to the north east and south west,

however none are shown to flow directly through the site. These watercourses are fed by surface water runoff and sub-surface discharges from the slate spoil heaps.

Existing Foul Drainage

10.7.7 There is an existing foul drainage system At Q6 but not at Q1. The risk of flooding from existing foul drains is therefore considered low and does not require further consideration.

Tidal Flood Risk

10.7.8 The local watercourses and water bodies are not tidally influenced, and the Site and surrounding area are at an elevation of at least 150m AOD. The risk of tidal flooding affecting the Development or of the Development having any influence on tidal flooding is therefore low and does not require further consideration.

Fluvial Flood Risk

Direct Risk to the Site

10.7.9 From the current EA Flood Map, shown in Volume 4, Figure 10.1, it can be seen that the majority of the Development is located within Flood Zone 1 which indicates that it is at a low and acceptable risk of fluvial flooding. Only the pumping station is in an area shown to be at risk of fluvial flooding.

10.7.10 The EA 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 smaller 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. 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 slopes around the site is considered low. The watercourses generally flow away from the site, with little likelihood that any flooding would effect on the site. The NRW Catchment Flood Management Plan (CFMP) identified Llanberis as an area

which has experienced flash flooding from rivers, but this is likely to occur once the watercourses reach the less steep ground near the lake.

10.7.11 The pumping station is located adjacent to Llyn Padarn. The current EA flood map confirms that the location of the pumping station is within Flood Zone 3, which is considered to have a 1% or greater chance of flooding in any given year.

10.7.12 Based on the above, direct risk of fluvial flooding to the development is considered low and does not require further consideration, with the exception of the pumping station which is considered in Section 9.10.

Risk Associated with Downstream Watercourses

10.7.13 To the south west of the site there is no significant risk of flooding currently from the Nant y Betws. Downstream of the Nant y Betws, there is a risk of flooding indicated around the Afon Gwyrfai, although the flood extents are not extensive.

10.7.14 The areas around the shores of Llyn Padarn and areas around the downstream watercourse, the Afon Rhythallt, are shown to be within Flood Zones 2 and 3 and are therefore considered to be at risk of fluvial flooding. During consultation, NRW noted that there are historic flooding problems downstream of Llyn Padarn and that flooding in this location is ‘not predictable’.

Risk of Flooding From Existing Reservoirs

10.7.15 The EA publish a Risk of Flooding from Reservoirs map to show the largest area which would be flooded in the event of existing reservoir failure. From Volume 4, Figure 10.1 it can be determined that the Development site itself, with the exception of the pumping station, 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.

10.7.16 Interrogation of the online EA map (Volume 4, Figure 10.1) reveals that there are currently six potential sources of reservoir flood risk in the vicinity of the site, with varying degrees of downstream influence. From Volume 4,

Figure 10.1, it can be seen that there is no risk of flooding from these other reservoir impacting on the safety of the Development. Although the pumping station may be at risk of flooding in the event of flooding from Llyn Peris, Marchlyn Mawr or Marchlyn Bach, the likelihood of such an event is considered unlikely and would not impact on the safe operation of the Development.

10.7.17 The risk of existing reservoir flooding to the Development is therefore considered low and does not require further consideration.

Future Baseline – Climate Change

10.7.18 PPW makes it a planning requirement to account for climate change in the assessment of flood risk and in the proposed design. The recommended allowances for climate change are set out within the FCA report (Volume 3, Appendix 10.1).

10.7.19 An increase in rainfall intensity could lead to increased surface water runoff which may be more likely to exceed the capacity of the site's drainage systems. An increase in peak river flows could lead to a reduced capacity for watercourses and water bodies to receive flows from the site.

10.7.20 The design life of the Development has been taken as 125 years. The Development must be designed to account for a minimum 30% increase in rainfall intensity, over its lifetime. The Development must also be designed to account for a 20% increase in peak river flow – this was confirmed and accepted to have been considered by NRW in their S42 response.

Importance of Flood Risk Receptors

10.7.21 To enable a meaningful assessment of environmental impact to be made in accordance with the guidance in DMRB HD45/09, the importance of flood risk receptors must be defined. The classification has been derived based on professional judgement and using the baseline information discussed above and the guidance set out in Section 10.3 and 10.5.

10.7.22 The significant receptors of flood risk effects are people and property that may be at risk from any flooding, including the Development and off-site properties. Although the development is largely within Flood Zone 1, which

indicated a generally 'low' risk of flooding, the effects of flooding from such a scheme could extend some way downstream, potentially affecting people and property elsewhere.

10.7.23 Downstream areas are potentially already at risk of flooding from watercourses as some areas are shown to be in EA Flood Zones 2 and 3. From the information available it is not possible to accurately determine the number of properties which are protected by the downstream flood plains , therefore a precautionary approach to defining the importance of receptors should be taken, For this reason, the flood risk receptors shall be considered as being of 'Very High' importance.

10.8 Potential Effects

10.8.1 The following sections identify the likely effects of the Development on flood risk and the mitigation to be implemented. Construction and operational effects have been considered separately. Decommissioning has been scoped out as per Section 10.2.4.

Potential Effects during Construction

10.8.2 During construction the following effects could occur if appropriate good practice and mitigation is not implemented:

- flooding of the pumping station construction site from Llyn Padarn;
- flooding on and off site due to restriction of flow by mud/debris entering the surface water drainage system or watercourses;
- risk of flooding due to temporary increases in impermeable area;
- risk of flooding from overland flow; and
- risk of flooding from groundwater.

Risk of Fluvial Flooding

10.8.3 Construction of the pumping station within the flood plain associated with Llyn Padarn will mean that the site itself is at an elevated risk of flooding during construction. Working within the flood plain, including any potential storage of materials and spoil within the flood plain, could lead to loss of flood storage resulting in an increase in flood risk elsewhere. Due to the

medium importance of the receptor (open flood plain with no adjacent residential properties) and the low magnitude of effect, this has the potential to have a **minor adverse** effect without appropriate mitigation.

Flooding Due to Restriction of Flow by Mud and Debris

10.8.4 There is a potential for the construction works to cause flooding on or off site through mud and debris entering constructed or temporary drainage systems or watercourses and causing blockages and restricting the flow. This could result in localised flooding, particularly after heavy or prolonged rainfall. This is considered to be of low importance and medium magnitude resulting in a potentially **minor adverse** effect.

Flooding Due to Temporary Increases in Impermeable Area

10.8.5 The construction process could potentially increase the effect of the development on flooding elsewhere if impermeable areas are temporarily increased without mitigation measures in place. Temporary hard standing or compacted surfaces could result in rapid surface water runoff to local watercourses via the surface water drainage system or increased overland flow. This could increase the risk of surface water flooding in the local area if there are no mitigation measures in place. This is considered to be of low importance with a medium magnitude of effect, resulting in a potential **minor adverse** effect.

Risk of Flooding From Overland Flow

10.8.6 The local topography of any construction site could influence the flood risk from surface water runoff if not adequately controlled by appropriate formal drainage and site management. The construction process could potentially cause flooding elsewhere, or on site within excavations or the reservoirs, if impermeable areas are temporarily increased without mitigation measures in place. Temporary hard standing or compacted ground could result in rapid surface water runoff to adjacent area or into the excavations, if there are no mitigation measures in place. This is considered to be of low importance with a medium magnitude of effect, resulting in a potential **minor adverse** effect.

Risk of Flooding From Groundwater

10.8.7 There is a risk of flooding of excavations or the reservoirs with groundwater during construction. Also, when de-watering this groundwater poses a flood risk if not disposed of appropriately. This is considered of low importance and low magnitude which would result in a potential **negligible** effect.

10.8.8 Table 10-5 summaries the predicted construction effects.

Potential Effects during Operation

10.8.9 The operational flood risks associated with the Development are discussed in detail in the FCA report (Volume 3, Appendix 10.1). The following provides a summary of the risks identified and the likely magnitude of the potential effect following appropriate detailed design and implementation of appropriate management measures.

10.8.10 The following is a summary of the risks identified therein which are:

- direct risk of fluvial flooding to the pumping station;
- risk of development increasing fluvial flood risk from Nant y Betws due to flows from the overflow and the relief value;
- risk of development increasing fluvial flood risk from Llyn Padarn and Afon Rhythallt due to flows from the overflow and the relief valve;
- risk of flooding from proposed dams and reservoirs;
- risk of pluvial flooding;
- risk of groundwater flooding;
- flooding from existing quarry drainage;
- flooding from proposed surface water drainage; and
- flooding from proposed foul drainage and associated pumping stations.

<u>Direct Risk of Fluvial Flooding to the Pumping Station</u>

10.8.11 With the exception of the small area occupied by the control kiosk, the pumping station will not result in land raising in the flood plain as it will be constructed underground. The very slight loss of flood plain storage due to the control kiosk is considered to be insignificant when considered against

the total extent of the flood plain area, and is therefore not considered to pose a significant risk of increasing the risk of flooding in the locality. This is considered of low importance and of negligible magnitude, thereby resulting in a **negligible** effect.

10.8.12 There is a risk of direct fluvial flooding to the pumping station which could cause inundation of the pumping station or failure of electrical components in the kiosk / control box, leading to failure of the pumping station. It should be noted however that the pumping station is not critical to the safe operation of the Development and its primary function is to facilitate the initial filling of the reservoir system and the occasional topping up. There would also be a risk to any maintenance personnel in the event of flooding occurring whilst they were present at the pumping station. It has been demonstrated within the FCA that adequate design and management of maintenance practices at this asset of low importance, combined with negligible magnitude of effect, results in a **negligible** effect.

Risk of Development Increasing Fluvial Flood Risk from Nant y Betws

Discharge from Overflow

10.8.13 The Development includes an overflow from Q1 to Nant y Betws as outlined in the Technical Note submitted to NRW (Volume 3, Appendix 2.8). Under normal operation the water level in Q1 will remain below the overflow level, but failure of the pumping system, or a restriction on the discharge to Q6 coinciding with a large storm event could cause the level in Q1 to increase by natural inflow. The freeboard to be maintained in Q1 will make the operation of the overflow less likely, but in the event levels were to reach the overflow there would be a discharge from the reservoir to Nant y Betws.

10.8.14 It has been demonstrated within the Flood Consequence Assessment that any flows would be comparable to the existing natural flow into Nant y Betws and are likely to be relatively low. The projected effect of the emergency overflow on flooding from Nant y Betws or the Afon Gwyrfai is of medium importance and negligible magnitude, thereby leading to a **negligible** effect.

Discharge from Relief Valve

10.8.15 The relief valve in the reservoir provides a method of the reservoir being drained down if required, with flows being discharged into Nant y Betws. The relief arrangement within the spillway infrastructure is a secondary means of drawdown with the main mechanism being the main draw off pipe down to Q6. The valve is only likely to be used in a controlled manner, when the flows in Nant y Betws and the Afon Gwyrfai are low enough to accept the flows from the relief without causing an increased risk of flooding from the watercourses and be in line with any operational discharge consent. The exception to this will be in an emergency situation.

10.8.16 Under normal operation of the Development there is no anticipated need to allow the reservoirs to spill or to release water to the Nant y Betws. The facility exists to drawdown (release water from behind the dam) *via* the Q1 reservoir relief *valve* to the Nant y Betws. This is an essential reservoir safety feature and, other than occasional small volumes released during valve testing (likely to be annually), there is no planned release of water to the Nant y Betws.

10.8.17 Any prolonged use of the relief valve would be in a situation when drawdown of the reservoir is required and the main draw off pipe to Q6 were unavailable. The occurrence of such an event is considered to be extremely unlikely.

10.8.18 The draw-down rate for Q1 (0.6 m^3/s) is approximately equivalent to the 1 in 2 year natural flow at the point of discharge, and less than one third of the flow of a 1 in 2 return period flow at Tyn yr Onnen; the first location with potential flood risk to persons or property. It is considered that the draw-down flow should be well within the capacity of the watercourse without adverse risk of flooding.

10.8.19 The projected effect of the relief on flooding from Nant y Betws or the Afon Gwyrfai is therefore of medium importance and of negligible magnitude, thereby leading to a **negligible** effect.

Risk of Development Increasing Fluvial Flood Risk from Llyn Padarn and Afon Rhythallt

Discharge under Normal Operating Conditions

10.8.20 As the Development will include a discharge to Llyn Padarn from Q6 under normal operation, measures must be put in place to ensure that the Development does not cause an increase in downstream flood risk from the lake itself or the Afon Rhythallt.

10.8.21 Without mitigation the effect could be of medium magnitude on a medium importance receptor, leading to a potential **minor adverse** effect. However, mitigation of this risk in normal operation will be achieved through an effective excess water management strategy which will be agreed in full with the NRW, as discussed in Section 9.9.

Discharge from Overflow

10.8.22 The Development spillway infrastructure also includes an overflow from Q6 to Llyn Padarn. Under normal operation the water level in Q6 will remain below the overflow level. When water levels are at the overflow level, natural inflow (direct rainfall) into the reservoir would be constantly discharged to Llyn Padarn.

10.8.23 It has been demonstrated within the Flood Consequence Assessment that any flows would be comparable to the existing natural flow into Llyn Padarn and are likely to be significantly less than other flows into Llyn Padarn and the downstream Afon Rhythallt. The projected effect of the emergency overflow on flooding from Llyn Padarn or the Afon Rhythallt is therefore of medium importance but negligible magnitude, thereby leading to a **negligible** effect.

Discharge from Scour

10.8.24 The scour valve in the reservoir provides a method of the reservoir being drained down if required, with flows being discharged into Llyn Padarn via the spillway infrastructure. The scour arrangement is a secondary means of removing water from the reservoir, with the main mechanism being pumping the water up to Q1. The valve is only likely to be used in a controlled manner, when the level in Llyn Padarn is low enough to accept the flows from the reservoir without causing an increased risk of flooding from Llyn Padarn and the Afon Rhythallt and be in line with any operational discharge consent. The exception to this will be in an emergency situation.

10.8.25 Any prolonged use of the relief valve would be in a situation when drawdown of the reservoir is required and the transfer to water to Q1 were unavailable. The occurrence of such an event is considered to be extremely unlikely.

10.8.26 For drawdown of Q6 direct to Llyn Padarn; the expected minimum drawdown rate (0.3 m^3/s) is considerably less than the natural inflow to the lake. An approximate estimate of the Q50 flow into Llyn Padarn is around 2.3 m^3/s. [Q50 (the 50^{th} percentile flow): The flow in cubic metres per second which is equalled or exceeded for 50% of the time.]

10.8.27 The projected effect of the scour on flooding from Llyn Padarn or the Afon Rhythallt is therefore of medium importance and negligible magnitude, thereby leading to a **negligible** effect.

10.8.28 It is considered that the design draw-down rate for Q6 could be increased while maintaining a negligible increase in flood risk within the downstream catchment as a result of the released flow. This is to be addressed within the "Excess Water Management Strategy" which will be agreed with NRW at a later date via a DCO Requirement.

Risk of Flooding from Dams and Reservoirs

10.8.29 The Development will include the creation of two new reservoirs at Q1 and Q6. As these structures impound a significant volume of water, there is an inherent risk of flooding associated with them. However, the probability of flooding from a reservoir occurring is considered extremely low due to the high standard of design, management, and maintenance required under law and provided by any responsible operator.

10.8.30 The FCA provides a detailed assessment which has been made to determine the risk associated with the dams and reservoirs, and to provide a balanced assessment of the flood risk associated with the structures based on a precautionary approach as prescribed in TAN 15. This report provides a summary of that work.

Wave Action

10.8.31 Significant wave action due to wind can cause damage to the dam wall, particularly the crest of the dam, and potential overtopping if the water level is high enough.

10.8.32 The design freeboard within the reservoirs mitigates the potential for wave action on the dam crest and potential overtopping by waves, by ensuring water levels are below the crest level of the dams. The crest of both dams is also to be fitted with a wave wall to dissipate the energy of any waves which reach the dam crest. Additional wave protection will be provided by the placing of selected rock against the upstream slope of the dams to dissipate the energy of any waves hitting the walls when water levels are lower. Assuming implementation of the above, the potential effect of wave action does not require further consideration.

Risk of Overtopping

10.8.33 As detailed above, each reservoir will include an overflow set at 1m below the crest of the dam. The normal operating level of Q1 will be 1m below the overflow level and the normal operating level of Q6 will be at overflow level. Maintenance of the maximum normal top water level, and hence the freeboard above this, will be a function of the excess water management strategy.

10.8.34 The evaluation within the FCA shows that the freeboard within the reservoirs is sufficient to mitigate the risk of overtopping due to restriction of the outflow in the event of failure of pumping, cessation of pumping due to water management requirements in Llyn Padarn, and blockage or failure of the emergency overflow, for rainfall events up to the PMF event.

10.8.35 The risk of overtopping is therefore considered to be low and the effect is therefore of negligible magnitude. The effect is therefore **negligible**.

Breach Analysis and Flood Routing

10.8.36 Although the likelihood of a dam breach occurring is extremely low, the consequences are significant. It is therefore necessary to look at the potential flow paths and effects of a breach to determine if the risk is

acceptable and to allow adequate emergency planning to be implemented in the future as mitigation in the unlikely event of a breach.

10.8.37 Hydrodynamic modelling (2D TUFLOW) analysis has therefore been undertaken based on a methodology agreed in principle with EAW in 2012 to define the potential areas at risk of flood inundation. The methodology set out in the Interim Guide to Quantitative Risk Assessment for UK Reservoirs (Interim Guide) was then followed to assess the fatality rate and hence the risk posed from the dams. These studies are reported fully within the FCA report (Volume 3, Appendix 10.1) and the accompanying Glyn Rhonwy Dam Breach Assessment (Appendix 10.2, CONFIDENTIAL - provided only to NRW).

10.8.38 The analysis shows that in the unlikely event of a breach, a significant area is at risk of inundation. Recognising that the likelihood of a breach event is very low, in line with the guidance set out in the Interim Guide the risk is classed as being acceptable based on the calculated number of fatalities and the estimated probability of failure.

10.8.39 Also, with reference to the current EA Reservoir Flood mapping it can be surmised that the area at risk of reservoir flooding in the Afon Gwyrfai would not be increased by the dam at Q1, although additional lives would be at risk from the flow path between Q1 and the Afon Gwyrfai. The area around Llyn Padarn and the downstream Afon Rhythallt which would be affected by flooding in the event of a breach of the Q6 dam would not be any greater than that which is already at risk from existing reservoirs in the catchment, although additional lives would be at risk from the flow path between Q6 and Llyn Padarn.

10.8.40 The analysis has shown that the Development will not lead to an unacceptable increase in risk due to breach. The effect of the dams on flood risk will therefore be **negligible**.

10.8.41 As the flow paths from Q1 and Q6 are not coincident, simultaneous breach would not lead to a cumulative effect. Also, the total impounded volume within the pump storage system is equal to the volume within one of the reservoirs, therefore under operational conditions one reservoir will always

be drawn down below impoundment level. The risk of simultaneous breaches therefore does not exist and does not require further consideration.

Fluvial Flooding

10.8.42 The EAW CFMP highlights that, due to the steeply graded and semi-impermeable nature of the site and surrounding area, it should be expected that local storm events produce rapid surface water runoff. 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 runoff from these areas. It is also recognised that during the winter, surface water runoff could be increased by melting snow on the mountainside.

10.8.43 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 site and capacity of the proposed surface water drainage systems. Landscaping and drainage of the site should be designed to intercept and dispose of any runoff which will mitigate any increase in risk to on-site or off-site areas from this source of flooding. Threshold levels of any proposed buildings should be located 150mm above external ground levels to ensure any excess pluvial flows cannot enter properties.

10.8.44 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 of negligible magnitude, thereby resulting in a **negligible** effect.

Groundwater Flooding

10.8.45 The analysis within the FCA demonstrates that design will take account of local groundwater flows to mitigating the risk of raising groundwater levels and flows on site or elsewhere, take account of groundwater flows into the reservoirs, and ensure that groundwater inflow does not pose a risk to users of the below ground areas.

10.8.46 Any expected significant groundwater flows in the surface layers should be considered by the surface water drainage design for the site to ensure that

any break outs do not cause a risk of flooding to the development or downstream areas. Ground floor finished floor levels of proposed buildings should be set a minimum of 150mm above the local ground level to mitigate the risk of any potential groundwater flows entering the properties.

10.8.47 Assuming design in accordance with the above, the risk of flooding on-site and off-site from groundwater flooding is considered to be low and of negligible magnitude, thereby resulting in a **negligible** effect.

10.8.48 It is currently proposed that a pumped system will serve the below ground areas of the turbine complex to ensure that any groundwater inflows do not cause flooding of the shaft. 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 or 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.

10.8.49 Assuming implementation of the above, the risk of flooding on-site and off-site from groundwater flooding is considered to be low and of negligible magnitude, thereby resulting in a **negligible** effect.

Flooding from Existing Quarry Drainage

10.8.50 It is currently considered possible that there is an existing drainage path through the quarry system between Q3 and Q8 which conveys water to Llyn Padarn.

10.8.51 The analysis with the FCA demonstrates that the Development is unlikely to have a detrimental effect on existing drainage patterns and downstream flood risk, provided the existing drainage is fully accounted for in the design.

10.8.52 Stoppage of flow into Q6 from Q3 to Q5 could potentially result in filling of Q3 to Q5 if no other drainage route exists and may therefore require diversion.

10.8.53 Providing the further investigations above are undertaken at detailed design, and assuming appropriate design of any diversion system, the risk of

flooding due to existing surface water drainage is considered to be low and of negligible magnitude, thereby resulting in a **negligible** effect.

Flooding from Surface Water Drainage

10.8.54 Development of the site may increase the impermeable areas on-site. Additionally a predicted increase in rainfall intensity by 30% over the lifetime of the development is likely to increase surface water runoff from the site. A Drainage Assessment is included within the FCA report, which details the options and constraints for disposal of surface water from the site.

10.8.55 The assessment shows that in addition to proposed impermeable areas, the surface water drainage system will need to consider potential pluvial flows from within and outside the site, 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.

10.8.56 Surface water drains for the development will be designed to Building Regulations Part H and in accordance with other current good practice and legislation. 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 of negligible magnitude, thereby resulting in a **negligible** effect.

Flooding from Foul Drainage

10.8.57 Foul waste water is likely to be discharged to the public sewerage infrastructure off-site, or stored temporarily on site in a cesspit for appropriate disposal.

10.8.58 Any system for disposal to the public sewer will be designed in accordance with the requirements of Dwr Cymru Welsh Water (DCWW) to ensure that there is no detrimental effect on the existing public sewer system. The drainage designer should undertake a more detailed assessment of the foul drainage requirements and agree the allowable foul discharges with DCWW at the detailed design stage.

10.8.59 Foul drains for the development will be designed in accordance with Building Regulations Part H. 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 of negligible magnitude, thereby resulting in a **negligible** effect.

10.8.60 In the event of failure, overflow from the pumping station could pose a flood risk. The pumping station will be designed to Building Regulations Part H standard which allows for the provision of emergency storage. Telemetry to warn of high levels or pump failure should also be included. Regular inspection and maintenance should ensure the pumping station remains in a suitable condition.

10.8.61 Assuming implementation of the above, the risk to the development and areas off-site from pumping station failure is considered to be low and of negligible magnitude, thereby resulting in a **negligible** effect.

10.8.62 Table 10-5 summaries the predicted effects from the operational phase of the Development.

10.9 Mitigation, Compensation and Enhancement Measures

Construction Phase

10.9.1 Appropriate measures will need to be put in place prior to and during construction work in accordance with legislative requirements and good site practice guidance to prevent flood risks occurring.

Risk of Fluvial Flooding

10.9.2 The risk of flooding from Llyn Padarn should be considered at an appropriate level within the risk assessments and management plans for the pumping station construction site. Appropriate emergency procedures should be put in place to be implemented in the event of a flood occurring. Storage of materials and plant should be outside of the flood plain as far as practicable to ensure no increase in flood risk elsewhere. Any requirement for storage of materials within the flood plain will need to be agreed with the NRW. Assuming implementation of the above, this risk is reduced to a **negligible** effect, and therefore **not significant**.

Flooding Due to Restriction of Flow by Mud and Debris

10.9.3 Debris and other material should be prevented from entering temporary or permanent drainage systems or watercourses, through appropriate site management, to ensure that the systems remain operational. Assuming implementation of the above, this risk is reduced to a **negligible** effect, and therefore **not significant**.

Flooding Due to Temporary Increases in Impermeable Area

10.9.4 An increased risk of surface water flooding, as a result of increasing the proportion of impermeable area within the site, should be mitigated by installing an appropriate temporary drainage system which utilises SUDS components where practicable, which must be maintained adequately to ensure their correct operation. The use of detention basins or other temporary attenuation may be required during construction to limit flow to the existing rate of runoff or 'greenfield' equivalent rate, as appropriate to ensure that an increase in flow is not passed forward. Assuming implementation of the above, this risk is reduced to a **negligible** effect, and therefore **not significant**.

Risk of Flooding From Overland Flow

10.9.5 The risk of flooding from overland flow should be mitigated by installing an appropriate temporary drainage system (as discussed above) which takes into account the topography of the site and local area to ensure that any significant overland flows are intercepted or diverted to avoid causing inundation from flooding. Assuming implementation of the above, this risk is reduced to a **negligible** effect, and therefore **not significant**.

Risk of Flooding From Groundwater

10.9.6 De-watering of excavations may be required to mitigate potential inundation with groundwater. De-watering should be undertaken in a manner which cannot cause an increase in flood risk by its disposal. Any dewatering of excavations will require agreement with NRW. Assuming implementation of the above, this risk is reduced to a **negligible** effect, and therefore **not significant**.

Operational Phase

10.9.7 Appropriate mitigation measures to ensure flood risks do not adversely affect the operation of the Development are discussed in full in the FCA report. The following is a summary of measures which may be required.

Further Mitigation of Direct Risk of Fluvial Flooding to Pumping Station

10.9.8 As mitigation against flooding of the below ground infrastructure, consideration should be given to raising the pumping station covers and the level of the lowest electrical components within the control kiosk above the 1:100 year plus climate change flood level if feasible to reduce the likelihood of inundation with flood water. The feasibility of this should be considered at detailed design.

10.9.9 With this additional mitigation, the risk of flooding to the pumping station and the consequences of this flooding would remain a **negligible** effect, and therefore is **not significant**.

Excess Water Management Strategy

10.9.10 An excess water management strategy is required to ensure the pumped storage system continues to operate effectively whilst maintaining operational water level and appropriate freeboard within the reservoirs. Excess water entering the system through natural inflows such as direct rainfall or inflows from drainage will need to be released to Llyn Padarn to maintain the levels at or below the Maximum Operational Water Level without having an adverse effect on flood risk downstream.

10.9.11 As detailed within the FCA report, the strategy must take account of the possible variations in level in Llyn Padarn, including allowing for the operational requirements of the Dinorwig scheme, and an appropriate limit and criteria for restriction of the flow into Llyn Padarn which will be agreed with the EA at detailed design.

10.9.12 The excess water management strategy will be a fundamental part of the overall operating procedures for the development to ensure that downstream flood risk is not increased whilst maintaining an appropriate freeboard within the reservoirs.

10.9.13 The excess water management strategy will need to be reviewed periodically to ensure the freeboard and discharge limits are being met by the current operating and environmental conditions, and to plan for any projected future changes to operation and environmental conditions.

10.9.14 Assuming implementation of an appropriate excess water management strategy and agreement with NRW, this will ensure that downstream flood risk is not increased whilst maintaining an appropriate freeboard within the reservoirs, thereby ensuring that the risks are of **negligible** effect, and therefore **not significant**.

Reservoir Act

10.9.15 Both Q1 and Q6 will be of a volume by which they are regulated under the Reservoirs Act 1975. The proposed dams 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 of both reservoirs indicates that both reservoirs would be categorised as Category A reservoirs and therefore would be subject to the most stringent design standards with the capability to convey the Probable Maximum Flood (PMF) as a design flood.

10.9.16 In line with discussions already commenced with NRW, the Applicant will ensure that the design, inspection and maintenance in accordance with the legislative framework of the Reservoirs Act 1975 will ensure that the risk of failure of the proposed dams remains low throughout their working life.

Emergency Planning

10.9.17 Although it has been demonstrated that the flood risk from the dams and reservoirs will be low, effective local emergency planning will need to be implemented to ensure an appropriate response in the unlikely event of a reservoir failure. An appropriate emergency plan will be developed in conjunction with NRW and Gwynedd Council to ensure that an effective and coordinate response to any emergency can be implemented to further mitigate the potential consequences of such an event. This will further mitigate any risk from the Development ensuring that it remains low and of **negligible** effect, and therefore **not significant**.

On-Site Drainage Systems & Design

10.9.18 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.

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

10.9.20 Assuming implementation of the above, the residual risk of flooding from the proposed drainage systems is considered to remain a **negligible** effect, and therefore **not significant**.

10.9.21 In addition, landscaping and drainage will be designed to intercept and dispose of surface water runoff, therefore maintaining the **negligible** effect for fluvial flooding. This is therefore **not significant**.

10.9.22 Pumping systems for groundwater flows will be designed into the Development and linked to telemetry to ensure that any issues can be identified immediately. Therefore this mitigation maintains the **negligible** effect which is therefore considered **not significant**.

10.9.23 Flooding from surface water and foul drainage systems can be mitigated by design through designing the systems to Building Regulations Part H. This will maintain the **negligible** effect, which is considered **not significant**.

10.9.24 Flooding from the existing Q3 – Q8 quarries is subject to detailed design and further investigations. Once a suitable diversion system has been identified, this will mitigate any potential effects to the site hydrology and maintain the **negligible** effect, which is therefore considered **not significant**.

10.10 Residual Effects

10.10.1 Appropriate mitigation has been discussed in Section 10.9. Overall, it is considered that the residual effects during construction and operation of the

Development, assuming appropriate design and management, including implementation of the mitigation measures, will result in no significant effects.

10.10.2 Table 9-5 presents a summary of the residual construction and operational impacts for the Development, accounting for the effects of mitigation measures on the worst-case impacts as determined within this assessment.

Table 10-5 Summary of Assessment										
Description of Receptor		**Description of Potential Effect**					**Description of Residual Effect**			
Receptor	**Value / Sensitivity**	**Effect**	**Nature of Effect**	**Duration**	**Magnitude**	**Potential Significance**	**Summary of Mitigation**	**Residual Effect**	**Residual Significance**	**Change from 2012 chapter**
Construction										
Construction work at pumping station	Medium	Working with the floodplain	Adverse	Temporary	Medium	Minor Adverse	Implementation of an Emergency Response Plan which will be incorporated into the CoCP	Negligible	Not Significant	No change to significance
Construction works and third parties	Medium	Flooding due to restriction of flow by mud or debris	Adverse	Temporary	Medium	Minor Adverse	Implementation of appropriate site management to be outlined in the CoCP to ensure watercourses are kept free of debris	Negligible	Not Significant	No change to significance
	Low	Risk of fluvial flooding	Adverse	Temporary	Medium	Minor Adverse	Implementation of an Emergency Response Plan which will be incorporated into the CoCP	Negligible	Not Significant	No change to significance
	Low	Flood due to temporary increase in impermeable area	Adverse	Temporary	Medium	Minor Adverse	Installation of temporary SuDS or temporary attenuation allowing runoff at Greenfield rate or less	Negligible	Not Significant	No change to significance
	Low	Risk of flooding from overland flow	Adverse	Temporary	Medium	Minor Adverse	Installation of temporary SuDS or temporary attenuation allowing runoff at Greenfield rate or less	Negligible	Not Significant	No change to significance
	Low	Risk of flooding from groundwater	Adverse	Temporary	Low	Negligible	Method of dewatering of excavations to be agreed with NRW in line with the options in CoCP	Negligible	Not Significant	No change to significance
Operational										
Pumping station equipment	Low	Risk of fluvial flooding from Llyn Padarn	Negligible	Permanent	Negligible	Negligible	Raising the level of the kiosk and electrical components above the 1:100 year plus climate change flood level to reduce inundation by flood water	Negligible	Not Significant	No change to significance

Table 10-5 Summary of Assessment

Description of Receptor		Description of Potential Effect					Description of Residual Effect			
Receptor	**Value / Sensitivity**	**Effect**	**Nature of Effect**	**Duration**	**Magnitude**	**Potential Significance**	**Summary of Mitigation**	**Residual Effect**	**Residual Significance**	**Change from 2012 chapter**
Llyn Padarn flood plain and users	Low	Increase of flooding to Llyn Padarn to third parties from construction of pumping station	Negligible	Permanent	Negligible	Negligible	The area required for the kiosk is negligible compared to the overall area of the Llyn Padarn floodplain and therefore it is highly unlikely that the amount of impermeable landtake needed would increase flood risk to the third party users in the area	Negligible	Not Significant	No change to significance
Nant Y Betws	Medium	Increased fluvial flood risk from discharge from Q1 spillway	Beneficial	Temporary (in an emergency)	Negligible	Negligible	Discharges to the Nant Y Betws will be, as outlined in Volume 3, Appendix 10.1 FCS, would be very similar to the existing natural flow. As the Nant Y Betws is often in times of stress, these additional flows may actually be beneficial downstream to the salmon grounds.	Negligible	Not Significant	No change to significance
	Medium	Increased fluvial flood risk from relief from Q1 spillway	Adverse	Temporary (in an emergency)	Negligible	Negligible	Discharges to the Nant Y Betws will be, as outlined in Volume 3, Appendix 10.1 FCS, would be very similar to the existing natural flow and therefore no adverse effects from relief are anticipated. Prolonged use of the relief would only be in an emergency situation.	Negligible	Not Significant	No change to significance
Llyn Padarn and Afon Rhythallt	Medium	Discharge under normal operating conditions	Adverse	Permanent	Medium	Minor Adverse	Intermittent discharges to Llyn Padarn may be required and will be, as outlined in Volume 3, Appendix 10.1 FCS, would be very similar to the existing natural flow.	Negligible	Not Significant	No change to significance

Table 10-5 Summary of Assessment

Description of Receptor		Description of Potential Effect					Description of Residual Effect			
Receptor	**Value / Sensitivity**	**Effect**	**Nature of Effect**	**Duration**	**Magnitude**	**Potential Significance**	**Summary of Mitigation**	**Residual Effect**	**Residual Significance**	**Change from 2012 chapter**
	Medium	Discharge from Q6 overflow	Adverse	Temporary	Negligible	Negligible	Intermittent discharges to Llyn Padarn may be required and will be, as outlined in Volume3, Appendix 10.1 FCA, would be very similar to the existing natural flow.	Negligible	Not Significant	No change to significance
	Medium	Discharge from Q6 scour	Adverse	Temporary	Negligible	Negligible	Prolonged use of the scour would only be in an emergency situation and with prior approval from NRW.	Negligible	Not Significant	No change to significance
Surrounding Environment	Low	Overtopping of dam / reservoirs from excess water from wave action	Adverse	Temporary	Negligible	Negligible	Design of the reservoir will mean that the operating level will be 1m freeboard. Maintenance of the maximum water level will be a function of the excess water management strategy	Negligible	Not Significant	No change to significance
	Low	Breach Analysis and flood routing	Adverse	Temporary	Negligible	Negligible	Volume 3, Appendix 10.1 and 10.2 outline the mitigation in more detail. Review of design by panel engineer in line with the requirements of the Reservoir Act	Negligible	Not Significant	No change to significance
	Low	Fluvial flooding	Adverse	Permanent	Negligible	Negligible	Landscaping and drainage should be designed to intercept ad dispose of surface water runoff. Threshold levels to be 150mm above external ground levels to ensure pluvial flows do not enter	Negligible	Not Significant	No change to significance
Operational Staff & Third Parties	Low	Offsite groundwater flooding	Adverse	Permanent	Negligible	Negligible	Threshold levels to be 150mm above external ground levels to ensure pluvial flows do not enter	Negligible	Not Significant	No change to significance

Table 10-5 Summary of Assessment

Description of Receptor		Description of Potential Effect					Description of Residual Effect			
Receptor	**Value / Sensitivity**	**Effect**	**Nature of Effect**	**Duration**	**Magnitude**	**Potential Significance**	**Summary of Mitigation**	**Residual Effect**	**Residual Significance**	**Change from 2012 chapter**
	Low	Onsite groundwater flooding	Adverse	Permanent	Negligible	Negligible	Installation of pumping system for groundwater flows in Development linked to telemetry. Regular inspection and maintenance of pumping system should ensure suitable mitigation against onsite flooding	Negligible	Not Significant	No change to significance
	Low	Flooding from surface water drainage	Adverse	Permanent	Negligible	Negligible	Surface water drainage to be designed to Building Regulations Part H	Negligible	Not Significant	No change to significance
	Low	Flooding from proposed foul drainage	Adverse	Permanent	Negligible	Negligible	To be discharged to local foul sewerage network and any system designed in line with Building Regulations Part H	Negligible	Not Significant	No change to significance
	Low	Flooding from existing quarries	Adverse	Temporary	Negligible	Negligible	Subject to detailed design, further investigations and appropriate design of diversion system	Negligible	Not Significant	No change to significance

10.11 Summary and Conclusions

10.11.1 This chapter and the further information within the FCA report demonstrates that there are potential risks during construction and operation from groundwater flooding, pluvial flooding and flooding from existing drainage which require consideration within the detailed design of the site, the buildings, the surface water drainage systems and the reservoirs.

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

10.11.3 The FCA 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 new development.

10.11.4 This assessment 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.

10.12 References

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