

9 WATER RESOURCES

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9 WATER RESOURCES

9.1 Introduction

9.1.1 This chapter presents an assessment of the Development, as set out in Chapter 4 Project Description, in relation to the water environment. This chapter describes the existing baseline surface water and groundwater conditions and identifies potential impacts on the water environment resulting from the construction, operation and decommissioning of the Development. This chapter also describes mitigation measures that would form part of the Development and assesses any residual environmental impacts.

9.1.2 The potential for flooding issues associated principally with the operation of the Development are discussed in Chapter 10 Flood Risk. A detailed assessment of the impacts on freshwater ecology is provided in Chapter 7 Ecology.

9.1.3 The following appendices support this chapter:

- Appendix 9.1 WFD Compliance Appraisal;
- Appendix 9.2 Information on Private Water Supplies from Gwynedd Council;
- Appendix 9.3 Q1/Q6 Water Quality Sampling Programme;
- Appendix 9.4 Water Quality Results; and
- Appendix 9.5 2015 Private Water Supply Information

Summary of 2012 Environmental Statement Chapter

9.1.4 The 2012 Environmental Statement chapter concluded that there are a number of surface water features on and around the Development site. The majority of incident rainfall currently drains in a north easterly direction through the quarries to Llyn Padarn. Due to the hydrogeology of the area,

groundwater is not thought to form an important contribution to regional or local water resources.

- 9.1.5 The assessment established that various potential impacts on the surrounding water bodies may occur as a result of construction, operation and decommissioning of the Development. These will be mitigated by careful design, implementation of an effective CoCP and environmental permitting.
- 9.1.6 With implementation of effective mitigation measures the residual impact on water resources of the Development from the 2012 assessment was considered to be negligible or of no significance.
- 9.1.7 Also contained within the 2012 Environmental Statement chapter was an appraisal of compliance of the Development with the objectives of the Water Framework Directive (WFD) for water bodies in the area. The assessment showed that the Development is compliant with the objectives of the WFD in that the predicted effects of the proposed Development are not considered significant and would not result in the deterioration in quality or quantity or failure to improve of any water body.

Scope of 2015 Environmental Statement Chapter

- 9.1.8 This chapter has been updated as follows:
- Relevant planning policy updates for the water resources assessment (Section 9.3);
 - Relevant baseline updates for the water resources assessment (Section 9.5);
 - Assessment of the changes to the Order Limits and Rochdale Envelope;
 - Amendment to the significance criteria and assessment methodology to be broadly in keeping with the UK wide guidance set out in HD45/09 of the Design Manual for Roads (Highways Agency, 2009). The significance test criteria presented in HD45/09 are independent of the development type and provide a robust method for the prediction of impact significance with regards to the water environment that is used across the UK;

- Review of latest WFD classifications, targets, mitigation and improvement measures and an update to the WFD assessment summarised in Section 9.10 and presented at Appendix 9.1; and
- Any changes to the Development have been reviewed and the impact and WFD compliance assessments updated accordingly.

9.2 Scope of Assessment

9.2.1 The area studied for this assessment consists of the Development itself and extends to cover the catchments of the Afon Gwyrfai and the Afon Seiont in so far as these water bodies might be reasonably affected by the proposed Development. Elements of the Development lie within both river catchments and both water bodies could also be affected by its operation.

9.2.2 The assessment has reviewed available information for groundwater and surface water conditions within the study area. The existing conditions taking into account reasonable future improvements (e.g. WFD targets) form the baseline, against which the impact assessment will be determined. The results of a preliminary ground investigation, which commenced in April 2015 and was completed in September 2015, are required to clarify the geological and hydrogeological conditions, were not available when this chapter was finalised. An assessment of the results of the ground investigation will be provided to NRW and Gwynedd Council during the pre-examination phase of the DCO.

9.2.3 The following matters are addressed in this chapter:

- The baseline surface water and groundwater resources within or close to the proposed storage reservoirs and the connecting spillway infrastructure;
- Options for the provision of a water supply for the Development (i.e. commissioning and future top up water);
- The potential for effects on the surface water and groundwater environments arising from the Development (including water quality and physical form);
- The potential effects on private water supplies in the area;

- Options for mitigating adverse impacts on the water environment; and
- Any residual environmental impacts of the Development (including surface water quality and bathing waters).

9.3 Legislation and Policy Framework

National Policies and Legislation

National Policy Statements

9.3.1 National Policy Statements (NPS) for energy infrastructure were designated under the Planning Act 2008. For this proposal, only the Overarching NPS for Energy (EN-1) published by The Department for Energy and Climate Change (DECC) in July 2011 is relevant.

9.3.2 Sections of the Overarching NPS for Energy (EN-1) include:

- Section 4.10: Pollution control and other environmental regulatory regimes; and
- Section 5.15: Water Quality and Resources.

9.3.3 Section 5.15 states:

“Where the project is likely to have effects on the water environment, the applicant should undertake an assessment of the existing status of, and impacts of the proposed project on, water quality, water resources and physical characteristics of the water environment as part of the ES or equivalent.” (Paragraph 5.15.2)

9.3.4 Paragraph 5.15.3 of NPS EN-1 provides advice on what the ES should describe in the baseline.

9.3.5 Fossil Fuel Electricity Generating Infrastructure NPS (EN-3) and Electricity Networks Infrastructure (EN-5) do not contain any relevant policy statements.

National Legislation and Guidance

9.3.6 Key national legislation and guidelines in respect of water resources considered in this assessment include:

- Water Act, 2003;

- Water Resources Act, 1991 (as amended 2003 and 2010) - Gives power to Natural Resources Wales to issue notices requiring work to be carried out to prevent or remedy pollution of “controlled waters” - surface waters and groundwater. Also provides for designating water protection zones;
- The Land Drainage Act, 1991 (as amended);
- The Environmental Permitting (England and Wales) Regulations, 2010 - Rules to force polluters to prevent and repair damage to water systems, land quality, species and their habitats and protected sites;
- The Environmental Damage (Prevention and Remediation) (Amendment) Regulations, 2010;
- The Conservation of Habitats and Species Regulations 2010 (as amended);
- Groundwater (England and Wales) Regulations, 2009 - Empowers the Environment Agency in England and Wales, now NRW, to prevent direct or indirect discharge of certain dangerous substances to groundwater and control pollution resulting from the discharge of those and other substances;
- Environmental Damage (Prevention and Remediation) Regulations, 2009 – Regulations to ensure that the environment is fully protected against the most serious environmental damage, to surface or groundwater, contamination of land where there is a significant risk to human health or serious damage to EU protected natural habitats and species or damage to Sites of Special Scientific Interest (SSSIs);
- The Eels (England and Wales) Regulations, 2009;
- Water Resources (Environmental Impact Assessment) (England and Wales) (Amendment) Regulations, 2006 - This transposes the provisions of the EC Environmental Impact Assessment Directive (85/337/EC) in respect of projects which require an abstraction licence under the Water Resources Act 1991;
- The Water Environment (Water Framework Directive) (England and Wales) Regulations, 2003 – Transposes the EC Water Framework

Directive (2000/60/EC) in England and Wales. The overall objective of the Water Framework Directive is the 'protection of the water environment' and requires amongst other actions, the implementation of measures to prevent further deterioration in the status of aquatic ecosystems (both quality and quantity) and to protect and enhance terrestrial ecosystems and wetlands;

- The Pollution Prevention and Control (England and Wales) Regulations, 2000;
- Environment Agency: Groundwater Protection: policy and practice;
- Environment Agency: Pollution Prevention Guidelines (PPGs);
- CIRIA (2005) C650 Environmental Good Practice on Site; and CIRIA (2006) C648 Control of Water Pollution from Linear Construction Sites (relevant to all construction sites and latest publication on the topic)

Regional Planning Policy

9.3.7 Planning Policy Wales (PPW) (Edition 7, July 2014) contains the following relevant policies:

- 12.2 – Water supply and waste water management;
- 12.3 – Development plans and water;
- 12.4 – Development management and water;
- 13.10 – Improving the quality of water and air;
- 13.11 – Development plans and improving the quality of water and air; and
- 13.12 – Development management and improving the quality of water and air.

The Government's Water Strategy for Wales, 2015 (consultation closed).

9.3.8 The Welsh Government is currently consulting on its proposed water strategy for Wales. The Strategy sets out the long-term policy direction in relation to water. It aims to balance the long-term needs of a sustainable and resilient environment with the need to ensure that there are sufficient,

reliable water resources and waste water services available to encourage sustainable growth. It also advocates a more integrated approach to managing water as part of our wider approach to natural resource management.

Local Policy

9.3.9 The potential effects of Development on the water environment are considered in Policy C29 of the Gwynedd Unitary Development Plan 2001-2016, which states:

“Proposals that will cause significant harm, which cannot be mitigated or managed effectively, on surface water, groundwater sources or freshwater ecosystems will be refused.”

9.3.10 The purpose of the Policy is to ensure that developments do not cause unacceptable adverse effects on existing water resources and water quality.

9.4 Consultation

9.4.1 A Scoping Report for the approved scheme was submitted to Gwynedd Council in November 2011 as part of the 2012 EIA. Responses to the Scoping Report were made by Gwynedd Council and by NRW. These can be seen in Appendix 2.2 of the 2012 ES (contained within Volume 3, Appendix 2.1).

9.4.2 The response from NRW included advice in respect of the need for a licence to abstract water from Llyn Padarn for the initial filling of the reservoir and the need to consider the potential impact of the Development on private water supplies in the area. A specific comment was made regarding the need to assess the impact of discharging excess water and the potential impacts of the Development on the current drainage pattern. A subsequent meeting was held with NRW in May 2012 to discuss the approach for the assessment of the development on water resources.

9.4.3 The Scoping response from Gwynedd Council included the requirement to assess the potential impact of the Development on Llyn Padarn SSSI as a result of discharges of ‘polluted’ water or changes to the temperature of the lake. Although this Chapter takes into account the SSSI status of Llyn

Padarn, please refer to Chapter 6 Ecology for the assessment of impacts on specific ecological receptors.

9.4.4 Further to the submission of the Scoping Letter on the amended Development on the 12th November 2014, NRW responded on the 16th December 2014 requesting that an extended private water supply survey be undertaken, and that a survey and report is carried out on the effect of the watercourses in the vicinity and boundary of the Development.

9.4.5 The DCO Scoping Report for the Development was submitted to PINS on the 5th January 2015. In addition to requesting that the previous 2012 assessment is updated to reflect changes to the Development, planning policy, guidance and consultation, a number of comments were made by PINS and other stakeholders relating to the scope of assessment which are summarised below:

- The need to reconsider the impact assessment criteria using more recent guidance (e.g. Weltag/Webtag);
- The potential for modifications to groundwater flow and risk of contamination from additional drilling, blasting activities and other underground plant;
- An assessment of the depth of any discharge to Llyn Padarn and its typical seasonal stratification;
- An assessment of potential geomorphic effects of discharges on Llyn Padarn;
- An assessment of potential effects on bathing waters in Llyn Padarn;
- A request that a water quality sampling programme is carried out, including water quality and sediment samples from Q6; and
- An assessment of the risk to the Afon Gwyrfai from any water transfer from Llyn Padarn and Q1.

9.4.6 A meeting with NRW took place on the 15th July 2015 to discuss ongoing aquatic ecology surveys and water quality sampling as well as other scheme progress. Further to this meeting NRW provided the following additional comments on the application:

- In commenting on the on-site water quality survey data provided at the time, NRW were in agreement that the data did not show any anomalies or departures from EQS values;
- Runoff from areas where there is slate waste needs to be carefully controlled, especially when crushed, since this could give rise to high suspended sediment loads. Slate is also high in aluminium that can be toxic to fish, especially when the pH is low. The potential impacts on Llyn Padarn and the Afon Gwyrfai needs to be considered and NRW would expect mitigation measures on site to deal with this specific issue.
- NRW expect that a programme of catchment water quality monitoring is undertaken prior to and during the construction phase. This should include the preparation of an Action Plan in the event that adverse or unusual monitoring results are observed. The sampling programme should consider the following parameters as a minimum: Total and dissolved metals, suspended solids, chemical oxygen demand (COD), and biochemical oxygen demand (BOD), ph and electrical conductivity; and
- The installation of a coffer dam in Llyn Padarn required for the installation of the spillway infrastructure may require an Environmental Permit.

9.4.7 NRW granted an abstraction license in July 2015 to abstract water from Llyn Padarn. The licence was for a total abstraction of 1,100,000m³ of water from Llyn Padarn limited to 2000 m³ /day and 550,000 m³ / year in the aggregate (i.e. abstraction at the maximum daily rate is allowed for only 275 days per year). Abstraction is also prohibited unless the water level at the Pablic Mill Gauging Station on the Afon Seiont (NGR SH 49450 62269) is equal to or greater than 0.343 m.

9.4.8 In addition to the above, NRW have advised that a Water Activity Permit (i.e. an environmental permit otherwise known as a discharge consent) may be needed for the discharge of water from Q1 and Q6 to enable works to start in the quarry. NRW also advises that should the water in Q1/Q6 be contaminated during operation (including temperature differences) then an

environmental permit will also be required for the treatment of the water prior to discharge.

9.4.9 In addition, an application for a Flood Defence Consent under Section 109 of the Water Resources Act 1991 (as amended) has been approved for the installation of the spillway infrastructure within the byelaws distance from the lake margin. A Land Drainage Consent will also be required from Gwynedd Council as the lead local flood authority responsible for Ordinary Watercourses for any permanent or temporary works within the byelaws distance of the Nant-y-Betws stream in accordance with Section 23 of the Land Drainage Act 1991 as amended by the Floods and Water Management Act 2010.

9.5 Baseline Conditions

Sources of Information

9.5.1 The following sources of information have been used in the assessment of the water environment in the area of the Development:-

- AECOM (2012) A report of a hydrogeological site walkover investigation by AECOM (please refer to Volume 3, Appendix 8.1);
- AECOM (2012) Water quality sampling at four locations around Q6 and Q7 for range of physico-chemical, metal, and major ion parameters;
- Bennion, H., Burgess, A., Roe, K., Yang, H., and Thomas, R (2010) Palaeoecological Study of Llyn Padarn, CCW Contract Science Report No. 918 39pp, ENSIS Ltd, University College London;
- British Geological Survey (BGS) 1:50,000 scale map, Sheet 106 Bangor;
- BGS 1:10,000 scale map SH56SE;
- CCW (2012) Bathymetric data for Llyn Padarn;
- Daily Llyn Padarn levels from September 2007 to August 2015 (NRW, 2015);
- Daily mean flows in the Afon Seiont (at Peblig Mill) from August 1976 to August 2015 (NRW, 2015);

- Daily mean flows in the Afon Peris (at Nant Peris) from March 1982 to August 2015 (NRW, 2015);
- 15 minute river levels in the Afon Seiont (at Pablic Mill) from October 2009 to August 2015 (NRW, 2015);
- 15 minute river levels in the Afon Peris (at Nant Peris) from October 2009 to August 2015 (NRW, 2015);
- Llyn Padarn bathymetry data and associated level-storage table ((NRW, 2015);
- Environment Agency Wales (2006) The Llyn and Eryri Catchment Abstraction Management Strategy;
- Environment Agency Wales (2009) River Basin Management Plan: Western Wales River Basin District;
- Environment Agency Wales (2014) Draft Cycle 2 River Basin Management Plan: Western Wales River Basin District;
- ESI (June, 2011) Pumped Storage Hydroelectric Development: Hydrogeological desk study, report reference 60524TN1;
- Etive Ecology (September 2012) Glyn Rhonwy Pumped Storage Scheme: Llyn Padarn Freshwater Ecology Impact Assessment, Produced for Quarry Battery Ltd;
- Goldsmith, B., Henderson, G., Shilland, E.M., Dowman, S., Tomlinson, M. & Harwood, A. (ENSIS Ltd. June 2015) Aquatic Surveys: Glyn Rhonwy Quarries Q1 and Q6 - Final Report to AECOM;
- NRW (2015) Water quality for the Afon Gwyrfai January 2004 to April 2015 from a station just downstream of where the Nant-y-Betws confluence (NGR SH 52620 59030);
- NRW (2015) Water quality data for Llyn Padarn January 2004 to April 2015 from station close to the outfall to the Afon Seiont (NGR SH 55954 62329);
- NRW (2015) 2014 WFD classifications including new standard river specific Soluble Reactive Phosphorus (SRP) targets;

- NRW (2015) 2014 Bathing Waters Monitoring Data;
- Online Ordnance Survey Maps (<http://www.bing.com/maps/>);
- Thomas, R.H, and Holt, R. (2011) Diver Observations on Arctic charr (*Salvelinus alpinus* L.) Spawning Grounds in Llyn Padarn SSSI. CCW Staff Science Report No. 11/8/2; and
- Various correspondences with statutory consultees and other relevant stakeholders.

Desk Study

- 9.5.2 A desk study of the groundwater and surface water conditions of the Development site and the surrounding area has been carried out using a combination of published and unpublished information to facilitate a qualitative assessment of the potential impacts of the Development on water resources.
- 9.5.3 A site visit was carried out on 2nd February 2012 to identify water features in the area and the current surface water drainage characteristics. A copy of the report of the walkover investigation is provided in Volume 3, Appendix 8.1. A repeat site visit was undertaken on the 28th July 2015, the results of which are discussed in the WFD assessment presented in Appendix 9.1.
- 9.5.4 Water quality sampling of Q6 and the adjacent area was initially undertaken in July 2012 at the locations shown in Volume 4, Figure 9.3. Additional freshwater ecological surveys and water quality sampling was undertaken during the spring and summer of 2015 for both Q1 and Q6 by ENSIS Ltd to a scope agreed between AECOM and NRW.

Groundwater

- 9.5.5 There is very limited published information regarding the hydrogeological characteristics of the strata exposed in the Order Limits. As discussed in Chapter 8, the geology of the area is relatively complex with extensive faulting and folding of the strata.
- 9.5.6 Further information on the ground and groundwater conditions, is being gathered from a preliminary GI works, which were completed onsite in September 2015. The ground investigation targeted the two quarries (Q1

and Q6) which form the principal elements of the Development, together with the route of the penstock between the two quarries and the route of the spillway from Q6 to Llyn Padarn. A plan showing the locations of the boreholes and trial pits is provided in Figure 8.4. The factual geo-environmental findings of the ground investigation will be provided to NRW and to Gwynedd Council during the pre-examination phase of the DCO.

- 9.5.7 It is likely that the slates of the Llanberis Slates Formation have a very low primary (intergranular) permeability but a higher secondary permeability imparted by the presence of fractures. The sandstone units in the Llanberis Slates are heavily indurated and flow is likely to be limited to the fractures. These may provide local zones of higher permeability and areas of preferential groundwater movement. Generally, it is considered that groundwater flow is limited to the fractures and it is likely that the volumes of groundwater storage and flow are small.
- 9.5.8 It is likely that the sandstone, siltstone and conglomerate of the underlying Fachwen Formation also have a low primary permeability as the strata are heavily indurated and quartzitic with a higher secondary fracture permeability. Groundwater flow within these units again is likely to be dominated by fractures.
- 9.5.9 It is considered that groundwater flow within the Order Limits will be concentrated within fractures and fissures, and potentially blast fractures, in the shallow subsurface surrounding the quarries. Regionally, it is likely that groundwater flows in a north easterly direction towards Llyn Padarn.
- 9.5.10 It is likely that the principal control on shallow groundwater movement within the Order Limits is the reject slate material in the extensive spoil heaps, which includes large boulder sized material. The spoil heaps rest on the low permeability Llanberis Slates Formation, which impedes the vertical migration of water and maintains a perched water system in the overlying slate spoil. It is likely that there is the potential for significant groundwater flow through the voids present within the spoil heaps, which provide a high permeability pathway for the rapid movement of water. However, it is likely that groundwater storage within the spoil is negligible and that the volume of

groundwater movement is linked directly to rainfall with a very 'flashy' response and limited flow during periods of dry weather. As the topography of the base of the spoil heaps is not known, it is possible that the local direction of groundwater flow in the slate spoil differs from the apparent surface water catchments of the spoil heaps.

- 9.5.11 The Llanberis Slates and the Fachwen Formations are designated as Secondary B aquifers in the Environment Agency 'Groundwater Protection: Policy and Practice'. Secondary B aquifers typically are low permeability strata with limited ability to store and transmit groundwater, with groundwater flow often associated with fracture and thin permeable horizons. Such aquifers are of negligible importance for groundwater resources.

Local hydrogeology

- 9.5.12 This section describes the hydrogeological conditions and the surface water drainage in each of the quarries within the Order Limits.

Q1 Headpond (Chwarel Fawr)

- 9.5.13 An area of water is present in the south western part of the base of the quarry (Volume 3, Appendix 7.1: Photo 4). At the time of the site visit, there was no evidence of water ingress to the quarry or of flow from the quarry. It is likely that the fractured quartzitic sandstone exposed on the north western side of the quarry provides a pathway for water to leak from the quarry. Any water migrating from the area surrounding the quarry will drain in a south westerly direction into the Afon Gwyrfai catchment. A bathymetric survey of the quarry in May 2015 estimated the water to be up to 7m deep.

Q2 (Chwarel Cefn Du)

- 9.5.14 Q2 is located to the north east of Q1 and does not form part of the Development but is described here to provide descriptive context. The quarry is excavated largely in the slates of the Llanberis Formation, although there is evidence of more fractured strata on the north western side of the quarry. There is no evidence of water in the base of this quarry, although there is extensive spoil on the quarry floor which may obscure any

standing water or drainage. There was no evidence of water inflows to this quarry.

9.5.15 To the north east of the quarry, a small tunnel is present, which appears to have been excavated into sandstone. The tunnel provides a drainage adit and contained flowing water at the time of the site visit in February 2012. The water flows in a north north easterly direction to an area of seepage and springs above a large area of slate spoil (Volume 3, Appendix 8.1: Photo 3). The exit of the adit is at a significantly higher level (several tens of metres) than the base of Q2.

9.5.16 Water emerging from the area of springs and seepages passes into an extensive area of slate spoil from where there is evidence of water flowing both to the north and north east. It is likely that sub-surface flow within the spoil heap to the north emerges at the toe of the slate spoil to form the headwaters of a small un-named stream (Volume 3, Appendix 8.1: Photo 2). Flow to the north east emerges below the slate spoil heap in another series of seepages which drain to a small pond (Volume 3, Appendix 8.1: Photo 1) and then to a small north easterly flowing watercourse.

Quarries 3 and 4 (Cook and Ddol Slate Quarries)

9.5.17 Q3 and Q4 do not form part of the Development. It appears that the base of Q4 is higher than that of Q3 but the level of variation needs to be confirmed. Although there was no evidence of standing water in Q4, there were several flows of water entering the quarry on the south eastern side. These appear to be related to surface water drainage from the higher land to the south east and not to groundwater inflows. There is no evidence of drainage from Q4 to the north east.

9.5.18 Between Q4 and Q5 within the quarry spoil which forms the ground surface on the northern side of both quarries, shallow culverts have been identified. The purpose of these culverts is unclear but it is unlikely that these are connected to drainage of the quarry voids as they are located on the edge of the voids several tens of metres above the quarry floor.

Q5 (Locally known as Gideon Quarry)

9.5.19 Q5 does not form part of the Development. There is no evidence of water in the base of Q5 or of water ingress to the quarry. However, there are a number of tunnels in the north eastern quarry wall which may provide drainage from the quarry towards Q6. It will be necessary to investigate further the drainage from this quarry, particularly as it is proposed to raise the water level in Q6, which could 'back up' into Q5.

Q6 Tailpond (Glyn Rhonwy Quarry)

9.5.20 Q6 is the location for the tailpond reservoir. Currently much of the quarry is flooded. A bathymetric survey was undertaken of Q6 in December 2014 and this confirms that the water depth is approximately 17m. The aquatic survey of April/May 2015 showed that there was no substantial layer of sediment on the floor of the quarry, which consists of slate waste.

9.5.21 The water level in the quarry is controlled by an overflow at the north eastern end of the lake from where water passes into a small tunnel excavated into a pinnacle of slate, which runs approximately 75% of the way across the quarry from the south eastern edge. The overflow water seeps into the floor of the tunnel although there is no indication of where the flow proceeds from this point. The tunnel has been excavated into a section of poor quality slate with numerous fractures and evidence of 'shattering'. At the foot of the north eastern face of the quarry, there is another tunnel which may act as a drainage pathway for water to flow from the quarry. At the time of the site visit, there was no evidence of water flow into the tunnel.

Q8 (Former Munitions Store)

9.5.22 The Former Munitions Store does not form part of the Development as the spillway is diverted around the quarry and former store. However, it is likely that water incident to or flowing through the quarry from the upper quarries discharges to Llyn Padarn.

9.5.23 There is a manhole chamber to the east of Q8 adjacent to the car park between Llyn Padarn and the A4086 road which contains a 16" diameter pipe which appears to be directed towards Q8. There is evidence in the ESI

report of 2011, that this is related to a spring and that the pipe flows even in dry conditions and the chamber often overflows but also contradictory evidence that the pipe has been dry. There is anecdotal evidence that the pipe is regularly flowing half full and that during wet weather conditions the area around the manhole is flooded. At the time of the site visit in February 2012 and during a water sampling exercise in July 2012, there was no flow from the pipe. Based on these observations, it is considered that the flow from the pipe is very flashy, consistent with the assumed hydrogeological characteristics of the ground.

- 9.5.24 On both occasions in 2012, there was flow in the chamber below the pipe. This entered the chamber from the south east. The source of the water currently is unclear but it may reflect drainage from a small quarry (Q7) located between Q6 and Q8 and possibly from a former tunnel shown on historical OS plans, which ran easterly from Q5 (Volume 3, Appendix 7.4). The position of the exit from the tunnel is not currently known. It is assumed that water passing through the manhole flows towards Llyn Padarn but the discharge point to the lake has not been located.

Drinking Water Protected Areas

- 9.5.25 The objectives for Drinking Water Protected Areas (DrWPAs) are to 'ensure that, under the water treatment regime applied, the drinking water produced meets the requirements of the Drinking Water Directive, and ensure necessary protection in the DrWPA with the aim of avoiding deterioration in water quality in order to reduce the level of purification treatment required in producing drinking water.' According to the RBMP the Afon Seiont, Afon Gwyrfai and the Llyn & Eryri groundwater body are all included within DrWPAs. However, no potable water is currently abstracted from Llyn Padarn. It is anticipated that the scheme will have no adverse impact on any local raw water supplies, and thus this Protected Area shall not be considered any further.
- 9.5.26 NRW have provided details of a number of local licensed water abstractions which are shown in Figures 9.4 and 9.5, and summarised in Table 9.1 below.

Table 9-1: Licensed Water Abstractions							
Fig 9.4 ref	Licence Ref. No.	Abstraction point NGR	Licence Holder	Max Annual Quantity (MI)	Max Daily Quantity (m3)	Purpose	Orig. Effective Date
1	23/65/16/0009	SH54196386	Dwr Cymru Cyfyngedig	1244467.5	3409.5	Public Water Supply	29/11/1965
2	23/65/16/0019	SH48776151	Cyngor Gwynedd	382300.42	1047.398	Lake through-flow	29/11/1965
3	23/65/16/0039	SH50596193	Glan Gwna Holiday Park Ltd	93502.1	256.17	Private water supply	24/06/1968
4	23/65/16/0041	SH58025887	Chester Mountaineering Club	227.3	0.623	Private water supply	31/03/1969
5	23/65/16/0053*	SH58905985	First Hydro Company	3409500000	13638000	Electricity Generation	19/12/1973
6	23/65/16/0053	SH61546207	First Hydro Company	3409500000	13638000	Electricity Generation	19/12/1973
7	23/65/16/0062	SH57855931	The National Museum Of Wales	133325.08	666.625	Power generation	24/03/1986
8	23/65/16/0063	SH61855729	Dwr Cymru Cyfyngedig	43800	120	Public water supply	31/08/1989
9	23/65/16/0063	SH61935730	Dwr Cymru Cyfyngedig	43800	120	Public Water Supply	31/08/1989
10	23/65/16/0064	SH60686265	Dwr Cymru Cyfyngedig	1460000	4000	Public Water Supply	31/08/1989

Table 9-1: Licence Water Abstractions continued							
Fig 9.4 ref	Licence Ref. No.	Abstraction point NGR	Licence Holder	Max Annual Quantity (MI)	Max Daily Quantity (m3)	Purpose	Orig. Effective Date
11	23/65/16/0065	SH53266427	Seiont Gwyrfai & Llyfni Anglers Society	158112	432	Aquaculture - Fish	11/10/1965
12	23/65/16/0067	SH57825931	DHG Hydro Limited	20498400	56160	Electricity Generation	24/09/1991
13	WA/065/0016/009	SH62109566 48	Jones	5991840	16416	Electricity Generation	20/12/2013
14	WA/065/0016/010	SH61394591 17	Peris Hydro Ltd	6120576	21859.2	Electricity Generation	10/12/2013
15	WA/065/0016/012	SH61344601 42	Peris Hydro Ltd	5056128	18057.6	Electricity Generation	29/11/2013
16	WA/065/0016/014	SH61906579 94	Afon Las Hydro Limited	2612736	9331.2	Electricity Generation	19/06/2015

Private Water Supplies

- 9.5.27 The Order Limits area is exempt from abstraction licensing for groundwater supplies. The Development does not lie within a Source Protection Zone for a sensitive groundwater abstraction.
- 9.5.28 Information has been obtained from Gwynedd Council on known private water supplies in the area. In addition, as part of the 2012 ES SPH obtained information on private water supplies in the vicinity of the Development through a ‘mail shot’ to properties in the area, seeking information on the presence and details of any private water supplies. A copy of the letter is provided in Volume 3, Appendix 9.2.
- 9.5.29 Responses were not received from all addresses to the 2012 “mail shot” and hence it was not been possible to confirm that all the private water supplies in the area had been identified. Initially, letters were sent to 15 properties and replies were received from, and meetings held with nine property owners.
- 9.5.30 As a result of the change in the Order Limits, in 2015 SPH has undertaken a repeat survey to identify any additional private water supplies. A total of 21 private groundwater and surface water supplies have been identified in the area. Letters were sent to 9 other properties where a private water supply was anticipated but from where no replies previously had been received and for other properties in close proximity to the extended Order Limits. A summary of the known private water supplies is provided in Table 9.2. A plan showing the locations of the private water supplies in the area is provided in Volume 4, Figure 9.1.
- 9.5.31 Based on the responses, it is considered that the sources in two areas are of greatest significance in respect of the Development. Several sources are located to the north of the Development. These are principally supplies from streams and springs, which rise from slate stockpiles to the north east of Q2. The properties of Llys Elen, Capel Glegyr, Tan Hafoty, Craig Y Llyn, Ty Newydd, Hafod Wen and Goat Cottage, all obtain their water supply from springs or a stream, which flows in a north north-easterly direction immediately to the north of the development site. The stream rises at the

foot of a large slate stockpile (NGR SH55940 60860). It is considered that the source of the stream is the high level discharge from Q2, together with incident rainfall and surface water runoff into the large slate stockpile to the north east of Q2. It is understood that the flow in the stream reduces during drought periods but remains sufficient for the supplies.

9.5.32 A number of sources are located to the south west of the Development in the catchment of the Afon Gwyrfai. The two properties of Ynysoedd and Tyn y Ceunant obtain their water supply from the Nant-y-Betws, which flows in a south westerly direction from Q1. The Nant-y-Betws is a tributary of the Afon Gwyrfai.

9.5.33 Other private water supplies have been identified from the responses to the north and south west of the Development. The supplies to the south west, include Tyr yr Onnen Farm and Camp Site, Tyn Wern, Ffridd Farm, Gwastad Faes, Hendy Gwastad Faes and two properties at Tai Isaf. These consist mainly of springs and abstractions from watercourses, which rise on the western flank of Bryn-Mawr. These springs are more than 1km from the western edge of Q1 and are located above the Nant-y-Betws stream valley. It is reported that there are borehole supplies at 1 Tai Isaf and at Tyn y Onnen Caravan Park and Campsite.

9.5.34 The known private water supplies to the north of the Development comprise a borehole at Parciau Glesion and other nearby sources, including Lakeside, below Parciau Glesion. These sources are approximately 1.5km north of the Development. There are a number of shallow valleys between the Development and these properties, which would restrict the extent of any effects on these supplies.

Table 9-2: Private Water Supplies			
Ref. No	Name	NGR (SH)	Source
1	Llys Elen	55786093	Stream
2	Tan Haforty	56076087	Spring
3	Ty Newydd	56076087	Spring (joint with Tan Haforty)
4	Capel Clegir (Malones)	55936086	Spring
5	Bryn Clyd	55676128	Stream
6	Pendraw	55586122	Stream
7	Gallt y Celyn	55446145	Stream
8	Hafod Wen	56446144	Stream
9	Goat Cottage	56446144	Stream
10	Craig y Llyn	56446155	Stream
11	Parciau Glesion	54806191	Borehole
12	Glyn Peris Cottage	N/K	N/K
13	1 Tai Isaf	53205882	Borehole 24.4m deep
14	2 Tai Isaf	53205865	Stream
15	Hendy Gwastad Faes	53275912	Stream
16	Gwastad Faes	53255912	Stream
17	Ffridd Felen	53615914	Spring
18	Ynysoedd	53425894	Stream (Nant-y-Betwys)
19	Tyn y Ceunant	53895917	Spring and stream (Nant-y-Betwys)
20	Tyn y Onnen Caravan Park and Campsite	53805898 53915888	Spring, well, borehole and stream
21	Tyn Wern	53675861	Stream

NOTE: The NGR refer to the supply source location (where known).

9.5.35 The locations of the private water supplies are shown on Figure 9.1.

Surface Water Features

9.5.36 There are number of surface water features within the Order Limits and the study area including:

- Quarry Basins and Local Watercourses;
- Llyn Padarn;
- Nant-y-Betws (including tributaries) and the Afon Gwyrfai; and
- Afon Rhythallt and the Afon Seiont.

9.5.37 There are other surface water bodies within the study area, but as these have no hydrological connection to the site and cannot be impacted by the proposed development they have not been considered.

Quarry Basins and Local Watercourses

9.5.38 The Development is located in an area of high rainfall. The estimated annual rainfall at the site is 1867 mm. Q1 and Q6 contain water, with the greatest amount of water in Q6. It is estimated that there is 500m³ of water in Q1 and approximately 100,000 m³ of water in Q6 (this is a worst case assumption based on an estimate of 50,000 m³ of water in the standing water column and a further 50,000 m³ in the voids of the slate waste believed to reside in the bottom.

9.5.39 As the slate has a low permeability which restricts groundwater flow, it is surprising that the quarries do not hold larger quantities of water as there is no obvious visual drainage within most of the quarries, other than in Q6. The absence of water in many of the quarries suggests that there may be an abandoned drainage system, which was used to maintain dry quarries during working and that this continues to provide adequate drainage of the quarries preventing water accumulating in the voids. Adits have been identified in some of the quarries often at elevated levels above the quarry floor. It is possible that the higher level adits were utilised for access or for the removal of slate to the lake and railhead.

9.5.40 An investigation of Q1 has identified a partially filled tunnel at the north eastern end of the quarry on the quarry floor. It is likely that the lower tunnels were over-excavated and then partially backfilled with slate spoil to provide a drainage pathway, but also access between the quarries. This is

consistent with observations in Q6 where water drains through the floor of a tunnel in the slate buttress on the north eastern side of the lake. Further investigation of the tunnels and hydraulic connection between the quarries is required to confirm what measures, if any, are necessary to manage surface water drainage between Q5 and Q6. This will be carried out as part of the detailed design phase prior to construction.

- 9.5.41 The quarries are located on the south western side of Llyn Padarn and it is considered that surface water and associated groundwater flows in a generally north easterly direction towards the lake. A number of surface water catchments have been identified across the Development and the approximate surface water divides are shown in Volume 4, Figure 9.2. The lower quarries are located within the catchment of the Afon Glyn to the south, which drains to Llyn Padarn.
- 9.5.42 There are few surface watercourses within the Order Limits and the area of the quarries. Where present they are small and fed by surface water runoff and sub-surface discharges from the slate spoil heaps. They are expected to respond rapidly to storm events and are unlikely to provide a sustained volume of water due to the nature of the geology and catchment.
- 9.5.43 To the north of the quarries and beyond the Order Limits there are a number of small watercourses, which generally rise from issues within the slate spoil heaps and flow in a north-north easterly direction towards Llyn Padarn. To the south east of the quarries, surface water flows in a generally south easterly direction to the Afon Glyn, a small watercourse rising within the southern extents of the former slate quarries and flowing eastwards towards Llyn Padarn via Llyn Tomos to the north west of Llanberis village at approximately NGR SH 57300 60800. The location is to the south of the 'lagoons' but the precise location is uncertain as the watercourse is believed to enter a culvert under the A4086 and this could not be located during the site visits. The Nant-y-Betws and tributaries drain the south and eastern margins to the Order Limits and are described in more detail below.

Llyn Padarn

9.5.44 Llyn Padarn is designated as a SSSI primarily for its rare and genetically unique population of Arctic charr (*Salvelinus alpinus*), nationally scarce water plant Floating Water-plantain (*Luronium natans*) and exposed Cambrian rocks. Arctic charr are known to spawn in the Afon y Bala area at the southern area of the lake, although there are indications that other spawning sites around the littoral margins of the lake to depths of approximately 8 m may also be used. An investigation by CCW with hydroacoustic and scuba dive surveys in December 2010 implied that Arctic charr may use the littoral edge around the 'sidings' at SH 57166 61213 and extending to the northwest, close to where the spillway infrastructure structure is proposed (Thomas & Holt, 2011).

9.5.45 Llyn Padarn was recently designated as a bathing water under the Revised Bathing Waters Directive. In addition, the lake is also used for a range of water-based adventure activities including canoeing and kayaking, especially in and around the area known as 'the lagoons' approximately in the mid-point on the southern bank. Water samples are collected to monitor compliance from a monitoring station at NGR SH 57396 60866. In 2014, this bathing water had excellent quality with no observations of sewage debris, animal faeces, oil and tarry residues, and only trace observations of litter. Bathing water quality is dependent on the characteristics of the catchment and NRW has identified the principle risks to maintaining good water quality as being: in-flowing rivers and streams, discharges from Llanberis WwTW, emergency and storm water overflows, misconnections, indirect impacts from the Dinorwig Hydropower Station and unsewered domestic waste water discharges.

Afon Rhythallt and Afon Seiont

9.5.46 The outflow from the north western end of Llyn Padarn drains via the Afon Rhythallt, which becomes the Afon Seiont approximately 3 km downstream. The Afon Seiont flows westerly and then south westerly before discharging to the Menai Straits at Caernarvon, approximately 11 km downstream of the lake. The Afon Seiont was designated as a salmonid river under the Freshwater Fish (Consolidated) Directive, before it was subsumed by the

WFD. Please refer to Appendix 9.1 for further details of the water quality of this watercourse.

Nant-y-Betws and the Afon Gwyrfai

- 9.5.47 Q1 is in different surface water catchments than the remaining quarries (such as Q6). Runoff from the area surrounding the uppermost Q1 and the southern part of Q2 does not drain towards Llyn Padarn, but flows in a westerly direction through a small watercourse, known as the Nant-y-Betws to the Afon Gwyrfai (although there are no known flow pathways between the existing Q1 and the Nant-y-Betws stream). There are also private water supplies taken directly from the Nant-y-Betws (please refer to Figure 9.1).
- 9.5.48 The Nant-y-Betws is a small upland watercourse with a bed dominated by bedrock, boulders and cobbles but that is known to have some erosion issues in places. It rises just west of the Bwlch-y-Groes disused slate quarry and tip and flows westwards through the Donen Lâs forest picking up numerous tributaries flowing downslope perpendicular to the valley direction. Three tributaries flowing due south coalesce to the west of the existing slate waste tip and join the Nant-y-Betws on the edge of the Order Limits.
- 9.5.49 The Nant-y-Betws joins the Afon Gwyrfai approximately 2.5 km west south west of Q1. The Afon Gwyrfai flows in a westerly direction and discharges to the sea in the Menai Straits. The Afon Gwyrfai is a sensitive watercourse as it forms part of the Afon Gwyrfai a Llyn Cwellyn SSSI/SAC for Atlantic salmon (*Salmo salar*), floating water plantain (*Luronium natans*), otter (*Lutra lutra*) and floating vegetation often dominated by water crow-foot (*Ranunculus aquatilis*). The Afon Gwyrfai has also been identified by NRW as an over-licensed catchment from which no further consumptive abstractions will be permitted. It was designated as a salmonid river under the Freshwater Fish (Consolidated) Directive, before it was subsumed by the WFD.
- 9.5.50 The whole length of the river, extending approximately 8 km upstream from the confluence with the Nant-y-Betws, is designated as a SSSI for its geological and biological features. The geological interest is related to a

small trial mineral working located on the shore of Llyn Cwellyn, which contains fluorite mineralisation. The biological interest is associated with the presence of Arctic charr within the nutrient-poor lake and for the presence of a number of rare plant species. The Afon Gwyrfai is considered to be one of the best examples of an oligotrophic to mesotrophic river with submerged beds of aquatic plants. The river also supports populations of Atlantic salmon and lamprey and a significant population of otters. Please refer to Appendix 9.1 for further details of the water quality of this watercourse. In addition, Volume 3, Appendix 6.1.2 provides the formal designation of the SSSI.

Surface Water Quality – Quarry Basins

9.5.51 There is currently limited information on the water quality in the quarry lakes or for the discharges at the manhole below Q8. In July 2012, water samples were collected from four locations within the development area in the vicinity of Q6. At the time of sampling there was no flow from the pipe in the manhole below Q8 (Location 2). Additional water quality sampling has been undertaken in 2015 in accordance with the methodology described in Appendix 9.3 for locations shown on Figure 9.3. The samples were analysed for the parameters listed below:

Analytical suite for water samples

pH, electrical conductivity, metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, aluminium, antimony, barium, boron, cobalt, lithium, iron, manganese, molybdenum, strontium), cyanide, alkalinity, calcium, magnesium, sodium, potassium, chloride, sulphate, nitrate, nitrite, ammoniacal nitrogen, orthophosphate, total petroleum hydrocarbons, PAH (16), BOD, & COD.

9.5.52 The 2012 results of the laboratory analyses are presented in Volume 3, Appendix 9.4. The laboratory results show that there was no evidence of contamination of the surface waters sampled and that the water quality was satisfactory. The concentrations for all of the determinands analysed were below the respective EQS values for 'freshwater' where these exist. The electrical conductivity values were low, ranging between 147 $\mu\text{S}/\text{cm}$ in the Q6 lake and 270 $\mu\text{S}/\text{cm}$ in standing water in the Former Munitions Store. The pH value varied between 7.75 and 7.9 and it is considered likely that

the low electrical conductivity of the water in the quarries reflects the absence of any significant groundwater inflow to the quarries.

9.5.53 Ammoniacal nitrogen concentrations were below the laboratory limit of detection (0.2 mg/l) at all four locations. The nitrate concentration (as N) varied between approximately 0.4 mg/l and 0.6 mg/l. The total petroleum hydrocarbons and total PAH (16) concentrations also were below the laboratory limits of detection for all four samples. The trace metal levels were low for all four samples. The highest concentrations of the parameters tested generally were reported for the standing water in the Former Munitions Store.

9.5.54 The water quality in Q6 was very similar to that reported in July 2012. It is understood that there is no evidence of stratification of the water in Q6. The water in Q6 was circumneutral with an average pH of 7.59 with moderate to high alkalinity. Electrical conductivity was low at an average of 180 $\mu\text{S}/\text{cm}$. Total phosphate concentrations exhibited a relatively wide range with an average of 31 $\mu\text{g}/\text{l}$, above the target value of 10 $\mu\text{g}/\text{l}$ set for oligotrophic waters under the Habitats Directive quality guidance (JNCC 2015). Ammoniacal nitrogen concentration were below the laboratory limit of detection in seven samples, but unusually they were elevated in three others although they were all still below the WFD standard for Good Ecological Status. COD and BOD were also generally low. Metals were typically low or reported below the limits of detection, other than dissolved copper and iron. Dissolved metals, particularly copper can be toxic in aquatic environments and the average value was 6.51 $\mu\text{g}/\text{l}$ which is above the WFD EQS (mean annual) of 1 $\mu\text{g}/\text{l}$ bioavailable copper, although the upper limits for short term concentrations are less stringent and not all of the dissolved copper would be bioavailable. Dissolved iron concentrations averaged 20 $\mu\text{g}/\text{l}$, but had a wide range between 4 $\mu\text{g}/\text{l}$ and 120 $\mu\text{g}/\text{l}$. If the maximum value was not included the average reduces to 13.4 $\mu\text{g}/\text{l}$, although this still would exceed the annual average EQS for surface waters of 1 $\mu\text{g}/\text{l}$ (bioavailable).

9.5.55 All organic compounds were reported at below the respective limits of detection, apart from phenols which were reported at 0.153 $\mu\text{g}/\text{l}$.

9.5.56 The water quality in Q1 was generally similar to that from Q6, although the reported concentrations were lower. The water was circumneutral with an average pH of 7.4 with moderate alkalinity. Electrical conductivity was low at 120 $\mu\text{S}/\text{cm}$ and the ammoniacal nitrogen, nitrate and nitrite concentrations all below the laboratory limit of detection. However, total phosphate levels were on average 65.5 $\mu\text{g}/\text{l}$, which is above the 10 $\mu\text{g}/\text{l}$ Good Ecological Status target for Llyn Padarn. Chemical and Biological Oxygen Demands were both low. Metal concentrations were generally low or below detection limits, although like Q6 the concentration of dissolved copper and iron was elevated above the Good Ecological Status standard for surface waters, but not as much as in Q6 (copper averaged 2.8 $\mu\text{g}/\text{l}$ and iron 5 $\mu\text{g}/\text{l}$, although two results were reported below the detection limit of 4 $\mu\text{g}/\text{l}$ and so this is likely to overestimate the average dissolved iron content). Furthermore, as with the samples from Q6, the only organic compound present above the limit of detection was phenol at approximately 0.06 $\mu\text{g}/\text{l}$.

9.5.57 Overall, the 2015 water quality results for Q6 were similar to the water quality result reported in July 2012 (AECOM, 2012). No water quality sample was collected from Q1 in 2012 due to the difficulties gaining access. However, these water samples only provide a 'snap shot' of water quality, although given the nature of the water body (i.e. lake) and limited inputs / outputs water quality may be relatively stable.

9.5.58 There was no evidence of any significant sedimentation (sampling was attempted but no discernible samples could be collected) or stratification in either quarry and the results are assumed to be analogous throughout both quarry water bodies.

Soil Leachate Tests

9.5.59 Slate contains high levels of aluminium that could be leached by surface water runoff and conveyed to Llyn Padarn. The release of dissolved and particulate aluminium in runoff during construction would be exacerbated on the site by activities to crush, work or transport slate as part of excavations and earthworks to construct dams, and from the stockpiling of unused material. Leachate tests on 40 soil samples taken from trial pits close to Q1

and Q6 have variable concentrations between 170 ug/l to a maximum of 260 ug/l, with a mean of 100 ug/l (please refer to Tables C3 and C4 in Appendix 9.1). In comparison, the average concentration of aluminium-filtered and aluminium total in Llyn Padarn based on predominantly weekly sampling between September 2011 and March 2013 by NRW was 17.7 ug/l (ranging 11.1 ug/l to 24.8 ug/l) and 35.8 ug/l (ranging 16.5 ug/l to 138 ug/l), respectively (please see Table C1 in Appendix C). It should be noted that the long term average of pH in Llyn Padarn is circumneutral.

WFD Water Bodies

- 9.5.60 The ecological status of watercourses and water bodies within England and Wales is presented in a series of River Basin Management Plans (RBMP) for the WFD. The Development is located within the Western Wales River Basin District. The classification of the water features and their objectives under the WFD in the vicinity of the Development are described in Appendix 9.1, shown in Figures 9.4 and 9.5 and summarised below and in Table 9.3.
- 9.5.61 Llyn Padarn is a freshwater lake water body that is heavily modified due to non-specific water storage. It is currently at Good Ecological Potential and Good Chemical Status, although not all mitigation measures have been implemented (i.e. Biological quality elements etc. are at Good Status but there could still be improvements (for example to deal with episodic algal blooms). NRW has provided information on the proposed mitigation measures and these are summarised in Table 4 of Appendix 9.1 including details of the status of their implementation.
- 9.5.62 Water level and water quality data for Llyn Padarn was obtained from NRW from a monitoring station close to the outfall to the Afon Rhythallt / Seiont (NGR SH 55954 62329) and this data is summarised in Appendix C of Volume 4, Appendix 9.1.
- 9.5.63 The Afon Seiont (lower) is currently at Good Ecological Status with chemical status not requiring assessment. No water quality data or details of any WFD mitigation measures were provided by NRW for the Afon Seiont. There was also no water quality data for any of the local watercourses on or near the Order Limits, including the Nant-y-Betws stream.

9.5.64 The Afon Gwyrfai is designated under the WFD as a 15.19 km long HMWB that is at Good Ecological Potential (2014 classification), although the full mitigation measures assessment has not yet been completed. Fish are at good status and invertebrates at high status with the hydrological regime supporting Good Ecological Status. Monitored supporting physico-chemical parameters are all at high status (including ammonia, dissolved oxygen, pH, phosphorus, and temperature) and a range of monitored metals and other priority substances are all at good status. Despite the mitigation measures assessment not yet being completed NRW has identified the mitigation measures for the Afon Gwyrfai and these are presented in Table 5 of Appendix 9.1.

9.5.65 Water quality data for the Afon Gwyrfai was obtained from NRW from a station just downstream of the Nant-y-Betws confluence (NGR SH 52620 59030) and this data is summarised in Appendix C of Volume 4, Appendix 9.1.

Table 9-3: Water Framework Directive Classifications			
Watercourse	Hydro - morphological Status	Current Ecological Status or Potential	Current Chemical Quality (and quantity for groundwater bodies)
Llyn Padarn	HMWB (due to non-specific water storage)	Moderate Ecological Potential (dissolved oxygen mitigation measures not being in place)	Good Status
Afon Seiont (lower)	Not designated	Good Ecological Status	Does not require assessment
Afon Gwyrfai	HMWB (due to non-specific water storage)	Good Ecological Potential	Good Status
Llyn & Eryri Groundwater Body	N/A	Good Status	Good Status

(Source: NRW, 2015)

9.5.66 All water bodies that could be affected directly by the construction and operation of the Development have been assessed against the WFD objectives for the water body. Further details of the assessment are provided in Volume 3, Appendix 9.1. In particular the assessment has considered the following potential impacts:

- The effects on Llyn Padarn, the Afon Gwyrfai and the Nant-y-Betws stream from surface water runoff, dewatering of the head and tailpond (Q6 and Q1) and the risk of chemical spillages during construction;
- The effects on Llyn Padarn from the abstraction of water during commissioning of the Development;
- The effects on Llyn Padarn from the construction of a new abstraction spillway infrastructure;
- The effects on Llyn Padarn from 'routine' and 'emergency' discharges down the spillway from Q6 (including the depth of discharge and typical seasonal stratification, and geomorphology);
- An assessment of potential effects on bathing waters in Llyn Padarn;
- The indirect effects on the Afon Seiont from the abstraction of commissioning water from Llyn Padarn.
- An assessment of the risk to the Nant-y-Betws and the Afon Gwyrfai from any water transfer from Llyn Padarn and Q1;
- The effects on the Nant-y-Betws and the Afon Gwyrfai from dewatering Q1 during construction;
- The effects on the Nant-y-Betws and the Afon Gwyrfai from 'routine' and 'emergency' discharges down the spillway from Q1; and
- The potential morphological effects on Nant-y-Betws and its tributaries from the construction of new watercourse crossings for access and the diverted PRow.

9.5.67 NRW has also identified the possibility that discharge from the Development into Llyn Padarn could result in 'seeding' an algal bloom within the lake. This has been assessed within the ecological impact in Chapter 7 Ecology.

9.5.68 With relevance to the WFD, Table 9-4 identifies which water body is susceptible to each potential impact mechanism.

Table 9-4: Impact Mechanism Screening				
Potential Impact Mechanism	Water Body			
	Llyn Padarn	Afon Seiont	Afon Gwyrfai	Llyn & Eryri
	Lake	River	River	Groundwater
Construction phase effects - various	✓	✓	✓	✓
Abstraction of commissioning water	✓	✓	x	x
Physical effect of the installation of new abstraction structure	✓	x	x	x
Discharges of excess water routinely from Q6, and occasionally from Q1	✓	x	✓	x
Emergency release of water from Q6, and potentially Q1	✓	x	✓	x

Water Requirement

9.5.69 The Development would require approximately 1,300,000m³ of water for operation. Once the quarries have been filled, it is unlikely that there would be a need for substantial volumes of 'top up' water. Currently, there is only approximately 500 m³ of water in Q1 with approximately up to 100,000 m³ of water in Q6 (if estimates of water contained in slate waste voids is included), although this would be dewatered before construction starts. It is therefore recognised that there would be a need for additional water to facilitate the commissioning of the Development. The principal sources of water available to meet the initial water requirements are:

- Rainfall;
- Groundwater;
- Quarry drainage;

- Surface water streams; and,
- Abstraction from Llyn Padarn.

9.5.70 The strata in the area generally have a low permeability and storage coefficient. Accordingly, it is concluded that a groundwater source would not provide an adequate or reliable source of water supply for the initial filling of the quarries.

9.5.71 The quarries are located in an area of high rainfall. As per section 9.5.39, the low permeability of the slate and the absence of water in many of the quarries suggests the existing drainage systems continue to provide adequate drainage of the quarries preventing water accumulating in the voids.

9.5.72 The proposed works in Q1 and Q6 include sealing of the quarry walls and floors to minimise the potential for leaking of water held in the quarries. Any redundant drainage system would be located and sealed to increase the ability of the quarries to retain water. It has been calculated that incident rainfall to Q1 and Q6, based on an annual rainfall of 1867 mm and an annual evaporative loss of 465 mm, would result in the collection of approximately 476,000 m³ of water per annum in the quarry. Assuming average rainfall and evaporation, it would take approximately 3 years to fill the reservoir.

9.5.73 Water is present in the culvert downstream of Q8, although at the times of the site walkover and monitoring visit, the apparent discharge from the quarry was dry. It is understood that during wet weather, the pipe runs at full bore (ESI, 2011) and that the area floods. If the pipe in the manhole does represent the outflow from the quarry drainage system, it may provide an intermittent source of water to fill the quarries. Further investigations would be necessary to assess the reliability and deployable yield of this source. It also would be necessary to identify the source of water which enters the manhole from the south east.

9.5.74 The only surface watercourses in the area of the Development are small and fed by surface water runoff and sub-surface discharges from the slate spoil heaps. A number of the streams support private water supplies, although

they are unlikely to provide substantial volumes of water. It is considered that interception and abstraction from these streams would have an adverse effect on riparian owners, including the private water supplies, downstream of the abstraction points. Accordingly, it is concluded that abstraction from the surface watercourses in the area would not be a valid option as a water supply for the Development.

9.5.75 The main water body in the area is Llyn Padarn and it is proposed that an abstraction from the lake would form an important source of water for initial filling of the quarries. Llyn Padarn is a SSSI and any proposals for abstraction of water would need to consider the potential impact on the lake, and the Afon Rhythallt / Seiont. In July 2015 NRA approved a full licence to abstract water from Llyn Padarn subject to conditions. This includes limits on the daily rate and volume of abstraction, annual volume of abstraction, and the enforcement of a 'hands off flow' in the Afon Seiont of 0.343 m as measured at the Peblig Mill gauging station. Abstraction from Llyn Padarn and the collection of incident rainfall to Q1/Q6 would therefore comprise the principal sources of water for initial filling of the reservoir and it is estimated that it would be possible to fill the reservoir over a period of approximately 2 years.

9.5.76 Subsequent to gaining the current abstraction licence Snowdonia Pumped Hydro identified from recent detailed bathymetric surveys of the quarry system that the quarries could hold a total of 1,300,000m³. It is now proposed to abstract water at a rate of up to 3300 m³ per day within a total period of approximately 18 months, depending on licence conditions linked to the lake water level, flows along the Afon Seiont and environmental considerations yet to be agreed with NRW. The abstraction of water from Llyn Padarn will require an amendment to the existing abstraction licence, which is being sought in parallel to this DCO application. Until this is determined it has been assumed by this assessment that abstraction will be made at the maximum proposed rate providing there is sufficient water in Llyn Padarn to maintain the hands off water level on the Afon Seiont at the Peblig Mill gauging station, as required by the current approved abstraction licence.

9.5.77 A new spillway infrastructure and pumping station would be located at approximately SH 57150 61200 in the centre of the western bank of Llyn Padarn. The spillway infrastructure will extend approximately 30 m into the lake at its largest extents. It will be positioned so that it is at least 5 m below the average minimum water level of the lake and a similar depth above the typical shallowest depth of the thermocline in order to avoid potentially adverse impacts on ecological and recreational constraints. The spillway infrastructure will be constructed using an open cut method but within a dry working area supported by a coffer dam and an outer silt curtain.

9.6 Impact Assessment Methodology

9.6.1 The methodology used to assess the potential impacts on water resources (surface water and groundwater) of the Development was based on guidance in the *Environmental Impact Assessment: A guide to procedures (2000)*, *The Institute of Environmental Management and Assessment (IEMA) 'Guidelines for Environmental Impact Assessment (2004)'* and also the government's Planning Practice Guidance for Environmental Impact Assessment¹, where this is applicable to Wales. In particular, the assessment of impact criteria is broadly in keeping with nationally recognised guidance set out in the Design Manual for Roads and Bridges (DMRB) Volume 11 Section 3 Part 10 (otherwise known as HD45/09). Although developed for the impact assessment of new road and bridge developments, this guidance is independent of the nature of the development and provides a robust and nationally accepted method for determining the significance of effects on the water environment. In assessing the significance of the potential effects of the Development on water resources, three key factors were considered:-

- The probability of an effect being realised;
- The sensitivity and/or importance of the receiving environment; and
- The potential magnitude of any effect.

¹ <http://planningguidance.planningportal.gov.uk/blog/guidance/environmental-impact-assessment/>

9.6.2 The likelihood of an effect occurring is based on a scale of: certain, likely or unlikely. The importance of the receiving water environment is defined in Table 9-5.

Table 9-5: Water Resources: Receptor Sensitivity Criteria	
Importance	Criteria
Very High	The receptor is of international or national importance and has little capacity to absorb impacts without fundamentally altering its characteristics (i.e. it may be very sensitive). It is or is expected to be classified under the WFD and either be overall at High Ecological Status or have numerous parameters that are at high status. The water body may have sensitive habitats of national importance that may be protected under EU or UK wildlife legislation (SAC, SPA, SSSI, Ramsar site and former salmonid fisheries). However if a large water body, it may not be sensitive to small discharges and minor physical modifications. It is likely to provide critical social or economic uses such as water supply, fisheries or navigation and may offer significant potential for recreational pursuits, particularly water sports and activities. For groundwater bodies, typical characteristics include designation as a primary aquifer with potable water supplies in the vicinity and as Source Protection Zones 1 or 2.
High	High important water bodies tend to be of regional importance with good water quality (i.e. overall Good ecological status/potential under WFD or a significant number of parameters at good status). It may have sensitive habitats of regional importance, including the presence of protected aquatic species (and formerly cyprinid fisheries). However if large, it may not be particularly sensitive to small discharges and physical modifications. Limited social or economic uses. Primary aquifer without adjacent abstraction. Source Protection Zone 3.
Medium	Of local importance with moderate water quality (i.e. Moderate ecological status/potential under WFD). Secondary aquifer of limited importance for water supply. May be locally designated for nature conservation (when features of interest are relevant to the water environment).
Low	Of less than local importance on a small scale. Poor ecological status/potential under WFD). Habitats of local or less than local importance and excluding Protected Species. Minimal economic or social uses. Non-aquifer. Area with limited groundwater resource potential.

Table 9-5: Water Resources: Receptor Sensitivity Criteria	
Importance	Criteria
Negligible	Non-aquifer. Area with limited/no groundwater resource potential. Note that this classification does not apply to waterways, lakes or ponds.

- 9.6.3 Water bodies are each classified with a level of importance to assist with the determination of the significance of effects. The importance level does not mean that a poorer quality discharge can be made to a water body of lower importance, as all water bodies are considered controlled waters and permits are required from NRW to discharge potentially polluting substances to them in accordance with the Water Resources Act 1991 as amended by the Environmental Permitting (England and Wales) Regulations 2011. The importance setting is required to allow for the robust prediction of the significance of effects to inform planning decisions.
- 9.6.4 For the purpose of this assessment Llyn Padarn (including as a bathing water), the Afon Seiont and the Afon Gwyrfai are all considered to be receptors of very high importance. The Nant-y-Betws stream is considered to be of moderate importance, due in part because of its connectivity with the very high important Afon Gwyrfai, a SSSI.
- 9.6.5 Groundwater in the area of the Development is considered to be of low or negligible importance.
- 9.6.6 The magnitude of any effects considers the likely scale of the predicted change to the baseline conditions resulting from the predicted effects and takes into account the duration of the effects. Table 9-6 provides an explanation of the impact magnitude criteria in respect of water resources.

Table 9-6: Water Resources: Impact Magnitude Definitions	
Magnitude	Criteria
High	Results in effect on integrity of attribute, including fundamental change to water quality or flow regime and / or loss of all or a significant part of the feature
Medium	Results in effect on integrity of attribute, including measurable change to water quality or flow regime and / or loss of part of the feature
Low	Minor change to water quality, flow regime or physical form
Negligible	No measureable impacts on water quality, flows or other uses of water / waterway
<p>Duration:</p> <p>The magnitude of impact takes into account the duration and characteristics of that impact including whether or not it is permanent or temporary, short term or long term, continuous or intermittent. For example, the same impact may occur from the continuous discharge of low levels of a pollutant compared to an intermittent discharge of a higher level of a pollutant.</p>	
<p>Adverse versus Beneficial:</p> <p>Impacts can be adverse or beneficial. Due to the nature of the Development only criteria for potential adverse effects are considered.</p>	

9.6.7 A qualitative approach was used in the assessment generally following the significance classification from Table 9-7 and through professional judgement. The significance of a predicted effect is based on a combination of the sensitivity or importance of the attribute and the predicted magnitude of any effect. Effects are identified as beneficial or adverse, temporary or permanent and their significance as **major, moderate, minor** or **negligible**.

Table 9-7: Water Resources: Impact Assessment Significance					
Magnitude	Sensitivity				
	Very High	High	Medium	Low	Negligible
High	Major	Major	Moderate	Moderate	Negligible
Medium	Major	Moderate	Moderate	Minor	Negligible
Low	Moderate	Moderate	Minor	Negligible	Negligible
Negligible	Minor	Minor	Negligible	Negligible	Negligible

- 9.6.8 The assessment first considers impacts on the water environment without mitigation before determining residual impacts with the implementation of mitigation measures. The details of any mitigation measures were developed based on good practice and standard construction techniques.
- 9.6.9 Adverse impacts may be predicted where the Development is deemed to pose a negative effect on the baseline surface water or groundwater flow or quality conditions. Residual impacts assessed as negligible or minor adverse are considered to be environmentally acceptable. Adverse residual impacts assessed as moderate or higher are considered to be significant. Beneficial impacts may be predicted where the Development is considered to result in an improvement in the baseline conditions, such as an improvement in water quality.
- 9.6.10 In order for a potential impact to be realised, three factors must be present. There must be a source of a potential effect, a receptor which can be adversely affected, and a pathway or connection which allows the source to impact the receptor. Only when all three factors are present can a potential impact be considered.

9.7 Potential Impacts

Construction Phase

- 9.7.1 The works necessary to construct the main elements of the Development have the potential to cause adverse effects on the water environment albeit temporary in nature. The construction works would require the use of heavy plant and machinery on site, as well as the temporary storage of construction materials, oils, diesels and chemicals. During the construction period, site compounds housing construction materials, plant, equipment, office accommodation and toilet facilities for contractors would be located at Q1 and Q6.
- 9.7.2 There is the potential for the accidental spillage or release of construction materials (such as cement, concrete, diesel or hydraulic fluid) directly into surface water drains and into the quarries in the vicinity of construction activities. Such materials may also become mobilised by surface runoff and eventually enter watercourses, drainage systems or groundwater and may

result in a deterioration in water quality and pose a **temporary minor adverse** effect with regards to groundwater and all surface waters except Llyn Padarn, where a **temporary localised moderate adverse effect** is predicted due to its position downstream of the works and the need for works directly in the lake.

- 9.7.3 Silty water can arise from earthworks, exposed ground, dewatering, stockpiled materials, site and local roads leading to and from the construction zone. Construction activities associated with land raising, in particular the construction of the dams at Q1 and Q6, would require extensive earthworks. Surface water runoff could mobilise exposed sediment or other construction materials and result in the pollution of surface water bodies and adverse impacts on aquatic habitats and species. There is a specific concern that runoff generated on slate waste could be high in aluminium, that could result in toxic effects on aquatic organisms. Two new slate mounds will be constructed to the south and west of Q1, although this would be at least 10 m from the edge of the Nant-y-Betws watercourse.
- 9.7.4 High sediment loading in surface waters could also cause blockages in culverted sections of watercourses, reducing the hydraulic capacity of the water bodies and increasing the potential for flooding. On the contrary, high uncontrolled rates of runoff could cause erosion in the receiving watercourse and mobilise downstream additional fine sediment where it could smother aquatic habitats and impact on aquatic flora and fauna. Several of the watercourses downstream (north) of the site are used as a source of private water supply and hence a high suspended sediment loading in the watercourse could affect the quality of the supply.
- 9.7.5 High sediment loads in runoff may also arise where dewatering activities are required and during the open-cut laying of the spillway infrastructure in Llyn Padarn within a trench approximately 30 m long and 5 m wide. Water pumped from excavations is likely to contain a level of suspended solids. The works within the lake itself are likely to agitate bed material into the water column.

- 9.7.6 If left to drain untreated, sediment loaded runoff would discharge to natural drainage systems which eventually drain to Llyn Padarn or to the Afon Gwyrfai via the Nant-y-Betws, potentially affecting water quality. The deterioration of water quality through an increase in the sediment load could also affect the private water supplies which abstract from the Nant-y-Betws. Works in the lake itself will cause locally increased turbidity, although this will be isolated behind a silt curtain. Overall, there is the potential for polluted drainage from the construction activities to enter a number of different controlled waters where impacts of **temporary localised moderate significance** effect may occur.
- 9.7.7 There is currently an estimated 100,000 m³ of water in Q6 that will be dewatered and discharged to Llyn Padarn. Likewise, approximately 500 m³ of water currently within Q1 will be discharged to the Nant-y-Betws and the Afon Gwyrfai. Water quality samples taken from both quarry basins suggest that the water is generally good, although both contain levels of dissolved copper, dissolved iron and total phosphorus above the EQS for Llyn Padarn and the Afon Gwyrfai (there is no total phosphorus standard for the Afon Gwyrfai). The quality of the water in Q6 is poorer in terms of the two dissolved metals, but better in terms of total phosphorus when compared to Q1.
- 9.7.8 Dissolved copper, iron levels and total phosphorus are all above the annual average EQS for Llyn Padarn and the Afon Gwyrfai, although discharge water will be diluted and rapidly dispersed in the receiving water bodies. Preliminary results of groundwater quality analyses suggest that an elevated copper concentration is a naturally occurring feature associated with the bedrock in the area. The discharges of dewaterers to Llyn Padarn and the Afon Gwyrfai (via Nant-y-Betws) would also be a one-off event and would need to be made under an Environmental Permit from NRW, which would set rates of runoff and specify any restrictions on the rate of discharge and pre-treatment that is required. However, there may be some localised adverse effects in the vicinity of the spillway infrastructure where the discharge immediately enters either water body. On this basis any impact on receiving waters is considered to be **temporary moderate adverse**

effect for Llyn Padarn, the Afon Gwyrfai, and the Nant-y-Betws. Please refer to the WFD appraisal presented in Appendix 9.1 for further details of this assessment.

9.7.9 Foul water from construction site welfare facilities will be directed to the nearest public sewer or where this is not possible, facilities will be maintained by a specialist contractor for appropriate disposal off-site to a suitable licensed waste facility.

9.7.10 However, there remains the possibility that uncontrolled discharges of construction site runoff and the risk of chemical spillages could have an adverse impact of **temporary localised moderate adverse effect** on bathing waters, if appropriate mitigation is not implemented.

9.7.11 To facilitate the development of Q6 as the lower reservoir, it would be necessary to dewater the lake in the quarry; remove the slate buttress to reprofile the quarry and extend the size of the reservoir; and, construct a dam on the northern side of the quarry. There is a possibility that munitions may be discovered as part of the quarry development. These would need to be managed to remove any risks to human health and controlled waters, in particular to the water quality in the quarry lake. This issue is addressed in Chapter 8 Geology and Ground Conditions.

9.7.12 The penstock would be constructed using a tunnelling method with a drive from Q6 to Q1 (or vice versa). As these works would be carried out deep underground, they will have no direct impact on surface water resources or quality. The tunnel would be driven within the Llanberis Slates. Due to the low permeability of the slates, it is anticipated that significant volumes of groundwater would not be struck during tunnelling. It is likely that any water would have a high suspended solids concentration as a result of the tunnelling operations but no significant chemical contamination. This is considered to pose an **temporary minor adverse effect**.

9.7.13 A significant volume of material will be moved from Q6 to Q1 as part of the construction works. The material will be moved using a conveyor within the penstock and hence there will be no risk to surface water quality, which could occur if the material was transported above ground.

- 9.7.14 The catchment is 'flashy' with a good correlation between lake level and flows in the River Seiont meaning that inflows to the lake are quickly passed forward along the Afon Rhythallt. A daily abstraction of 3300 m³ equates to approximately 0.00022 % of the total lake volume per day or approximately a 3.4 mm drawdown per day across the entire lake surface. However, due to the 'flashy' nature of the catchment significant cumulative lake levels falls are unlikely to occur. In any case, once the lake level corresponding to the hands off flow is reached abstraction would stop and it is predicted that no significant littoral areas of the lake would be exposed. There is some uncertainty regarding the area close to the spillway infrastructure that was not surveyed, although observations suggest it would not dry up completely and that hydrological connectivity with the Afon Rhythallt would be maintained.
- 9.7.15 It is considered that there would be no significant adverse effect of the abstraction on lake levels in Llyn Padarn. This is due to the hands off flow condition, linked to levels in the downstream Afon Seiont. Consequentially it is considered that there would be no effect on aquatic receptors in the lake (including at its margins). Overall, the abstraction regime is not considered to have any significant impact on lake water levels (and therefore littoral habitat quality and extents) and / or water quality (as it is affected by changing water levels). Accordingly this will not result in the deterioration of any of the BQE present and physico-chemical supporting parameters or likelihood of failing to meet at least good status for lake water levels. Therefore, a **negligible impact** is predicted on Llyn Padarn from the short term abstraction of commissioning water and any future 'top-up' abstractions.
- 9.7.16 The hands off flow condition of the abstraction licence would help ensure that the lowest flows in this river and the upstream Afon Rhythallt would not be reduced as a result of the abstraction. Moderately low flows, greater or equal to the Q₉₀ may be reduced as a result of the abstraction by up to 4%. This would likely manifest as a reduction in river velocities rather than a reduction in water level and is not considered to be significant (with flow naturally being reduced to a greater extent on a regular basis around 10%

of the time). The abstraction also would not have any impact on the pattern of flows, which can be important for certain fish species, and would last for only a relatively short period of time. It is therefore considered that the proposed abstraction would have no significant hydrological or environmental effects on the downstream Afon Rhythallt or Afon Seiont. Overall, as an insignificant impact on the lake water level is predicted, together with the enforcement of a 'hands off' water level, this is considered to have a **negligible effect** on the Afon Seiont from the abstraction of commissioning water and any future 'top-up' abstractions from Llyn Padarn.

Operational Phase

- 9.7.17 During the operation of the Development, potential impacts on water resources would largely be restricted to the management of excess water from within the Development, although permanent morphological effects of new lake bed infrastructure is considered, together with the potential impact of blocking existing quarry drainage and potential flooding of Q5. Although an operational phase impact, the need for future top-up abstractions from Llyn Padarn has been discussed earlier under 'Construction Phase' alongside the discussion of the commissioning water abstraction.
- 9.7.18 It is considered that the operation of the Development would not pose any risk of adverse impacts on the water quality of private water supplies located to the north of the Development and therefore would be considered a **negligible effect**.
- 9.7.19 The spillway from Q6 initially would form the spillway infrastructure from Llyn Padarn to assist in the filling of Q6. It is proposed that the spillway infrastructure would consist of two pipes which will extend into Llyn Padarn for approximately 30 m. These will connect the new pumping station with the permanent spillway infrastructure on the lake bed. The intake will be fitted with a screen to prevent the egress of fish into the spillway infrastructure. The spillway infrastructure will be fitted with a diffuser head to help disperse flows and avoid scour of the lake bed immediately in front of the spillway. The spillway infrastructure will be positioned at least 5 m below the average minimum annual water level so as to avoid impacts on lake

users, and above the thermocline. Although the loss of lake bed to new structures has been minimised, in accordance with the assessment criteria a **permanent moderate adverse effect** is predicted.

9.7.20 Both Q1 and Q6 would be engineered to reduce leakage from the quarries. It is calculated that for average rainfall and evaporation conditions, approximately 476,000m³ of water would accumulate annually in the two quarries. Due to the sealing works, it is considered that this volume of water would significantly exceed leakage from the system and the excess water would require management. Spillways will be constructed from both Q1 and Q6 to provide a controlled discharge from the two quarries to manage excess water. It is proposed that under normal operation excess water would be discharged from Q6 to Llyn Padarn, rather than from Q1 to the Afon Gwyrfai via the Nant-y-Betws, although the facility at Q1 would be utilised should it not be possible to use the Q6 spillway or transfer water from Q1 to Q6.

9.7.21 The potential effects of routine runoff or an emergency spill on water quality and hydromorphology of receiving watercourses has been considered in detail by Appendix 9.1 Glyn Rhonwy Pumped Storage Scheme WFD Compliance Appraisal. This includes a detailed consideration of the risk from the transfer of water from Llyn Padarn to the Afon Gwyrfai catchment, and the future water quality of the pumped storage scheme under operation. Based on this appraisal, and taking into account the predicted future water quality in the pumped storage reservoirs, the relative proportions of runoff to dilution potential, and the intermittent (and infrequent with regards to Nant-y-Betws and the Afon Gwyrfai) nature of the discharges, it is considered that a **negligible effect** would occur from discharges to Llyn Padarn (including bathing waters) and the Afon Gwyrfai. However, due to the smaller size of the Nant-y-Betws stream and its lower dilution potential a **minor adverse effect** is predicted, despite the extremely low frequency of discharges to this watercourse.

9.7.22 In addition, there is also the potential that discharges to the Nant-y-Betws will cause erosion of the banks and floor of the stream, which could adversely affect the quality of the water abstracted from the stream by

private water abstractors. Measures to dissipate energy have been proposed for the spillway. These will be developed further during detailed design in accordance with a DCO Requirement (an approach agreed with NRW). However, due to the current uncertainty of proposals an adverse impact on the Nant-y-Betws of **minor significance** has been predicted.

9.7.23 The existing access track near Q1 will be diverted and will cross the main channel of the Nant-y-Betws in two places and a tributary in one location to provide access to the rear of Q1 and in part for the diversion of an existing PRoW around the new slate mound. A small upper tributary will also be diverted around the new slate mound and existing crossing points reconstructed. The detailed design of either crossing is yet to be undertaken. Therefore, it has been assumed that the Nant-y-Betws will be culverted as this is the worst case from a hydro-morphological perspective. The design of both crossings will be reviewed during the detailed design stage and as part of the consent from the Lead Local Flood Authority for works affecting an Ordinary Watercourse. At this stage however, should the Nant-y-Betws be culverted for two short sections a **localised moderate adverse effect** is predicted.

9.7.24 There is a possibility that sealing of Q6 would disturb the existing surface water drainage through the quarries and prevent water currently draining through quarries Q2, Q3, Q4 and Q5 from discharging through Q6 and thence into Llyn Padarn. Further investigation is necessary to establish the precise drainage between the quarries and the impact that sealing of Q6 may have on water flows. If the current drainage is through Q6, blockage of the existing drainage paths could have a permanent effect of medium magnitude on surface water flows resulting in a **moderate adverse effect**.

Decommissioning

9.7.25 To decommission the Development, the water contained within the reservoirs will be discharged via the Q6 spillway into Llyn Padarn. This will be undertaken via the Decommissioning Plan agreed with the appropriate regulators at that time.

9.7.26 As the discharge will be undertaken via the Environmental Permit, with suitable control measures in place under this regime, it is not considered further in this assessment.

9.7.27 Once the water has been discharged from the reservoirs, the hydrological situation will revert to the current conditions.

9.8 Mitigation, Compensation and Enhancement Measures

Construction Phase

9.8.1 Mitigation measures to avoid, minimise and reduce potentially adverse effects during construction have been identified and described in this section.

9.8.2 To mitigate likely significant impacts during the construction phase, all works associated with the construction of the Development would be undertaken with due regard to the guidance contained within CIRIA Document C650 'Environmental Good Practice on Site,' CIRIA Document C648 Control of Water Pollution on Linear Construction Sites' and the following NRW Pollution Prevention Guidelines (PPGs):

- PPG01 - General Guide to the Prevention of Pollution (May, 2011);
- PPG02 - Above Ground Oil Storage Tanks (August, 2011);
- PPG03 - Use and Design of Oil Separators in Surface Water Drainage Systems (April, 2006);
- PPG05 - Works and Maintenance in or Near Water (no date);
- PPG06 - Working at Construction and Demolition Sites (March, 2012);
- PPG07 - Refuelling Facilities (August, 2014);
- PPG08 - Safe Storage and Disposal of Used Oils (February, 2004);
- PPG 13 - Vehicle Washing and Cleaning (July 2007);
- PPG 18 - Managing Fire Water and Major Spillages (June 2000);
- PPG 21 - Pollution Incidence Response Planning (March 2009); and
- PPG 22 - Dealing with Spills (April 2011).

- 9.8.3 A CoCP would be implemented by the appointed Principal Contractor (PC) to ensure adequate protection of the water environment. The terms of the construction contract would require the PC to deliver all the mitigation measures contained within this ES.
- 9.8.4 A draft CoCP has been provided in Volume 3 Appendix 16.1 with pollution prevention a key objective. The draft CoCP sets out the various roles and responsibilities on site, training requirements and broadly how the construction works would be managed to deal with discharges to surface water and groundwater bodies, the management of suspended sediment, pollution prevention and emergency response, the storage and use of fuel, lubricants and any other potentially polluting substance on site, and the overall approach to monitoring. The draft CoCP is supported by a Water Management Plan (WTMP), a Pollution Prevention Plan (PPP), and a Silt Management Plan (SMP) all of which will provide more specific details of how water pollution will be minimised.
- 9.8.5 Training would be given in the actions to take in the event of a spillage of potential contaminants. Emergency procedures to be implemented in the event of a spillage or leakage of any polluting material such as fuel, oil or silt-laden drainage, would be in place on-site and incorporated into the CoCP. Provision for containment and clean-up of the material would be made. The procedure would follow the recommendations contained within PPG21. Any oil or similar material would be cleaned away immediately using appropriate absorbent material to prevent it entering any local watercourse. Oil spill kits would be provided on site and on mobile plant (e.g. fuel bowsers) and training given to all site personnel in their use.
- 9.8.6 The appropriate drainage and discharge licences would be sought from NRW for both temporary and permanent discharges. Where drainage is a discharge to a watercourse, the appropriate permits would be sought from NRW.
- 9.8.7 To prevent materials leaking from static plant, such as pumps and generators, contaminating the ground and being washed into the drainage system, static plant would be placed on drip trays wherever practicable.

Facilities for washing plant and equipment contaminated with concrete or other chemicals would be provided. Wash water from the facilities would be contained so as to prevent pollution of surface water and groundwater. If on-site batching facilities are required they would be operated under the conditions of the appropriate authorisation.

Storage

- 9.8.8 Chemicals, fuels and oils would be stored in bunded (110 % capacity), secure and designated storage areas and in accordance with the appropriate regulatory requirements, including COSHH Regulations 1994. Storage areas would be located on hardstanding to prevent the possible infiltration of contaminants into the soil and at least 20 m from any watercourse (the same applies to refuelling of mobile plant). Stockpiles of dry materials would be stored in locations that prevent contamination of surface waters and materials would not be stockpiled without appropriate safety and mitigation systems in place.
- 9.8.9 Bentonite or drilling fluid will also be stored appropriately in bunded tanks holding 110% of its capacity. Any waste or used drilling fluid will be stored and tankered away off-site.
- 9.8.10 On-site toilet facilities will be provided for construction staff. Where necessary any foul drainage generated would be collected in a suitable storage facility (e.g. sealed cess pit) for collection and appropriately disposed of off-site.

Runoff

- 9.8.11 During the initial site preparation works prior to the start of construction, there would be a requirement for the implementation of temporary measures to ensure controlled management of runoff draining from the construction site. Runoff from the construction site would not be allowed to drain directly into any watercourse and would be filtered and attenuated using sediment traps, settlement ponds, silt busters or other temporary measure to help filter runoff (e.g. straw bales). The arrangements of such drainage infrastructure would be prepared during the detailed design and, as appropriate, agreed with NRW prior to the commencement of construction.

The above measures would ensure that any sediment (including any adsorbed pollutants) carried in suspension in the surface water runoff from the site would have settled out to an acceptable level before being discharged to Llyn Padarn or the Nant-y-Betws under an environmental permit from NRW.

Earthworks

9.8.12 All earthworks would be undertaken in accordance with BS6031:1981 'Code of Practice for Earth Works.' Land disturbance would be kept to a minimum and disturbed areas would be stabilised as soon as possible after construction. Mitigation measures relevant to controlling soil erosion and surface runoff, focusing on those areas where there would be excavations and the crushing and storage of slate wastes would include:

- Scheduling construction activities to minimise the area and period of time that soil would be exposed, particularly during wetter periods;
- Construction areas would be demarcated from the rest of the site so as to minimise the disturbance of land not required for development;
- Installation of cut-off drains around the working areas to intercept surface runoff and divert it around the works;
- Minimising the stockpiling of materials and locating essential stockpiles as far away as possible from watercourses;
- Implementation of site working practices to minimise the risk of concrete spillages; and
- Movement of construction vehicles and plant would be strictly controlled to minimise the potential for soil compaction and erosion.

Water Quality

9.8.13 To minimise the effect on the water quality in the Nant-y-Betws and the Afon Gwyrfai, measures would be put into place to intercept runoff above the watercourses from the construction site at Q1. It is proposed that runoff from the area would be intercepted in a series of drainage grips which would run across the slope and direct water to either temporary storage lagoons or other means to filter runoff (e.g. silt busters or straw bales) before the water

overflows to the Nant-y-Betws and ultimately the Afon Gwyrfai. Discharges from the collection lagoons will be subject to the conditions of an environmental permit issued by NRW. The conditions of the permit will be developed to ensure that the discharges do not adversely impact on the water quality of the Nant-y-Betws and hence will not affect the quality of the water abstracted by the private supplies from the watercourse.

9.8.14 Where slopes are disturbed by the construction works, temporary drainage measures would be designed to prevent the direct discharge of runoff to watercourses. Temporary drainage grips would be constructed to convey runoff to temporary storage lagoons for settlement or other means to filter runoff before it is discharged to surface watercourses to minimise the potential for sediment-rich runoff to enter controlled waters. The drainage from the settlement lagoons would be subject to a permit issued by NRW. The permit would contain conditions on the allowable quality and quantity of the water discharged from the lagoons.

9.8.15 All water arising from the tunnelling operations will have its own dedicated treatment system.

9.8.16 For works in and around Llyn Padarn, due regard will be given to PPG5 Works and Maintenance In and Near Water, and the CoCP, including the WTMP, PPP and SMP, which will outline measures to be taken to minimise mobilising lake bed sediments and managing the risk of chemical spillages. A pre-construction survey of the lake bed which would be affected by the spillway infrastructure would be undertaken to identify local habitats and any features considered sensitive to the Development, building on the surveys carried out in 2015 in support of this ES. Any effects of siltation will be of short-term and limited to the period of construction of the spillway infrastructure. However, any loss of habitat will be a permanent impact. This issue is discussed further in Chapter 7 Ecology.

Monitoring

9.8.17 A water quality monitoring programme would be established in conjunction with NRW to monitor any variation in the water quality and the potential

impact of construction works on Llyn Padarn, the Nant-y-Betws and the Afon Gwyrfa.

- 9.8.18 NRW have confirmed that a programme of catchment water quality monitoring is required prior to and during the construction phase. This should include the preparation of an Action Plan in the event that adverse or unusual monitoring results are observed. The sampling programme should consider the following parameters as a minimum: Total and dissolved metals, electrical conductivity, pH, suspended solids, chemical oxygen demand (COD), and biochemical oxygen demand (BOD).
- 9.8.19 The catchment monitoring programme will be developed further during the detailed design phase prior to construction commencing as part of the Water Management Plan (WTMP) described in the CoCP (see Appendix 16.1). As stated in the draft CoCP, this will include a combination of targeted water quality sampling together with regular observations of watercourses.

Impact on Private Water Supplies

- 9.8.20 There are a number of private water supplies from small watercourses which rise from a slate stockpile to the north of the development site. It is considered that one of the sources of the stream is water from a high-level drainage adit from Q2. These supplies would be very sensitive to changes in the surface water drainage pattern in the area north of Q2 and/or to disturbance of the ground in the catchment to the stream.
- 9.8.21 As there are no proposals for works around Q2, there would be no risk of the generation of sediment causing an increase in the suspended solids concentration in the shallow sub-surface water or in surface water runoff, which could impact on the quality of the watercourses and of the water abstracted downstream. In addition, there are no proposals to disturb the slate stockpiles which could affect the surface water catchments and the volume of flow. As a result, the private water supplies downstream (north) of Q2 would not be at risk from the Development.
- 9.8.22 The Nant-y-Betws supports a number of private water supplies. Disturbance of the ground around Q1 and Q2 could result in the mobilisation of sediments, which could affect the quality of the Nant-y-Betws and the

private abstractions. The measures which will be developed to manage surface water runoff from the construction site will ensure that there is no significant impact on the quality of the Nant-y-Betws downstream of the development site. With the implementation of these control measures, the private water supplies will not be adversely impacted by the construction activities.

Operational Phase

- 9.8.23 The principal impacts on water resources would be associated with the construction phase of the Development. Following the completion of construction, it is considered that any impacts on water resources would be associated with the management of excess water entering the two quarries from incident rainfall and local surface water drainage, or from an emergency situation requiring the rapid draining down of a reservoir when it is not possible to transfer water to the other reservoir in the system.
- 9.8.24 The operational phase of the Development does not pose a risk to the quality or quantity of groundwater in the surrounding strata.
- 9.8.25 Once the reservoir has been filled, it is anticipated that, under normal operating conditions, there would be no requirement for the continual abstraction of water from Llyn Padarn.
- 9.8.26 It is estimated that annually, approximately 476,000m³ of water would enter the system from incident rainfall. The majority of the excess water to the system would be conveyed to Q6, from where it would be discharged to Llyn Padarn via a spillway. As the majority of the incident rainfall to the Development currently drains to Llyn Padarn, it is considered that this would have a negligible adverse impact on the water level or water quality in the lake or on the Afon Seiont downstream. Furthermore, the risk of oxidising sulphides as water is passed regularly through the turbines is considered to be low due to the relatively low levels of sulphate in the original water abstracted from Llyn Padarn, which will be diluted over time by natural runoff into the quarries. However, this is based on only a limited number of samples, and thus long term monitoring of the water quality in the pumped

storage scheme will be undertaken by the operator in order to identify any future trends and inform periodic remedial action should it be required.

9.8.27 It is estimated that the spillway from Q1 to the Nant-y-Betws would have an average discharge of approximately 400m³/day in the unlikely and infrequent occasions this is required. Currently, there is no obvious discharge from Q1 in this direction (i.e. surface water in a watercourse although it is likely that there is sub-surface flow and limited movement of groundwater). Runoff will be preferentially discharged from the system to Llyn Padarn via Q6 and it is predicted that the spillway from Q1 will not be used frequently. No significant contamination is expected in the quarry water and this will be rapidly diluted and dispersed downstream along the Nant-y-Betws and the Afon Gwyrfai. Flow disruptors will also be included on the outfall from the spillway to reduce the risk of channel erosion occurring.

9.8.28 There is a potential that sealing of Q6 may have a moderate adverse effect on surface water flows, potentially causing Q5 to flood. To control water in Q5, it will be necessary to install a water management system in the quarry to prevent a build up of water. Further information on the existing surface water drainage in the quarries is needed before a detailed mitigation measure is designed if required.

Decommissioning

9.8.29 Mitigation will be undertaken as per the conditions of the Environmental Permit. The rate of discharge from both Q1 and Q6 and any monitoring regime will be agreed at the appropriate time with NRW.

9.9 Residual Impacts

Construction Phase

9.9.1 Measures such as compliance with legislation, good practice construction management, PPGs and the production of a final CoCP would be implemented to manage surface water runoff containing high suspended sediment loads and spillage risk from the construction areas, and hence minimise any impacts on local watercourses and Llyn Padarn. With mitigation measures being implemented impacts are predicted to be **minor**

adverse with regards to Llyn Padarn and **negligible** for all other water bodies.

Operational Phase

- 9.9.2 During the operational phase, the loss of a 0.0013ha of lake bed would result in a **permanent moderate adverse** effect, primarily due to the classification of Llyn Padarn as a SSSI. There would also be a residual effect of **moderate adverse effect** on the Nant-y-Betws stream due to the potential culverting of two short sections of this watercourse to provide access for the PRow diversions.
- 9.9.3 Although the current (and any future altered abstraction licence from Llyn Padarn) will include an option to abstract water to ‘top up’ the pumped storage scheme, it is very unlikely that this would need to be used given the estimated natural runoff into Q1 and Q6. If used, the volume of abstraction would be relatively small and the duration short, when compared to the abstraction of commissioning water, which has been shown not to have any significant impact. Therefore, the effect of future ‘top up’ abstractions is **negligible**.
- 9.9.4 As the majority of the site will drain to Llyn Padarn, from where water would have been originally abstracted, and given the lack of any significant source of water contamination during operation (including temperature changes), impacts of the Development on Llyn Padarn (including bathing waters) during operation would be **negligible**.
- 9.9.5 The residual impact of spillway discharges on the Afon Gwyrfai would also be **negligible**, but are predicted to be **minor adverse** (in terms of water quality and morphological impacts) for the Nant-y-Betws, which is more sensitive due to its smaller size, the presence of abstractions for domestic supplies and the recognition of existing erosion issues.
- 9.9.6 The design of a water management scheme, if required, in Q5 will control water inflows from the upper quarries and prevent flooding of the quarry. With the implementation of the water management scheme, the residual **minor adverse effect** on drainage.

Decommissioning

9.9.7 It is unlikely that any residual effects will occur, as the discharge of the water to Llyn Padarn will be controlled under the Environmental Permit. Therefore it is considered to pose a **negligible** impact.

9.10 Compliance with the Water Framework Directive

9.10.1 An assessment of the potential impacts of the Development on Llyn Padarn, the Afon Gwyrfai, the Afon Seiont and the Llyn & Eryri groundwater body has been undertaken in accordance with the objectives of the WFD for the relevant water bodies. A summary of the assessment is provided below with the detailed assessment at Volume 3, Appendix 9.1.

Llyn Padarn

9.10.2 Llyn Padarn is a HMWB that is currently at Moderate Ecological Potential due to dissolved oxygen levels with not all mitigation measures having been implemented. This appraisal has assessed the compliance of the proposed Development against the objectives for this water body considering the potential effects of water abstraction, dewatering Q1 and Q6, construction site runoff, routine and emergency discharges, and physical impacts from new structures. It has also considered the compliance with proposed mitigation measures (i.e. prevention of improvement objectives) and SSSI objectives (principally for Arctic charr and floating water plantain).

9.10.3 Abstraction of raw water from Llyn Padarn has been agreed in principle with NRW who issued a licence in July 2015 to abstract up to 2,000 m³ per day subject to conditions including a 'hands off' water level as measured at the Peblig Mill gauging station on the Afon Seiont. Since this licence was issued the total volume of water that could be stored in the pumped storage scheme has increased and it is now proposed to abstract up to 3,300 m³ per day over a period of up to 18 months. A water balance study has been undertaken of this new rate and is presented in Appendix B. This shows that water can be abstracted at this rate whilst maintaining the hands of water level and without significant impacts on Llyn Padarn. It has therefore been concluded that the proposed abstraction would be compliant with the WFD.

- 9.10.4 The existing quality of water in Q6 and Q1 that will be discharged to Llyn Padarn does not raise any significant concerns, although dissolved copper, dissolve iron and total phosphorus levels are elevated in both and above the EQS for Llyn Padarn. It is believe that Q6 already drains to Llyn Padarn via old mine workings and fractures in the bedrock, although directly discharging the water will likely increase the rate of discharge above natural flows. However, the discharge would be a 'one off' event and the effluent would be significantly diluted and dispersion in Llyn Padarn and no long term effects on aquatic organisms is predicted.
- 9.10.5 Any discharge to Llyn Padarn will be in accordance with an Environmental Permit agreed with NRW. If required, the need for specific mitigation measures will be agreed with NRW as part of the permitting process. This may include restrictions on the rate of discharge, discharging intermittently to allow time for dispersion, or pre-treatment on site in advance of discharging. Overall, the future quality of water in the pumped storage scheme is unlikely to contain excessive levels of nutrients, contaminants or high levels of suspended sediment, or be significantly different in pH or temperature to the water quality of Llyn Padarn.
- 9.10.6 With the dilution potential of Llyn Padarn and taking account of the relative rate and likely volume of discharges, no significant changes in water quality in Llyn Padarn is predicted, and thus no deterioration of any BQEs or failure to meet chemical EQSs as a consequence of the Development. In addition, no evidence of any alien species have been identified in Q1 or Q6 by aquatic ecology surveys carried out for this Development, and measures will be undertaken to avoid Nuttal's Waterweed being abstracted from Llyn Padarn.
- 9.10.7 During construction there is the possibility of site runoff becoming enriched with aluminium from the surrounding slate waste, especially where this has been worked or crushed. To reduce the risk to the aquatic environment it is proposed to carefully manage construction site runoff to reduce this risk as far as reasonably possible and to only discharge construction site runoff to Llyn Padarn in accordance with an Environmental Permit agreed with NRW. In addition to the application of standard treatment of construction site

runoff, other measures to reduce the risk could be to discharge at a suitably slow rate or intermittently allowing the discharged waters to disperse.

- 9.10.8 The proposed new spillway infrastructure will result in the permanent loss of a small area of lake bed, although as the spillway infrastructure may be buried the physical impact of the Development has been minimised and the overall effect is considered to be insignificant. Both structures will be located above the thermocline but sufficiently deep to avoid disrupting the activities of other lake users. The new intake pipe will be fitted with a suitable screen to prevent ingress or abrasion of fish, particularly Arctic charr. The depth of the lake bed falls relatively quickly at the location of the spillway meaning that the potential for scour is low.

Afon Seiont

- 9.10.9 The Afon Seiont originates from the outfall from Llyn Padarn and is currently at Good Ecological Status. It was also a salmonid river under the Freshwater Fish (Consolidated) Directive, which has now been subsumed by the WFD. The Afon Seiont will not be directly impacted by the Development, but has been considered as an adjacent designated WFD water body that could be impacted indirectly through changes to the flow regime and water quality in Llyn Padarn.
- 9.10.10 Abstraction from Llyn Padarn will be controlled so that the flow regime downstream along the Afon Seiont is not significantly affected and water levels are maintained above 0.343 m at the Peblig Mill gauging station as required by the current abstraction licence. The abstraction will only take place for up to 18 months and thus is unlikely to result in any long term permanent effects.
- 9.10.11 In terms of water quality, the changes in water level within Llyn Padarn are negligible and are not expected to alter the physio-chemical quality of the lake when compared to EQSs. In addition, it is not expected that discharges from the construction and operation of the Development will significant effect lake water quality providing suitable mitigation measures are adopted. Therefore, the Development is not expected to cause deterioration of any WFD parameter relevant to the Afon Seiont and it is considered to be

compliant with the objectives for this water body and any water dependent Protected Areas.

Afon Gwyrfa

9.10.12 The Afon Gwyrfa is a lake fed river whose flow has been modified by water storage for drinking water supplies, and which is thus a HMWB. In undertaking this appraisal we have also considered the potential compliance with the objectives for the SSSI and SAC designations that apply.

9.10.13 The Development will not have any direct effects on this river, with the potential for indirect effects on WFD parameters to occur from discharges of existing quarry water, construction site runoff, overflow discharges (routine operation) or emergency release of flows using the relief valve via the Nant-y-Betws upland stream.

9.10.14 During the operation of the Development discharges from Q1 are not predicted to contain significant concentrations of any pollutants, be enriched in nutrients, have a low pH, or have high levels of suspended sediment. Excess water will also preferentially be discharged from Q6 to Llyn Padarn rather than from Q1 to the Nant-y-Betws stream, and thus regular discharges to the Afon Gwyrfa are unlikely. Overall, the risk from operational discharges to the Afon Gwyrfa is low and no significant impact on WFD parameters has been predicted.

9.10.15 The rate of flows from the Q1 overflow will be controlled to ensure that they do not lead to further erosion of the Nant-y-Betws stream and the mobilisation of fine material downstream and into the Afon Gwyrfa. It has been agreed with NRW that the detailed design of the spillway infrastructure can be subject to a DCO Requirement. The detailed design will consider the risk of hydromorphological impacts so that suitable measures can be incorporated into the final design.

9.10.16 Overall, the Development is considered to be compliant with all WFD objectives for the Afon Gwyrfa water body, taking into account mitigation measures and Protected Areas.

Llyn & Eryri Groundwater Body

9.10.17 Groundwater resources in the area of the Development, which is included in the Llyn and Eryri groundwater body, are of negligible significance. The strata in the area are designated as Secondary B aquifers, which are low permeability strata with limited ability to store groundwater. Groundwater abstractions in the vicinity of the Development are generally for small scale domestic and farm supplies.

9.10.18 The Development will have no significant impact on the quality or quantity of groundwater and hence the Development will not affect the WFD status of the groundwater body.

9.11 Evaluation of Significance

Construction Phase

9.11.1 Potential adverse effects on water resources, in particular on surface waters, have been identified as a result of the construction of the Development. Appropriate mitigation measures have been proposed which would minimise the risks associated principally with the generation of suspended solids during earthworks. All runoff from the construction areas would be managed to prevent direct discharges, without settlement or appropriate treatment, to surface watercourses.

9.11.2 With the appropriate mitigation measures in place, the construction works would not affect the surface water catchments surrounding the Development and hence would not impact on current drainage systems. The majority of runoff from the site currently drains to Llyn Padarn and this would continue.

9.11.3 Water would be discharged to Llyn Padarn to facilitate construction of the lower reservoir. Although the quality of water in Q1 and Q6 is such that there are some parameters present at levels that exceeds the annual average EQS for Llyn Padarn and the Afon Gwyrfai, the discharge of quarry dewaterers would be a 'one of' event and the potential impacts can be minimised by treatment or restriction on how discharges to be determined during the environmental permitting process.

9.11.4 It also is proposed that water would be abstracted from Llyn Padarn to facilitate the initial filling of the reservoir in accordance with the conditions of

the abstraction licence. It is proposed that an abstraction of up to 3,300m³/day would be made from the lake for this purpose over a period of up to 18 months. It is concluded that this rate of abstraction will have a **negligible** effect on the lake and the Afon Seiont into which the lake overflows.

9.11.5 It is considered that with the implementation of the above controls and through the general environmental/pollution controls which would be included in the CoCP, the magnitude of any impacts of the Development on water resources, both from a quality and quantity perspective, would be **negligible**.

Operational Phase

9.11.6 The principal effect on water resources arising from the operation of the Development is the management of excess water. Any discharges from Q6 to Llyn Padarn would be in accordance with the conditions of an Environmental Permit from NRW. Similarly any excess water would be discharged from Q1 into the Nant-y-Betws and ultimately the Afon Gwyrfa under the terms of a permit. Based on a review of available water quality data and an understanding of the operation of the Development no significant adverse impacts are predicted on any of the receiving water bodies.

9.11.7 The operation of the Development would have no impacts on the continuity of private water supplies in the area, which do not rely on water in either Q1 or Q6, the only quarries which form part of the operation of the Development. Water is abstracted for private supplies from the Nant-y-Betws. There is a risk that discharges from Q1 could cause further erosion of the banks of the stream, which could increase the sediment loading in the stream and cause a deterioration in the quality of the abstracted water. Measures will be prepared at the detailed design stage to reduce the potential for erosion in order to minimise the risk of a reduction in water quality of the Nant-y-Betws.

9.11.8 Appendix 9.1 presents the results of a WFD Assessment which concludes that the Development would be compliant with the objectives of the WFD for

effected water bodies, notably that it would not cause deterioration, prevent improvement and be consistent with the objectives of Protected Areas, at the water body level.

9.11.9 Table 9-8 presents a summary of the residual water resources impacts for the Development, accounting for the effects of mitigation measures on the predicted worst-case impacts as determined within this assessment.

Table 9-8: Summary of Assessment										
Description of Receptor		Description of Potential Impact					Description of Residual Impact			Change from 2012 Chapter
Receptor	Value Sensitivity /	Effect	Nature of Effect	Duration	Magnitude	Potential Significance	Summary of Mitigation	Residual Effect	Residual Significance	
Construction Phase										
Surface Waters and Groundwater	Medium – Groundwater and Nant-y-Betws	Quality of controlled waters – Accidental Spillage of contaminants (fuel oils, chemicals etc.)	Adverse	Temporary	Low	Minor	Compliance with PPGs and CoCP	Measures such as compliance with legislation, good practice construction management, PPGs and the CoCP would be implemented to manage potential contaminants used in the construction works and reduce minor / moderate adverse impacts on water quality to negligible / minor.	Negligible	No change to significance
	Very High – Llyn Padarn					Moderate			Minor	Llyn Padarn classified as medium importance in 2012
	Very High – Afon Gwyrfai and Afon Seiont					Minor			Negligible	No change to significance
Surface Waters and Groundwater	Very High - Llyn Padarn	Quality of controlled waters – High sediment load in surface water run off	Adverse	Temporary	Low	Moderate	Compliance with PPGs and CoCP	Measures such as compliance with legislation, good practice construction management, PPGs and the CoCP would be implemented to	Negligible	No change to significance

Table 9-8: Summary of Assessment										
Description of Receptor		Description of Potential Impact					Description of Residual Impact			Change from 2012 Chapter
Receptor	Value Sensitivity /	Effect	Nature of Effect	Duration	Magnitude	Potential Significance	Summary of Mitigation	Residual Effect	Residual Significance	
	Very High - Afon Gwyrfai and Afon Seiont				Low	Moderate		manage surface water runoff containing high suspended solids from the construction areas and hence reduce impacts to negligible		
	Medium - groundwater and Nant-y-Betws				Medium	Moderate				
Surface Waters	Very High – Llyn Padarn	Quality of controlled waters – Dewatering of Q6	Adverse	Temporary	Low	Moderate	Rate and treatment measures to be determined with NRW during application for an Environmental Permit	Potential for localised and short term increase in copper concentrations, although these will not persist and should not result in the EQS being exceeded.	Minor	New effect following additional information.
Surface Waters	Very High – Llyn Padarn	Effect on bathing waters	Adverse	Temporary	Low	Moderate	Compliance with PPGs, CoCP and Environmental Permit conditions	Water abstraction for commissioning and construction runoff / spills will be controlled through the implementation	Negligible	New effect following recent designation of Llyn Padarn bathing waters

Table 9-8: Summary of Assessment										
Description of Receptor		Description of Potential Impact					Description of Residual Impact			Change from 2012 Chapter
Receptor	Value Sensitivity /	Effect	Nature of Effect	Duration	Magnitude	Potential Significance	Summary of Mitigation	Residual Effect	Residual Significance	
								of the CoCP and PPGs. Foul water from construction welfare to be connected to the nearest public sewer where possible or managed by a suitable contractor for disposal off site		
Surface Waters	Very High – Afon Gwyrfai	Quality of controlled waters – Dewatering of Q1	Adverse	Temporary	Low	Moderate	Rate and treatment measures to be determined with NRW during application for an Environmental Permit	Due to the relatively small volume to be discharged compared to the flow in the Afon Gwyrfai and the 'one off' nature of the emission a negligible impact is predicted	Minor	New effect following additional information
Surface Waters	Nant-y-Betws	Quality of controlled waters – Dewatering of Q1	Adverse	Temporary	Medium	Moderate	Rate and treatment measures to be determined with NRW during application for an Environmental Permit	Impact is considered to be greater than for the Afon Gwyrfai due to the lower dilution capacity	Negligible	New effect following additional information

Table 9-8: Summary of Assessment										
Description of Receptor		Description of Potential Impact					Description of Residual Impact			Change from 2012 Chapter
Receptor	Value Sensitivity /	Effect	Nature of Effect	Duration	Magnitude	Potential Significance	Summary of Mitigation	Residual Effect	Residual Significance	
Private water supplies - surface waters	Medium	Sediment impacted surface water runoff to Nant-y-Betws	Adverse	Temporary	Medium	Minor	Compliance with PPGs and CoCP None	Measures such as compliance with legislation, good practice construction management, PPGs and production of the CoCP would be implemented to manage surface water runoff containing high suspended solids from the construction areas and potential contaminants used in the construction works to minimise adverse impacts on water quality. n/a	Minor adverse	Change in significance from negligible to minor following identification of private water supplies from Nant-y-Betws
Private water supplies - groundwater (wells and boreholes)	Medium	Sediment impacted runoff	Adverse	Temporary	Negligible	Negligible	None	n/a	Negligible	No change to significance
Groundwater	Medium	Quality of controlled waters -Tunnelling activity	Adverse	Temporary	Low	Minor	All water arising from the tunnelling operations will have its own dedicated treatment	.Appropriate treatment and settlement of the tunneling water will minimise adverse	Minor Adverse	No change to significance

Table 9-8: Summary of Assessment										
Description of Receptor		Description of Potential Impact					Description of Residual Impact			Change from 2012 Chapter
Receptor	Value Sensitivity /	Effect	Nature of Effect	Duration	Magnitude	Potential Significance	Summary of Mitigation	Residual Effect	Residual Significance	
							system	impacts on water quality		
Llyn Padarn and Afon Seiont	Very High	Water level and quality - Abstraction of water for commissioning	Adverse	Temporary	Negligible	Negligible	Abstraction volumes are significantly below the capacity of Llyn Padarn and the abstraction will be controlled under the abstraction licence issued by NRW	The conditions of the abstraction licence are considered sufficient to limit adverse impacts on water levels to negligible.	Negligible	No change to significance
Operational Phase										
Private water supplies – groundwater	Medium	Water quality	Adverse	Permanent	Negligible	Negligible	None	n/a	Negligible	No change to significance
Private water supplies – surface water	Medium	Discharge from Q1 on water quality in Nant-y-Betws	Adverse	Permanent but not continuous	Low	Minor	Discharge quality and rate will be controlled by a discharge consent issued by NRW if appropriate	Flow control on the outfall to the Nant-y-Betws will help avoid significant erosion in the channel, minimising effects on private water abstractions	Negligible	No change to significance
Llyn Padarn	Very High	Morphological effects of new structures on lake bed and discharges	Adverse	Permanent	Low	Moderate	None proposed. Potential loss of lake bed minimised through design.	A small area of the lake bed will be lost but long term impacts on bed unlikely.	Moderate	Amended from 2012

Table 9-8: Summary of Assessment										
Description of Receptor		Description of Potential Impact					Description of Residual Impact			Change from 2012 Chapter
Receptor	Value Sensitivity /	Effect	Nature of Effect	Duration	Magnitude	Potential Significance	Summary of Mitigation	Residual Effect	Residual Significance	
Llyn Padarn	Very High	Future 'top-up' water abstraction	Adverse	Permanent but infrequent	Negligible	Negligible	Abstraction rate controlled by abstraction licence issued by NRW	Only infrequent abstractions would be required, resulting in a negligible effect. Abstraction will be within the limits of the abstraction licence.	Negligible	No change to significance
Llyn Padarn	Very High	Operational discharges from spillways	Adverse	Permanent but not continuous (i.e. intermittent)	Negligible	Negligible	The water quality of the reservoirs in the pumped storage scheme will be monitored and trends evaluated in the context of any remedial action that might be needed on a periodic basis. Discharge quality and rate will be controlled by an discharge consent issued by NRW if appropriate	As the majority of the site drains currently to Llyn Padarn and as this situation would continue during the operational period, effects of the Development on the main surface water feature in the area would be of minor adverse effects	Negligible	Revised following a review of new data
Llyn Padarn	Very High	Effect on bathing waters from discharges from spillways	Adverse	Temporary	Permanent but not continuous	Negligible	None required	Water in the pumped storage scheme is unlikely to	Negligible	New effect following recent designation of a bathing

Table 9-8: Summary of Assessment										
Description of Receptor		Description of Potential Impact					Description of Residual Impact			Change from 2012 Chapter
Receptor	Value Sensitivity /	Effect	Nature of Effect	Duration	Magnitude	Potential Significance	Summary of Mitigation	Residual Effect	Residual Significance	
								become contaminated. It will however be regularly monitored by the operator and if require remedial action could be taken periodically		water
Afon Gwyrfai	Very High	Discharges from spillways	Adverse	Permanent but not continuous (intermittent and infrequent)	Negligible	Negligible	The water quality of the reservoirs in the pumped storage scheme will be monitored and trends evaluated in the context of any remedial action that might be needed on a periodic basis. Discharge quality and rate will be controlled by a discharge consent issued by NRW if appropriate	Impact magnitude takes account of the unlikely of spills from Q1. Water is also unlikely to be contaminated. Flow control on the outfall to the Nant-y-Betws will help avoid significant erosion in the channel	Negligible	Revised following consultation with NRW and a review of new data
Nant-y-Betws	Medium	Discharges from spillways – Water quality	Adverse	Permanent but not continuous (intermittent and infrequent)	Low	Minor	Preference to discharge via Q6 to Llyn Padarn. Water quality will be	Low	Minor	New effect based on changes to water body importance classification

Table 9-8: Summary of Assessment										
Description of Receptor		Description of Potential Impact					Description of Residual Impact			Change from 2012 Chapter
Receptor	Value Sensitivity /	Effect	Nature of Effect	Duration	Magnitude	Potential Significance	Summary of Mitigation	Residual Effect	Residual Significance	
							monitored			
Nant-y-Betws	Medium	Discharges from spillways - Hydromorphology	Adverse	Permanent but not continuous (intermittent and infrequent)	Low	Minor	Preference to discharge via Q6 to Llyn Padarn. Flow control measures proposed on outfall, subject to detailed design and a DCO Req	Low	Minor	New effect based on changes to water body importance classification
Nant-y-Betws	Medium	Culverting and diversion of the Nant-y-Betws and its tributaries in various locations	Adverse	Permanent	Medium	Moderate	Detailed design to be undertaken at a later stage and alongside land drainage consent application	Medium	Moderate	New effect not reported previously in the Water Environment Assessment
Impact on quarry drainage of sealing Q6	Medium	Blocking of existing quarry drainage pathways leading to flooding of Q5	Adverse	Permanent	Medium	Moderate	Further investigation of the quarry drainage system is needed to facilitate detailed design. Installation of water management system in Q5, possibly including dewatering	Maintenance of an acceptable water level in Q5	Minor Adverse	Potential additional impact

9.12 Summary and Conclusions

- 9.12.1 As a result of the geological conditions of the area, it is considered that groundwater does not form an important contribution to regional or local water resources.
- 9.12.2 The majority of incident rainfall either runs off to small watercourses or drains in a generally north easterly direction through the quarries to Llyn Padarn. It is likely that there is shallow groundwater associated with the slate stockpiles. However, it is considered that groundwater flow and storage within the stockpiles is limited.
- 9.12.3 There are several private water supplies from springs, wells and boreholes in the area of the Development and also from the small watercourses which flow from the area surrounding the quarries. As the Development will have no impact on groundwater flow, it is concluded that the wells and boreholes will not be affected.
- 9.12.4 Q1 and a small area around Q2 drain in a south westerly direction to the Nant-y-Betws and other small watercourses towards the Afon Gwyrfai catchment. The Afon Gwyrfai is part of a SSSI.
- 9.12.5 There are a number of private water supplies from surface watercourses in the vicinity of the Development. The supplies of most significance are associated with a drainage adit from Q2 and the large slate spoil heap downstream of the adit. Drainage from this area supports small watercourses to the north of the development. A number of properties obtain their water supply from these streams. As Q2 and the area of the slate spoil heap will not be disturbed by the Development, the existing private supplies will not be affected by the scheme.
- 9.12.6 The construction phase of the Development presents a potential risk to water resources largely through the generation of runoff with high sediment loading (potentially containing elevated levels of aluminium), the risk from chemical spillages, and in the short term from the discharge of dewaterers from Q1 and Q6. Mitigation measures would be implemented around all construction areas to prevent the direct discharge of contaminated runoff to surface watercourses.

- 9.12.7 Normal construction site management would be implemented through a CoCP to control potentially contaminative activities associated with the construction site operations. The CoCP will be supported by a WTMP, PPP and a SMP.
- 9.12.8 Water would be discharged to Llyn Padarn during the construction phase from Q6, and to the Nant-y-Betws from Q1. The need for any treatment or monitoring would be discussed with NRW as part of an Environmental Permit application. The monitoring of the Nant-y-Betws also will allow an assessment of any impact on the private water supplies from the stream.
- 9.12.9 Following the completion of the works on Q6, water would be abstracted from Llyn Padarn to assist in the initial filling of the reservoir. The reservoir also would be filled through the storage of rainfall incident to the quarry and the surrounding area. Once the reservoir has been filled, there would be no further requirement for a continuous abstraction from Llyn Padarn. Infrequent abstractions may still be required (should there be significance water losses to evaporation) and the appropriate licences and consents will be obtained from NRW where relevant. However, any abstraction would be small compared to the initial commissioning abstraction that has already been approved by NRW.
- 9.12.10 It is concluded that with the implementation of the mitigation measures the impacts of the Development on water resources during the construction phase would be minor to negligible adverse and thus not significant in planning terms.
- 9.12.11 Following the completion of construction, impacts on water resources would be limited to those associated with the management of excess water in the system. Excess water preferentially would be discharged from Q6 to Llyn Padarn and would be similar to the perceived current situation. No significant adverse impacts are predicted.
- 9.12.12 Sealing of Q6 potentially may block existing drainage pathways between the quarries. This could cause flooding in Q5, which could have adverse ecological impacts. Subject to further detailed investigations, it may be necessary to provide a water management scheme in Q5, potentially

involving dewatering, to maintain an acceptable water level in Q5. Maintenance of an appropriate water level in Q5 will minimise ecological impacts and have an adverse minor residual impact on surface water flow.

9.12.13 Excess water also may be discharged from Q1 to the Nant-y-Betws, a tributary of the Afon Gwyrfai, although this is unlikely due to the preference during operation to discharge from Q6 to Llyn Padarn. However, a review of available water quality data and the proposed operation of the Development does not give rise to any concerns and no significant adverse impacts are predicted. Energy dissipation measures will be included on the outfall to the Nant-y-Betws stream, the detail design of which it has been agreed with NRW can be left to a later stage providing a suitable Requirement is included in the DCO. These measures will help to protect the quality of the stream, which supports a number of private water abstractions.

9.12.14 Surface water abstractions from the small watercourses which flow northwards from an area around Q2 also will not be impacted by the scheme as the catchments to these streams will not be disturbed by the Development. Private water abstractions from the Nant-y-Betws potentially may be at risk from the Development during construction from the accidental discharge of sediment rich runoff from the construction area. Mitigation measures designed to control surface water runoff and allow the settlement of suspended solids will be prepared. The implementation of these measures will minimise the risks to the private water supplies from the Nant-y-Betws. New structures on the Nant-y-Betws and two of its tributaries, together with the diversion of one tributary would result in a permanent effects of moderate adverse significance.

9.12.15 The results of an assessment under the WFD have shown that the Development is compliant with the objectives of the WFD and associated proposed mitigation measures for Llyn Padarn, the Afon Seiont, the Afon Gwyrfai and the Llyn & Eyri Groundwater Body.

9.12.16 Other than the possible need to include a water management system in Q5, it is concluded that the operation of the Development would have **negligible** impacts to water resources receptors other than a **minor** effect on the Afon

Gwyrfai via the Nant-y-Betws. No significant impacts on water resources are predicted.

9.13 References

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