14 ROAD DRAINAGE AND THE WATER ENVIRONMENT

14.1 Introduction

This chapter assesses the potential environmental impacts of the A487 Caernarfon and Bontnewydd Scheme (the Scheme) on the water environment. The assessment has been undertaken in accordance with relevant legislation, the methodology detailed in the DMRB Volume 11 Part 10 HD 45/09 [14.1] and in consultation with Gwynedd Council (GC) and Natural Resources Wales (NRW).). Chapter 8 should be referred for an assessment of the potential impacts on ecology and nature conservation and chapter 9 for an assessment of potential impacts on geology and soils.

The receptors that have the potential to be impacted by the Scheme, which are the subject of this chapter, include the coastal waters, surface water features and groundwater near the Scheme.

Tables 14.2.1 and 14.2.2 summarise the NRW and GC responses to the scoping request and further consultation undertaken during the assessment.

A Flood Consequence Assessment (FCA) has been prepared to support this chapter. The FCA assesses the existing flood risks posed to the Scheme and any changes to the flood risk posed to the Scheme or elsewhere because of the Scheme. The FCA is appended to this report (Volume 3, Appendix K.1). A Water Framework Directive Compliance assessment is embedded in the report (Section 14.7).

14.1.1 Proposed development

A full description of the Scheme is included in Chapter 2 of this Environmental Statement. The main features of relevance to this assessment are outlined below:

The Scheme is approximately 9.7km in length, predominantly new road construction through undeveloped land. The road alignment requires a combination of embankment, cutting and at-grade construction, which may locally affect drainage routes and flow regimes.

The Scheme includes a number of watercourse crossings. Seven Main Rivers are affected by the Scheme (Afon Carrog, Afon Rhŷd, Afon Plas, Afon Gwyrfai, Afon Rhosdican, Afon Seiont and Afon Cadnant) as well as a number of ordinary watercourses. The Main Rivers crossed by the Scheme are illustrated in Volume 2 Figure 14.1.

The Scheme involves diversions on the Afon Rhŷd, Afon Rhosdican, Afon Cadnant and other ordinary watercourses.

The Scheme runs broadly parallel to the Menai Strait and at a distance of between approximately 400m and 2.4km.

The Scheme would result in an increase in the total impermeable area due to the new road construction (the existing road would largely remain in place). A new sustainable drainage system would be provided with outfalls into watercourses along the length of the Scheme.

14.1.2 Legislation, policy and guidance

The management of water resources is governed by a range of legislative guidance set out in international, national and regional policies and plans. This assessment has been prepared whilst taking these plans and policies into account.

The Department of Environment, Food and Rural Affairs (DEFRA) manage the coordination of policies for the water environment. Many flood risk and water quality requirements are set at European level, which are then transposed into UK law. NRW, with local authorities, enforce flood risk and water quality requirements in Wales.

In addition to the legislation, policies and guidance summarised below, reference should be made to chapters 8 and 10 of this report, which reference additional legislation, policy and guidance specific to ecology, geology, soils and hydrogeology.

The FCA, provided as a technical appendix (Volume 3, Appendix K.1) to this report, provides a summary of additional legislation relevant to flood risk.

14.1.3 European policy and legislation

Water Framework Directive (2000/60/EC)

The overall objective of the Water Framework Directive (WFD)[14.1] is to bring about the effective co-ordination of water environment policy and regulation across Europe. The main aims of the legislation are to ensure that all surface water and groundwater reaches 'good' status (in terms of ecological and chemical quality and water quantity, as appropriate), promote sustainable water use, reduce pollution and contribute to the mitigation of flood and droughts. Specifically, each country has to:

- Prevent deterioration in the status of aquatic ecosystems, protect them and improve the ecological condition of waters;
- Aim to achieve at least good status for all water bodies by 2015. Where this is not possible and subject to the criteria set out in the Directive, aim to achieve good status by 2021 or 2027;
- Meet the requirements of Water Framework Directive Protected Areas;
- Promote sustainable use of water as a natural resource;
- Conserve habitats and species that depend directly on water;
- Progressively reduce or phase out the release of individual pollutants or groups of pollutants that present a significant threat to the aquatic environment. The WFD includes a 'List of Priority Substances'. Various substances are listed as either List I or List II substances, with List I substances considered the most harmful to human health and the aquatic environment. The purpose of the directive is to eliminate pollution from List I substances and reduce pollution from List II substances;
- Progressively reduce the pollution of groundwater and prevent or limit the entry of pollutants;
- Contribute to mitigating the effects of floods and droughts.
- Directive 2013/39/EU made some amendments to the original WFD however the overall objective is unchanged.

Floods Directive (2007/60/EC)

The key objective of the Flood Directive[14.2] is to coordinate the assessment and management of flood risks within Member States. Specifically it requires Member States to assess if all watercourses and coastlines are at risk from flooding, map the flood extent and assets and humans at risk in these areas, and take adequate and coordinated measures to reduce this flood risk. The directive also reinforces the rights of the public to access this information and to have a say in the planning process.

Groundwater Directive (2006/118/EC)

This Groundwater Directive[14.3] aims to set groundwater quality standards and introduce measures to prevent or limit pollution of groundwater, including those listed with the 'List of Priority Substances'. The European Council (EC) developed the directive in response to the requirements of Article 17 of the WFD, specifically the assessment of chemical status of groundwater and objectives to achieve 'good' status.

14.1.4 National Policy and legislation

Planning Policy Wales Edition 8 (Welsh Government, 2016)[14.5]

Planning Policy Wales (PPW)[14.4] sets outs the land use planning policies of the Welsh Government. In regards to environmental management, PPW states that the Welsh Government's objectives are to:

- Maximise environmental protection for people, natural and cultural resources, property and infrastructure; and
- Prevent or manage pollution and promote good environmental practice.

PPW states that planning authorities should adopt a precautionary approach that avoids the location of development in areas defined as being of flood hazard. This principle should be applied on the basis that climate change is likely to increase the risk of coastal and river flooding, sea levels and rainfall intensity. PPW also instructs local planning authorities to take a strategic approach to flood risk on a catchment wide scale.

PPW considers that that improvement of the quality of water and air is a material consideration in development control. PPW looks to pollution control authorities operating under the Environmental Protection Act (1990) and Water Resources Act (1991) for proper application of these regimes.

PPW is supported by Technical Advice Notes (TANs). TAN 15[14.5] (Welsh Assembly Government, 2004)[14.6] considers development and flood risk and is accompanied by a development advice map (DAM) describing three zones of flood risk. TAN 15 aims to locate new development away from those areas that are at high risk of flooding. Considering the vulnerability of development and the risk of flooding, developers must provide justification for the chosen location of new development in flood risk areas and the consequences of flooding to a development must be considered in the planning process.

Flood Risk Regulations 2009 and Floods and Water Management Act 2010

The Flood Risk Regulations[14.6] transpose the EC Floods Directive into UK law. Specifically, the Flood Risk Regulations place duties on NRW and Lead Local Flood Authority to prepare Preliminary Flood Risk Assessments (PFRAs), flood risk maps, flood hazard maps and flood risk management plans for areas at significant risk.

The Floods and Water Management Act (2010)[14.7] was prepared following the Pitt Review in 2007. The Act created the role of the Lead Local Flood Authority (typically the unitary authority or county council, as applicable) to take responsibility for leading the co-ordination of local flood risk management in their areas. The Act also establishes a Sustainable Drainage Systems Approving Body (SAB) within the Lead Local Flood Authority to promote, approve and adopt sustainable drainage systems in new developments and re-developments before construction begins. Enactment of the SAB role is pending at the time of completion of this assessment.

Environmental Permitting (England and Wales) Regulations 2010

The Environmental Permitting (England and Wales) Regulations 2010[14.8] replaced the Water Resources Act 1991[14.9] as the key legislation for water pollution in the UK. Under the Environmental Permitting Regulations it is an offence to cause or knowingly permit a water discharge activity, including the discharge of polluting materials to freshwater, coastal waters, relevant territorial waters or groundwater, unless complying with an exemption or an environmental permit. An environmental permit is obtained from NRW. NRW sets conditions that may control volumes and concentrations of particular substances or impose broader controls on the nature of the effluent, taking into account any relevant water quality standards from EC Directives.

Local Policy

Gwynedd Unitary Development Plan (2001 - 2016)[14.9]

GC is in the process of preparing a Local Development Plan (LDP) for the area. It is not anticipated that this will be complete and adopted until December 2016. Until then, the existing Unitary Development Plan (UDP)[14.10] is the primary documentation referred to by the Council when determining planning applications.

Several policies within the UDP are specifically relevant to the protection of the water environment from development. These are outlined below:

i Policy B29 – Development on land at risk from flooding, which reinforces the national policy set out in TAN15.

ii Policy B32 – Increasing Surface Water

This policy states that, “Proposals that do not include flood minimisation or mitigation measures that will reduce the volume and rate at which run off reaches rivers and other watercourses will be refused…”

iii Policy B33 – Development that creates pollution or nuisance

This policy states that, “Proposals that will cause significant harm to the quality of public health, safety or amenities, or to the quality of the built or natural environment as a result of higher levels of air, water, noise, or soil pollution will be refused unless adequate controls can be attained by means of planning conditions and powers of regulatory bodies, and that arrangements can be made to monitor discharges…”

Gwynedd Local Development Plan (2011 - 2026)

The joint Isle of Anglesey and Gwynedd Council Local Development Plan has not yet been adopted by the council however once adopted will set out the councils' plans for development. The deposit plan[14.11] is available and includes the following policies relevant to this assessment:

- Policy PCYFF1: 'Development Criteria', which states that planning permission will be refused where proposed development would have an adverse impact on the quality of ground or surface water.
- Policy PCYFF2: 'Design & Place shaping', which states that drainage systems for new developments should limit surface water run-off and flood risk and prevent pollution;
- Policy PCYFF5: 'Water Conservation', which requires that development proposals incorporate water conservation measures, including SuDS, and should implement flood minimisation or mitigation where possible, to reduce surface water run-off and minimise its contribution to flood risk elsewhere.
- Policy PS5: 'Sustainable Development'. This requires development to protect and improve the quality of the natural environment, its landscapes and biodiversity assets and to reduce the effect on local resources, avoiding pollution. The policy requires development to reduce the effect on water resources and quality; managing flood risk and maximizing use of sustainable drainage schemes; and progress the objectives of the Western Wales River Basin Water Management Plan.
- Policy PS6: 'Alleviating and adapting to the effects of climate change', which requires development to implement sustainable water management measures in line with the requirement of the Western Wales River Basin Water Management Plan and to locate development away from flood risk areas such that it is able to withstand the effects of climate change.
- Policy PS8: 'Proposals for large infrastructure projects'. The council will aim to ensure proposals include provision of flood protection measures to manage flood risk and, where feasible, deliver improvements in the locality.
- Policy PS16: 'Conserving and enhancing the natural environment', which states that development applications must safeguard habitats and species, considering designations and protected species.
- Policy AMG3: 'Coastal Protection', requires development to avoid causing unacceptable harm to water quality.
- Policy AMG4: 'Local Biodiversity Conservation', which requires development to create, improve and manage wildlife habitats and natural landscapes including wildlife corridors.

Other supplementary guidance documents relevant to this chapter

River Basin Management Plan

The River Basin Management Plan (RBMP) for the Western Wales River Basin District[14.12] was published in December 2009 and is in the process of being updated for the second cycle under the WFD. The 2015 Western Wales RBMP is in the process of being published but water body status information for the new RBMP is not currently available. This report therefore uses the 2009 plan data.

The RBMP has been prepared under the Water Framework Directive, which requires all countries throughout the European Union to manage the water environment to consistent standards

The plan describes the river basin district, and the pressures that the water environment faces. It shows what this means for the current state of the water environment and what actions will be taken to address the pressures. It sets out what improvements are possible by 2015 and how the actions will make a difference to the local water environment – the river catchments, the estuaries and coasts, and the groundwater.

The Scheme is located in the Llyn and Eryri management catchment. The WFD status and objectives for the relevant watercourses and groundwater in the Scheme area is described in Section 14.7.

Pollution Prevention Guidelines (PPGs)

Pollution Prevention Guidelines[14.13] (PPGs) were issued by the Environment Agency (EA) and a number of these guidelines are relevant to design and construction of the proposed development. In December 2015, the guidelines were withdrawn by the EA, however it is understood they have not been officially withdrawn by NRW. In the absence of replacement guidelines, they are still considered to outline best practice guidance. In particular, PPG 1 provides practical advice on site drainage, PPG5 provides guidance for works in, near or liable to affect watercourses, and PPG 6 provides guidance on the control of water pollution during construction and demolition stages of works. Implementation of the practice contained within these PPGs will need to be considered as part of the environmental management documentation developed for construction and occupation phases of the development.

The following documents provide guidance in relation to flood risk and are discussed in the FCA provided in Volume 3, Appendix K.1:

- Strategic Flood Consequence Assessment Level 1[14.14]
- Lleyn and Eryri Management Catchment Summary[14.15]
- Western Wales Flood Risk Management Plan[14.16]
- Local Flood Risk Management Strategy[14.17] – Of specific relevance to this assessment, the LFRMS states that the council will oppose the culverting of watercourses and take action against any unconsented works. Applications for culverts will be considered on their own merits and approved only if there is no reasonably practicable alternative, or the detrimental effects are so minor that a more costly alternative cannot be justified.

14.2 Methodology

In relation to the water environment, this assessment comprises the following components:

- A summary of relevant policy and guidance;
- A summary of consultation undertaken during the development of the Scheme;
- An assessment of the baseline conditions using Envirocheck data, other available published information, a site walkover and hydraulic modelling;

- A summary of the receptors that have potential to be sensitive to possible impacts arising from the development as well as the key risks to those receptors;
- An assessment, against the baseline scenario, of the likely magnitude and significance of possible impacts arising as a result of the scheme construction on receptors prior to implementation of mitigation measures;
- An assessment, against the baseline scenario, of the likely magnitude and significance of possible impacts arising as a result of the scheme operation on receptors prior to implementation of mitigation measures;
- A proposal of mitigation measures appropriate for the development;
- An assessment, against the baseline scenario, of the likely revised magnitude and significance of impacts arising during construction and operation of the scheme following implementation of the mitigation measures proposed;
- A summary of the residual risks associated with the Scheme;
- An assessment, against the baseline scenario, of the likely magnitude and significance of cumulative impacts arising during construction and operation of the scheme.

The scheme is approximately 9.7km in length and the assessment uses a 500m buffer zone either side of the scheme to identify water environment features with potential to be impacted by the scheme. Where it is considered that features further than 500m from the scheme have potential to impact or be impacted by the scheme these features are included in the assessment. These features have been identified according to the engineering judgement of suitably qualified professionals and are typically water bodies with direct hydraulic connectivity to the scheme.

Impacts on the water environment are assessed against whether they are permanent or temporary in relation to the duration of the impact. Assessments are also categorised by direct or indirect impacts.

Unless stated explicitly, the assessment of impacts on the scheme and elsewhere does not account for mitigation measures. Those aspects of the scheme that are not embedded in the scheme design are considered mitigation measures.

Consultation

Consultation has been undertaken with NRW and GC. Formal Scoping for the scheme was also undertaken. A summary of the requirements, advice and comments provided by NRW and GC is provided in Tables 14.2.1 and 14.2.2.

Table 14.2.1 Summary of consultation with NRW

Topic	Comment
Scope & approach to the FCA	A Flood Consequence Assessment is to be prepared in accordance with TAN15. The FCA should consider a range of flood flows for the watercourse crossings up to and including that of the 1000 year. Climate change allowances should be made but climate change allowances are not applicable for the 1000 year fluvial event. Climate change allowances of +20% (river flows) and +30% (drainage design) are acceptable. Hydraulic modelling is required for the larger Main River crossings (Afon Rhŷd, Afon Gwyrfai, Afon Seiont, and Afon Cadnant). NRW agreed that hydraulic modelling of the smaller Main River crossings would not be required and that a qualitative assessment would be sufficient if suitable freeboard is provided above the 100 year (climate change) flood level. 1D hydraulic models are acceptable for clear spanning structures (2D models have been used for the Afon Gwyrfai, Afon Rhŷd and Afon Cadnant). Hydrology and models should be submitted to NRW for review. Flood consequences to the Scheme should be in line with TAN15. The FCA should consider scour risks, particularly potential impact on 3rd parties. New channel sections should seek to keep as close to existing as possible. The FCA should include comment on temporary works. Full assessment / hydraulic modelling is unlikely to be required at this stage unless the impacts are deemed significant. It is suggested that the locations of balancing ponds/embankments within identified flood risk areas consider not only loss of floodplain (which would need to be compensated) but also conveyance. Balancing ponds that are located in floodplains may need to be modelled to ensure they do not displace flood waters or affect conveyance. Tidal flooding is unlikely to be an issue but it should be covered in the FCA.
Main River Crossings	Structures crossing Main Rivers should have a minimum freeboard of 600mm above the design flood level (1 in 100 year return period + 20% for climate change). Trash screens are unlikely to be required given the size and length of the proposed culverts and it is preferable not to have screens. Reference should be made to the DEFRA/EA Trash and Security Screen Guide 2009. Flood Defence Consents will need to be submitted under the requirements of Section 109/201 of the Water Resources Act 1991 for the main rivers crossings/diversions. All river and stream crossings should be designed to minimise disruption to the watercourse and maintain a natural bed to the watercourse and, wherever practicable, be clear span structures. Where culverts are required to accommodate wildlife e.g. Otters, bats etc. these should not compromise the primary watercourse requirements and features. A natural bed depth of 150 -300mm is considered appropriate. A set back for access at least 7m from either side of watercourses where crossings are proposed is encouraged wherever possible. However, it was confirmed this could be relaxed at the Afon Gwyrfai.

Topic	Comment
Ordinary watercourse crossings	Concerning the ordinary watercourse crossings, these will require consent from the Lead Local Flood Authority (LLFA) and we would suggest that the method of sizing the crossings should be agreed with the LLFA. A bifurcation occurs on the Afon Cadnant tributary at NGR SH 50991 64773. A percentage of the flow is directed towards the proposed culverts at Chainage 8900.Therefore culvert sizing at this location(s) for the bypass and associated road should ensure that the catchment is adjusted to consider this. It is understood that the bifurcation is to relieve flood risk issues in the town of Caernarfon. There is no formal bifurcation structure but the flow splits due to the natural ground and bed levels of the watercourses.
Surface water management	Drainage should mimic existing rates/volumes for a range of events up to the 1 in 100 year rainfall event. Balancing ponds should be designed to cater for the 1 in 100 year rainfall event (with due consideration given to climate change) with greenfield run off rates maintained. When designing the drainage system for the road it must be designed to maintain catchment separation i.e. not take run-off from one catchment and drain it to another. NRW encourages the use of soft SuDS in the management and treatment of run-off as close to source as possible. This could be through the use of filter strips, filter drains, swales, over edge drainage, retention ponds and detention basins these will also assist with balancing of run-off from the drainage.
Temporary works	Site compounds etc. should be located outside of any flood zones. Any temporary structures (e.g. bailey bridges) likely to affect the flow should be supported by hydraulic assessment to demonstrate the flood risk is acceptable. Bailey bridges will be subject to flood defence consent and should pass the 100 year flow with freeboard.
Afon Gwyrfai	NRW would be unlikely to support value engineered option with embankments extending into the floodplain. NRW may object to the increase in flood depths shown, above usual tolerances, due to the embankment extending into the floodplain as they consider this an increase in flood risk contrary to TAN15. If the landowner accepts the impacts (to farmland) then NRW would probably not object. NRW is unlikely to object to increased flooding shown around piers; it is accepted that the model accuracy is limited in this respect and there is no mitigation that could be provided. Floodplain compensation storage would not be required if the hydraulic modelling shows increases in flood depth within acceptable tolerances. The temporary bridge for the Gwyrfai should pass the 100 year flow with a suitable freeboard. The bridge & haul road should be modelled and included in the FCA due to the potential significance of impacts. A range of events up to the 100 year should be considered.
Afon Seiont	The road embankment on the southern land (shown as within current EA Flood Zones) is acceptable as the detailed modelling undertaken for the FCA shows this land lies outside of the 1000 year flood extent.
Afon Cadnant	Introduction of additional flows into the Afon Cadnant would not be acceptable due to existing flood risk in Caernarfon.
Afon Rhŷd	The proposed diversion may be acceptable subject to hydraulic modelling showing the effects are acceptable. The channel should not be trapezoidal and should include riffles etc. to slow flow, alongside any necessary bank / bed protection.

Construction phase mitigation	NRW have provided advice on the required elements of construction phase mitigation. They have provided the following advice for construction phase management: • Provision of a detailed Method Statement is required to show the different phases of construction, likely impacts on the environment of the different activities, and any mitigation measures already decided upon • As part of this Statement, the developer must show awareness of WFD and associated Protected Areas, and be aware of the potential impact of their activities on these sites – as a precursor to then proposing protection measures • Construction work should start with the premise of preventing any polluting discharges from entering watercourses or discharging to groundwater, and then mitigate where necessary. Where discharges are to take place, NRW have advised that: • They should ensure appropriate settlement and control of any contaminated surface water, particularly areas where there are vehicle movements and excavation work, and consequently the likelihood for contamination of runoff by sediments • If settlement is required prior to any discharge, methods of settlement must be discussed with NRW officers e.g settlement lagoons, filtration, reedbeds etc to ensure appropriate quality of discharge in terms of solids. • If groundwater is to be pumped out and discharged at any point e.g. to install footings, advice must be sought as to the need for any permits • Storage of any oils, chemicals etc. – containers must be stored safely, bunded where appropriate, and access around them marked clearly to prevent collisions with machinery and rupturing of tanks, as well as any spills. • Any activities involving the use of concrete that could affect watercourses must be discussed with NRW officers first, and any necessary permits obtained. • Depending upon the timing of the different phases, developers must be mindful of any impacts on the natural environment e.g. spawning in rivers. • Fish habitat and passage must also be protected – fish passage needs to be in place at all times, fish rescue will be required during any in-river works. •

Topic	Comment
	• There must be an agreed Emergency Plan for any incidents that do take place during construction, including numbers to call at NRW.

Table 14.2.2 Summary of consultation with GC

Topic	Comment
General Flood Risk	Culvert design where 3rd party flooding is a possibility is for a 1 in 100 year event plus 20% for climate change. Ordinary watercourse crossings should have a 300mm freeboard above the 100 year return period flow, including an allowance for climate change. During further consultation in respect of the Plas Menai crossing this requirement was relaxed.

14.2.1 Detailed methodology

Due to the size of the study area, water environment receptors have been grouped by type and catchment where possible for the purposes of both the baseline, qualitative and quantitative proposed scenario assessments. Assessments have been completed for construction impacts in the baseline year (2015) and operational impacts in the year 2033.

The construction phase assessment was undertaken against the 2015 scenario. The operational assessment was undertaken against the 2033 scenario where no Scheme has been developed. In most areas, no significant change is expected to the receptors between 2015 and 2033. However, where a water body has an objective to achieve a higher status by 2033 than the 2015 status (as detailed in the Western Wales RBMP), it is assumed that this objective will have been reached by 2033 and the 2033 assessment is made against the higher status. The assessment is based on the 2009 published River Basin Management Plan[14.12] as the 2015 revision was not available at the time of assessment.

The methodology adopted for this assessment is based on the methodology outlined within the Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 10: Road Drainage and the Water Environment HD 45/09, November 2009.

In accordance with the DMRB's quantitative methodology, the operational pollution impacts from surface water runoff and accidental spillages have been assessed using the Highways Agency Water Risk Assessment Tool (HAWRAT). The risk of pollution to groundwater from routine runoff has been quantified using the matrix provided within the same DMRB volume. A detailed description of the methodology employed in use of HAWRAT is provided alongside a description of the results of the assessment in section 14.4.3.

A qualitative assessment has been adopted to assess the potential impacts of construction works on the water environment. A detailed Flood Consequence Assessment has been prepared for the Scheme (Volume 3, Appendix K.1) and should be referred to for the assessment of the impacts of the Scheme on flood risk, and the impacts of flooding on the Scheme.

The level of assessment of impacts, as guided by DMRB methodology, is consequential and progressive. Where a simple assessment identifies that there are likely to be no impacts on the water environment, no further assessment will usually be required.

The DMRB promotes the following approach in reporting the results of an assessment:

i. Estimation of the importance of the attribute.

ii. Estimation of the magnitude of impacts through the results of assessments for each of the areas considered of the impact.

iii. Assessment of the significance of the impact based on importance of the attribute and magnitude of the impact.

Guidance for estimating these factors is provided in Table 14.2.3, Table 14.2.4 and Table 14.2.5 below.

Table 14.2.3 Estimating the Importance of Water Environment Attributes

Importance	Criteria	Example
Very High	Attribute has a high quality and rarity on regional or national scale	Water body of very good chemical or biological quality, i.e. Water Framework Directive (WFD) Class 'High'. Site protected/designed under EC or UK habitat legislation (Special Areas of Conservation (SAC), Special Protection Area (SPA), Site of Special Scientific Interests (SSSI), Water Protection Zone (WPZ), Ramsar site, species protected by EC legislation. EC designated Salmonid fishery. Principle aquifer providing a regionally important resource or supporting site protected under EC and UK habitat legislation. Source Protection Zone (SPZ) 1. A source used for public or local potable water supply. Water body of high amenity value, including areas of bathing and where water emersion sports are regularly practised.
High	Attribute has a high quality and rarity on local scale	Water body of good chemical and biological quality, i.e. WFD Class 'Good' Species protected under EC or UK habitat legislation EC designated Cyprinid fishery. Principle aquifer providing locally important resource or supporting river ecosystem. SPZ 2. A source used for domestic non-potable water supply. Water body of a moderate amenity value including public parks, boating, non-contact water sports, popular footpaths adjacent to watercourses, or watercourses running through housing developments/town centres.

Importance	Criteria	Example
Medium	Attribute has a medium quality and rarity on local scale	Water body of fair chemical or biological quality, i.e. WFD Class 'Moderate'. Aquifer providing water for agricultural or industrial use with limited connection to surface water. SPZ 3. Water body of particular local social/cultural/educational interest. Water body of low amenity value with only casual access, e.g. along a road or bridge in a rural area.
Low	Attribute has a low quality and rarity on local scale	Water of poor or bad chemical or biological quality, i.e. WFD Class 'Poor' Low sensitivity aquatic ecosystem. Non-Aquifer. Water body of no amenity value, seldom used for amenity purposes, in a remote or inaccessible area. Watercourse of moderate chemical or biological quality but with low significance in the wider catchment s due to small size and low rarity.

Table 14.2.4 Estimating the Magnitude of an Impact

Magnitude	Criteria	Example
Major Adverse	Results in loss of attribute and / or quality and integrity of the attribute	Loss or extensive change to a fishery / designated Nature Conservation Site. Loss or extensive change to an aquifer / groundwater supported designated wetlands. Change to the environmental status/classification of a water feature, including water quality classification.
Moderate Adverse	Results in effect on integrity of attribute, or loss of part of attribute	Partial loss or change to a fishery / designated Nature Conservation Site. Loss in the productivity of a fishery. Partial loss or change to an aquifer/ groundwater supported designated wetlands. Pollution of a receiving water body, but insufficient to change the environmental status/classification, including water quality classification.
Minor Adverse	Results in some measurable change in attributes quality or vulnerability	Potential low risk of some pollution to a surface water or groundwater body, but insufficient to cause loss in quality, fishery productivity or biodiversity.
Negligible	Results in effect on attribute, but of insufficient magnitude to affect the use or integrity	The proposed scheme is unlikely to affect the integrity of the water environment. No measurable impact upon an aquifer
Minor Beneficial	Results in some beneficial effect on attribute or a reduced risk of negative effect occurring	Potential for slight reduction in pollution to a surface water or groundwater body, but insufficient to cause noticeable benefit in quality, fishery productivity or biodiversity.
Moderate Beneficial	Results in moderate improvement of attribute quality	Moderate improvement to a fishery / designated Nature Conservation Site. Potential increase in the productivity of a fishery. Reduced pollution of a receiving water body, but insufficient to change the environmental status/classification, including water quality classification.
Major Beneficial	Results in major improvement of attribute quality	Significant improvement to a fishery / designated Nature Conservation Site. Removal of existing polluting discharge, or removing the likelihood of polluting discharges occurring. Change to the environmental status/classification of a water feature, including water quality classification.

Table 14.2.5 Estimating the Significance of Potential Effects

		MAGNITUDE OF IMPACT			
		Negligible	**Minor**	**Moderate**	**Major**
IMPORTANCE OF ATTRIBUTE	**Very High**	Neutral	Moderate to Large	Large to Very Large	Very Large
	High	Neutral	Slight to Moderate	Moderate to Large	Large to Very Large
	Medium	Neutral	Slight	Moderate	Large
	Low	Neutral	Neutral	Slight	Slight to Moderate

An assessment of the impacts of the Scheme on the ability of water body receptors to achieve the objectives of the WFD has also been completed. In completion of this assessment, reference has been made to the EA's supplementary guidance document, 488_10_SD01, Assessing new modifications for compliance with WFD: detailed supplementary guidance[14.19].

The WFD assessment comprises an assessment of the current water quality status of water bodies affected by the Scheme, and the water quality elements that support this status. The assessment is based on the 2009 published River Basin Management Plan[14.12] data, supplemented with information from the ecological assessment for the Scheme. The potential impacts of the Scheme on these water quality elements has been assessed to determine whether these impacts have the capacity to affect the water bodies' capabilities to achieve the objectives of the WFD.

Limitations

There was no Envirocheck data covering the Scheme north of Caernarfon. This presents a slight limitation to the assessment however as described in Section 14.3.4 it is unlikely that any significant pollution incidents, abstractions or discharges are present as these have not been identified through consultation with Gwynedd Council and NRW or from other relevant data sources.

Several of the waterbodies in the vicinity of the Scheme are small and of relatively low importance. There is therefore limited existing data and in respect of water quality as they are not directly monitored. The current characteristics and assessment of the waterbodies have been assess using a combination of water quality and WFD data for downstream waterbodies, site observations and the findings of the ecological assessment (chapter 8).

14.3 Baseline Conditions

This section provides a summary of the baseline condition of the water environment against which an assessment of the Scheme proposals has been made.

Two baseline scenarios have been considered:

- 2015 (construction impacts) - reflects the current status of the receptors.
- 2033 (operational impacts) - reflects the expected future status of receptors in 2033, including any targeted improvements in the quality of water bodies as set out in the Western Wales RBMP.

Volume 3, Appendix K.2 Scheme Proposals shows identified water features in the vicinity of the Scheme.

14.3.1 Site description

The Scheme is located around Caernarfon town, Gwynedd. Caernarfon is located on the east bank of the Menai Strait. The Scheme is located reasonably near the coast (approximately between 0.4 and 2.2km). Topography is reasonably level at the site, increasing in steepness toward the east and the Snowdon range. Many of the watercourses flowing through the study area have their source in the mountainous area around Snowdon.

The study area can be split into five main river catchments, as follows:

Afon Carrog

- Afon Rhŷd
- Afon Gwyrfai and Afon Rhosdican
- Afon Seiont
- Afon Cadnant

There is also a small area of land within the Scheme area that drains to the Menai Strait in a small catchment located north-west of the Afon Cadnant catchment. The primary watercourse in this catchment is unnamed.

The study area is predominantly agricultural with the exception of Caernarfon town

14.3.2 Ground conditions

Bedrock

British Geological Survey (BGS)[14.20] mapping, available online, indicates that the site area is underlain by three types of bedrock as outlined below:

The Scheme area within the Rhŷd catchment is predominantly underlain by interbedded sandstone and conglomerate bedrock;
The Scheme area within the Gwyrfai and Seiont catchments is predominantly underlain by mudstone, siltstone and sandstone bedrock;
The Scheme area within the Cadnant catchment is predominantly underlain by an unnamed igneous intrusion.

It is anticipated that sandstones and mudstones may provide reasonable transmission of groundwater, whilst the igneous intrusion may be less capable of supporting groundwater flow.

Superficial Deposits

BGS mapping indicates that the whole scheme area is overlain with superficial till deposits, which are likely to be of variable permeability.

Soils Survey of England and Wales maps (1:50,000 series, 1983)[14.21] provide information on soils across the study area. South of Caernarfon these are a mixture of 'deep, well drained, coarse loamy and sandy soils locally over gravel' and 'slowly permeable seasonally waterlogged fine loamy soils'. North of Caernarfon the Scheme area is dominated by soils described as 'deep, well drained, coarse loamy and sandy soils locally over gravel'. This suggests that in the Scheme area north of Caernarfon infiltration and transmission through soils is moderate to high and south of Caernarfon a mixture of moderate to high and moderate to low. However, site specific ground investigation (Volume 3, Appendix F.3) has indicated that infiltration rates along the length of the route alignment are very low. This information is considered more reliable than the coarse scale soils mapping.

Chapter 9, geology and soils, should be referred to for more detailed information.

14.3.3 Surface water features

Surface water features have been categorised by catchment as described above.

Volume 2 Figure 14.2 shows all of the water bodies in the vicinity of the Scheme and 500m buffer zone identified from OS mapping.

Section 8 (nature conservation) should be referred to for specific information relating to fisheries and protected species associated with the watercourses.

Afon Carrog catchment

A list of all surface water features in the Afon Carrog catchment that lie within the Scheme buffer zone is provided in Table 14.3.1, along with a brief description of the watercourses.

Table 14.3.1 Surface water features within Afon Carrog catchment

Feature	Distance from route alignment	Hydraulic connectivity to the Scheme	Description
Afon Carrog	380m	Indirect connectivity via tributary at CH:185m	- Main river - Good current ecological quality - No current chemical quality assessment

			- Not currently designated a Heavily Modified Waterbody (HMWB) - Overall status objective – Good Status by 2015
Unnamed ditches at CH:17m, 122m	0m	Direct connectivity	- Low amenity ditches - No water quality data available - Culverted at field entrances and under existing roads - Small with low rarity value
Unnamed tributary of the Afon Carrog at CH:185m	0m	Direct connectivity	- Ordinary watercourse - Culverts at field entrances - Small with low rarityvalue

Photo 14.1 is a photograph of the unnamed tributary to the Afon Carrog at CH:185m.

Photo 14.1 Unnamed tributary to the Afon Carrog at CH:185m, looking west

Afon Rhŷd catchment

A list of all surface water features in the Afon Rhŷd catchment that lie within the Scheme buffer zone is provided in Table 14.3.2, along with a brief description of the watercourses.

Table 14.3.2 Surface water features within Afon Rhŷd catchment

Feature	Distance from route alignment	Hydraulic connectivity to the Scheme	Description
Afon Rhŷd	0m	Direct connectivity at CH:545m	- Main river - No WFD assessment - Modified channel observed c.180m downstream (Photo 14.3)
Unnamed ditches crossing Scheme at CH:317m, 1320m	0m	Direct connectivity	- Low amenity value ditches - No water quality data available
Afon Plas (at Ch:1400m)	0m	Direct connectivity	- Ordinary watercourse - No water quality data available - Evidence of Water Voles noted in 2015 survey
Unnamed ditches/watercourses not crossing Scheme (many)	<500m	No connectivity	- Low amenity value ditches and tributaries of Afon Rhŷd - No water quality data available

Photo 14.2 is a photograph of the Afon Rhŷd upstream of where it is crossed by the Scheme at chainage 545m. Photo 14.3 is a photograph of the Afon Rhŷd downstream of the crossing.

Photo 14.2 Afon Rhŷd 210m upstream of CH:545m, looking east

Photo 14.3 Modified Afon Rhŷd channel 180m downstream of CH:545m, looking east

Afon Gwyrfai catchment

A list of all surface water features in the Afon Gwyrfai catchment that lie within the Scheme buffer zone is provided in Table 14.3.3, along with a brief description of the watercourses.

Table 14.3.3 Surface water features within Afon Gwyrfai catchment

Feature	Distance from route alignment	Hydraulic connectivity to the Scheme	Description
Afon Gwyrfai	0m	Direct connectivity at CH:2032m	- Main river - Afon Gwyrfai a Llyn Cwellyn SSSI along the watercourse in the Scheme area, designated for its running and standing water, aquatic plant assemblage, floating water plantain, Arctic charr (not in river section in close proximity to Scheme), Arctic salmon and Otter. - Afon Gwyrfai SAC along the watercourse in the Scheme area, designated for its oligotrophic standing waters and for its populations of Atlantic salmon, floating water-plantain and Otter. - No confirmed resting up sites or Otter holts. Only two spraints found along the Afon GwyrfaiGood current ecological quality - Good current chemical quality - Heavily modified hydromorphology - Overall Status Objective – Good Potential by 2015
Afon Rhosdican	0m	Direct connectivity at CH:2900, 3660, 4040, 4489, 4676m	- Main river - Moderate current and predicted ecological quality - Chemical quality not assessed - Not designated a HMWB
Unnamed ditches crossing Scheme at CH:1543m, 3162m	0m	Direct connectivity	- Low amenity value ditches - No water quality data available
Unnamed ditches/watercourses not crossing Scheme (many)	<500m	No connectivity	- Low amenity value ditches and tributaries of Afon Gwyrfai and Afon Rhosdican - No water quality data available

Feature	Distance from route alignment	Hydraulic connectivity to the Scheme	Description
Afon Bueno	300m	No connectivity	- Main river - No water quality data available - Evidence of Water Voles noted in 2015 survey

Photo 14.4 is a photograph of the Afon Gwyrfai upstream of where it is crossed by the Scheme at chainage 2032m.

Photo 14.4 Afon Gwyrfai 1.5km upstream of CH:2032m, looking west

Afon Seiont catchment

A list of all surface water features in the Afon Seiont catchment that lie within the Scheme buffer zone is provided in Table 14.3.4, along with a brief description of the watercourses.

Table 14.3.4 Surface water features within Afon Seiont catchment

Feature	Distance from route alignment	Hydraulic connectivity to the Scheme	Description
Afon Seiont	0m	Direct connectivity at CH:5500m	- Main river - Designated SSSI immediately downstream of Scheme buffer zone, for geological reaons. - No confirmed resting up sites or Otter holts but Otter activity observed during Sep 2015. - Moderate current ecological quality - No chemical quality assessment - Classified as a HMWB - Overall Status Objective – Good Potential by 2027
Unnamed ditches crossing Scheme at CH:5852m, 6470m, 6540m,	0m	Direct connectivity	- Low amenity ditches - Low rarity and scale - No water quality data
Unnamed ditches/watercourses/ponds not crossing Scheme (many)	<500m	No connectivity	- Ditches and tributaries of Afon Seiont - Pond in old clay works - No water quality data

Photo 14.5 is a photograph of the Afon Seiont upstream of where it would be crossed by the Scheme at chainage 5500m.

Photo 14.5 Afon Seiont 600m upstream of CH:5500m, looking west

Afon Cadnant catchment

A list of all surface water features in the Afon Cadnant catchment and vicinity that lie within the Scheme buffer zone is provided in Table 14.3.5, along with a brief description of the watercourses.

Table 14.3.5 Surface water features within Afon Cadnant catchment

Feature	Distance from route alignment	Hydraulic connectivity to Scheme	Description
Afon Cadnant	0m	Direct connectivity at CH:8160, 8360, 8500m	- Main river - Good current ecological quality - No chemical quality assessment - Not designated a HMWB - Overall Status Objective – Good Status by 2027
Unnamed tributary of the Afon Cadnant at CH:8180m	0m	Direct connectivity at CH:8180m	- Main river - No water quality data available
Unnamed ditches/watercourses/ponds not crossing Scheme (many)	<500m	No connectivity	- Low amenity value ditches and tributaries of Afon Cadnant - No water quality data available

Photo 14.6 is a photograph of the Afon Cadnant where it would be crossed by the Scheme at CH:8500m.

Photo 14.6 Afon Cadnant at Scheme crossing at CH:8500m, looking north

Catchments north of Afon Cadnant

A list of all surface water features which lie in this area, within the Scheme buffer zone, is provided in Table 14.12 along with a brief description of the watercourses.

Table 14.3.6 Surface water features within catchment north of the Afon Cadnant

Feature	Distance from route alignment	Hydraulic connectivity to Scheme	Description
Unnamed watercourse that discharges to Menai Strait	0m	Direct connectivity at CH:8954, 9020m	- Ordinary watercourse - Moderate current ecological quality - No chemical quality assessment - Not designated a HMWB - Overall Status Objective – Good Status by 2027
Unnamed ditches/watercourses/ponds not crossing Scheme (many)	<500m	No connectivity	- Low amenity value ditches and tributaries of Afon Cadnant - No water quality data available

Photo 14.7 is a photograph of the unnamed watercourse that discharges to Menai Strait, where it would be crossed by the Scheme at chainage 8954m.

Photo 14.7 Unnamed watercourse at Scheme crossing at CH:8954m, looking south-east

- *Menai Strait*

The Menai Strait is located between approximately 400m and 4km west of the Scheme. Table 14.12a summarises the receptor.

Table 14.3.6a Surface water features within catchment north of the Afon Cadnant

Feature	Distance from route alignment	Hydraulic connectivity to the Scheme	Description
Menai Strait	420m (minimum)	Indirect connectivity via Afon Carrog, Rhyd, Gwyrfai, Seiont, Cadnant and unnamed watercourse to the north of the Cadnant	- Y Fenai a Bae Conwy / Menai Strait and Conwy Bay SAC designated for its sandbanks, mudflats, sandflats, reefs, large shallow inlets, bays and caves. - Moderate current ecological quality - No chemical quality assessment

			- Heavily modified hydromorphology - Overall Status Objective – Good Potential by2027

14.3.4 Surface water pollution events

Envirocheck data[14.19] provided for the Scheme has been reviewed to identify significant historic pollution events to surface water features that may explain current water quality in the watercourses described above. No significant historic pollution incidents are recorded in the last ten years that might explain the current quality of water bodies in the Scheme area.

Note that no Envirocheck data has been made available for the Scheme area north of Caernarfon. There may therefore have been surface water pollution events in the Scheme area, particularly to the Afon Cadnant, that are not reported here. This presents a slight limitation to the assessment however, no surface water pollution events were reported by GC or NRW during consultation, and any factors influencing the abilities of water bodies to achieve the objectives of the WFD have been described in the RBMP, summarised in Section 14.7. It is therefore considered unlikely that there are significant surface water pollution events that have not been identified.

14.3.5 Surface water abstractions

Envirocheck data provided for the Scheme has been reviewed to identify active permitted water abstractions from surface water features in the Scheme area. These are listed in Table 14.3.7.

Table 14.3.7 Active permitted surface water abstractions in the Scheme area

Abstraction source	Abstraction use
Afon Gwyrfai	Effluent/slurry dilution
Afon Seiont	Process water
Afon Seiont	Lake and pond through flow
Old Clay Pit	Process water

In addition to the abstractions listed in Table 14.13, there are known to be private water abstractions in the Scheme area. The sources and uses of these abstractions are unknown however and these have therefore not been listed. Whilst no specific incidences of potable water abstractions are known of, it is possible that these exist in the scheme area.

Note that no Envirocheck data has been made available for the Scheme area north of Caernarfon. There may therefore be surface water abstractions in the Scheme area, particularly from the Afon Cadnant, that are not reported here, however, no surface water abstractions were reported by GC or NRW during consultation and there is therefore little reason to expect that any significant abstractions occur.

14.3.6 Surface water discharge consents

Envirocheck data provided for the Scheme has been reviewed to identify active discharge consents to surface water features in the Scheme area. These are listed in Table 14.3.8.

Table 14.3.8 Active surface water discharge consents in the Scheme area

Receiving water	Discharge type
Afon Carrog	Storm sewage overflow
Afon Rhŷd	Storm sewage overflow
Unnamed watercourse in Afon Gwyrfai catchment	Unspecified sewage and trade
Afon Gwyrfai	Storm sewage overflow
Afon Gwyrfai	Storm sewage overflow
Afon Beuno	Storm sewage overflow
Afon Beuno	Trade site drainage
Trib of the Afon Beuno	Treated effluent – not water company
Trib of the Afon Beuno	Treated effluent not water company
Afon Seiont	Trade site drainage
Afon Seiont	Treated effluent – water company
Afon Seiont	Treated effluent – not water company
Afon Seiont	Storm tank overflow – water company

Note that no Envirocheck data has been made available for the Scheme area north of Caernarfon. There may therefore be surface water discharge consents in the Scheme area, particularly to the Afon Cadnant, that are not reported here, however, no surface water discharge consents were reported by GC or NRW during consultation, and any factors influencing the abilities of water bodies to achieve the objectives of the WFD have been described in the RBMP, summarised in Section 14.7. It is therefore considered unlikely that there are significant surface water discharge consents that have not been identified.

14.3.7 Groundwater features

General ground conditions are described above in section 14.3.2.

The EA's Groundwater Vulnerability mapping[14.22] classifies the vulnerability of groundwater in different Scheme areas to contamination via leaching. South of Caernarfon, groundwater in the Scheme area is classified as a mixture of minor aquifer overlain by soils of high leaching potential and non-aquifer. North of Caernarfon, the groundwater vulnerability classification is unknown as no Envirocheck data has been made available for the Scheme area north of Caernarfon. Chapter 9 of this report notes that the majority of the route is underlain by Secondary B bedrock aquifers and that there is limited resource potential with respect to bedrock aquifers. Site-specific ground investigation (Volume 3, Appendix F.3) suggests that infiltration rates are very low at locations along the route alignment. This suggests the groundwater vulnerability classification north of Caernarfon is similar to the southern areas of the Scheme.

No Source Protection Zones (SPZ) have been identified in the vicinity of the Scheme.

The Western Wales River Basin Management Plan (2009)[14.12] designates groundwater in the Western Wales district under the requirements of the Water

Framework Directive. Table 14.3.9 summarises the quantitative and chemical designation for the current and predicted scenarios.

Table 14.3.9 Groundwater quality in the Western Wales river district

Criteria	Designation
Current Quantitative Quality	***Good***
Groundwater dependent terrestrial ecosystems (quantitative impacts)	*Good*
Impact on surface waters	*Good*
Saline or other intrusions	*Good*
Resource balance	*Good*
Current Chemical Quality	***Good***
Saline or other intrusions	*Good*
Groundwater dependent terrestrial ecosystems (chemical impacts)	*Good*
Impact on surface water chemical/ecological status	*Good*
Drinking Water Protected Area status	*Good*
2015 Predicted Quantitative Quality	***Good***
2015 Predicted Chemical Quality	***Good***

Groundwater in the area around Caernarfon is generally expected to flow from east to the west, away from high ground towards the Menai Strait.

Site-specific ground investigation has been undertaken and borehole logs along the route alignment indicate the current groundwater levels at the site. The majority of the borehole records do not show a groundwater strike, indicating the groundwater level is below the base of the borehole. However, some of the boreholes recorded groundwater nearer the surface. In addition to this information, OS mapping indicates the presence of springs in all of the main catchments through which the Scheme passes. This also indicates that groundwater levels may be relatively high causing groundwater emergence in the Scheme area. Baseflow from elevated groundwater may also have a moderate impact on watercourse flows in the area.

In specific relation to groundwater flooding, the EA's Areas Susceptible to Ground Water Flooding (AStGWF)[14.20] map classifies land in 1km grid squares based on what proportion of the square has geological and hydrogeological conditions in which groundwater could emerge. The FCA (Volume 3, Appendix K1) illustrates the classification of 1km grid squares in the Scheme area. In general, the Carrog, Rhŷd and Gwyrfai catchments are classified as being in areas where large areas of land may enable groundwater emergence, whilst the Seiont and Cadnant catchments have smaller areas of land that may enable groundwater emergence. The AStGWF map does not however provide any information on the likelihood of groundwater emergence in these areas. Only isolated areas within the overall susceptible area are likely to suffer the consequences of groundwater flooding

Further detail on groundwater is provided in Chapter 9 of this report, 'Geology and Soils'.

14.3.8 Groundwater pollution events

Envirocheck data has been reviewed to identify significant historic pollution events to groundwater. No events have been identified in the Scheme area.

Note that no Envirocheck data has been made available for the Scheme area north of Caernarfon. There may therefore have been groundwater pollution events in the Scheme area, particularly to the north of Caernarfon, that are not reported here. However, no groundwater pollution events were reported by GC or NRW during consultation, and any factors influencing the abilities of water bodies to achieve the objectives of the WFD have been described in the RBMP[14.12], summarised in Section 14.7. It is therefore considered unlikely that significant groundwater pollution events have occurred which have not been identified.

14.3.9 Groundwater abstractions

Envirocheck data, and data supplied by GC, has been reviewed to identify licenced abstractions from groundwater. No licenced abstractions have been identified in the Scheme area that are listed as groundwater abstractions specifically. Note that no Envirocheck data has been made available for the Scheme area north of Caernarfon. There may therefore be active groundwater abstractions in the Scheme area, particularly to the north of Caernarfon, that are not reported here. However, no groundwater abstractions were reported by GC or NRW during consultation, and any factors influencing the abilities of water bodies to achieve the objectives of the WFD have been described in the RBMP[14.12], summarised in Section 14.7. Further significant groundwater abstractions are therefore considered unlikely.

There are known to be private water abstractions within 300 m of the proposed route. It is noted in chapter 9 of this report that 39 private abstractions were identified and that 37 of these were fed by superficial aquifers with two deep boreholes abstracting from bedrock in the northern part of the scheme. Only 31 of these are currently in use with the remainder as back-up supplies or covered over (with the potential to be reopened). None of the abstractions are potable, with four for household use (only one active), 32 for livestock and three for irrigation. Full details including information about future monitoring requirements are contained within the appended Hydrogeological Desk Study.

14.3.10 Groundwater discharge consents

Envirocheck data has been reviewed to identify active discharge consents to groundwater. No events have been identified in the Scheme area.

Note that no Envirocheck data has been made available for the Scheme area north of Caernarfon. There may therefore be active groundwater discharge consents in the Scheme area, particularly to the north of Caernarfon, that are not reported here. However, no groundwater discharges were reported by GC or NRW during consultation, and any factors influencing the abilities of water bodies to achieve the objectives of the WFD have been described in the RBMP[14.12], summarised in Section 14.7. Further significant groundwater abstractions are therefore considered unlikely.

14.3.11 Flood Risk

A Flood Consequence Assessment (FCA) has been undertaken to accompany this ES chapter. The FCA is included in this study as Volume 3, Appendix K.1.

Reference should be made to the FCA for full details regarding flood risk to the Scheme and the impacts of the Scheme on flood risk but in summary, the existing flood risk to the site from fluvial, tidal, groundwater, overland flow and artificial sources has been assessed.

The majority of the scheme is assessed at low risk of flooding from any source. The main areas where flooding may present a constraint are where the scheme crosses or runs close to existing watercourses. The following sources of flooding are assessed to present a potential constraint to the scheme, or have the potential to be affected by the scheme:

- Fluvial flooding from Main Rivers and local watercourses;
- Overland flows from surface water flooding;
- Groundwater flooding where the scheme is in cutting.

The areas of the Scheme at risk of fluvial flooding are illustrated in Volume 2 Figure 14.1. This figure shows the following layers:

- Flood Zone 3 - Defined as land with an annual probability of flooding of 1% or greater (the 100 year flood extent), ignoring the presence of defences;
- Flood Zone 2 - Defined as land with an annual probability of flooding of between 1% and 0.1% (the 1000 year flood extent), ignoring the presence of defences;
- 1000 year surface water flood risk area - land that may flood during a storm with a return period of 1000 years. This layer includes areas at risk from overland flows in addition to rivers and watercourses, however has been included as it provides an indication of areas at risk from smaller watercourses where Flood Zones have not been defined.

14.3.12 Receptor Importance

Using the methodology outlined in Section 14.2 of this report, the receptors discussed above have been classified by their sensitivity to impacts. The sensitivity of each receptor is listed in Table 14.3.10. Ditches and watercourses in the buffer zone that have no hydraulic connectivity with the Scheme, and are located approximately 50m from the Scheme or more, have not been included in the table below. These have not been assessed in Section 14.4 because these are considered sufficiently far from the Scheme that they would not be affected by dust and debris or contamination by groundwater, and without hydraulic connectivity at the surface, there is no potential for construction or operational impacts on the receptors due to runoff from the Scheme.

Table 14.3.10 Summary of receptor importance

Feature	Description	Receptor Importance
Afon Carrog	- Main river - **Good current ecological quality** - No chemical quality assessment - Not designated a Highly Modified Water Body (HMWB)	High
Unnamed ditches in the Carrog catchment at CH:17m, 122m	- Low amenity ditches - No water quality data available - Culverted at field entrances and under existing roads - Low rarity	Low
Unnamed tributary of the Afon Carrog at CH:185m	- Ordinary watercourse - No water quality data available - Culverts at field entrances - Tributary of Afon Carrog	Medium
Afon Rhŷd	- Main river - No WFD assessment or water quality data available - Modified channel observed c.180m downstream (Photo 14.3) - **Minor amenity value crossed by public footpaths**	Medium
Unnamed ditches in the Rhŷd catchment crossing Scheme at CH:317m, 1320m	- Low amenity value ditches - No water quality data available - Low rarity	Low
Afon Plas at CH:1400m	- Ordinary watercourse - No water quality data available - Low amenity value	Medium
Afon Gwyrfai	- Main river - **SSSI & SAC** - **Good potential current ecological quality** - **Good current chemical quality** - Heavily modified hydromorphology - Otter spraint observed on watercourse	Very High
Afon Rhosdican	- Main river - **Moderate current and predicted ecological quality** - Chemical quality not assessed - Not designated a HMWB	Medium

Feature	Description	Receptor Importance
Unnamed ditches in Gwyrfai catchment crossing Scheme at CH:1543m, 3162m	- Low amenity value ditches - No water quality data available - Discharge directly to Afon Gwyrfai (SSSI&SAC) at CH:1543m	Medium
Afon Seiont	- Main river - **Moderate potential current ecological quality** - No chemical quality assessment - Heavily modified hydromorphology - **Overall Good Potential status objective by 2027** - Amenity value through caravan park - Afon Seiont (Middle) Wildlife site - Otter activity observed on watercourse but no holts or spraint.	Medium (2015 scenario) High (2033 scenario)
Unnamed ditches in Seiont catchment crossing Scheme at CH:5852m, 6470m, 6540m,	- Ditches - No water quality data - Low rarity	Low
Afon Cadnant	- Main river - **Moderate current ecological quality** - No chemical quality assessment - Not designated a HMWB - **Overall Good status objective by 2027**	Medium (2015 scenario) High (2033 scenario)
Unnamed tributary of the Afon Cadnant at CH:8180m	- Main river - No water quality data available - **Low amenity value** - Discharges to Afon Cadnant	Medium (2015 scenario) High (2033 scenario)
Unnamed watercourse that discharges to Menai Strait	- Ordinary watercourse - **Moderate current ecological quality** - No chemical quality assessment - Not designated a HMWB - **Overall Good status objective by 2027**	Medium (2015 scenario) High (2033 scenario)
Unnamed ditches in the Menai Strait catchment crossing the Scheme	- Low amenity value ditch, which is a tributary of the unnamed watercourse discharging into the Menai Strait - Low rarity and scale	Low

Feature	Description	Receptor Importance
Menai Strait	- **SAC** - Moderate Potential current ecological quality - No chemical quality assessment - Heavily modified hydromorphology - **Overall Good Potential status objective by 2027**	Very High
Groundwater in Scheme area	- **Good current and predicted quantitative and chemical quality** - No SPZs Private abstraction identified	High
Farmland surrounding Scheme	- Agricultural purposes only	Low (in respect of flood risk)
Existing people and property	- Downstream populated area in Caernarfon - Upstream populated areas in Bontewydd, Dinas and Llanwnda - Existing roads and railways	High
The Scheme	- Road Scheme with no properties “less vulnerable” to flooding	Medium
Construction site operatives and plant	- People and plant operating in Floodplain	Very High

**SPZ and groundwater abstraction locations unknown north of Caernarfon due to limited Envirocheck data. Assumed none existing based on current available information.*

14.4 Predicted Environmental Effects

References to watercourse crossings are reference to by crossing number in the following section. The Scheme drawings included in Volume 2 locate these crossings.

14.4.1 Construction phase

During construction, impacts on the water environment may arise as a result of the following:

- Increased sediment loads caused by site runoff containing elevated suspended sediment levels. This can result from land clearance, excavation, dewatering of excavations, stockpiles, wheel washings and movement of materials to and from the site;
- Release of hydrocarbons due to a large number of vehicles accessing the site, leakage from oil/fuel storage tanks and accidental spillages;
- Dust and debris caused by poor site management and demolition works;
- Accidental leaks of hazardous materials, particularly concrete and cement products, which can be contained in uncontrolled washdown water and surface water runoff;

The mechanisms behind each of these impacts is described in further detail below. In the following sections, the magnitude and significance of each impact on every receptor that has hydraulic connectivity to the Scheme is assessed in accordance with the methodology laid out in Section 14.2. This assessment is undertaken prior to the implementation of mitigation measures.

Dewatering of site excavations may be required for piling or construction of foundations. Risks associated with existing contaminated land are addressed in chapter 9 however the Scheme runs through rural land and therefore contaminated land is unlikely. Dewatering of excavations is unlikely to introduce polluted water to the water environment. Water removed during dewatering activities will be subject to appropriate mitigation (e.g. settlement ponds) prior to discharge to the water environment.

Specific construction risks to hydrogeology, including groundwater movement and quality, are addressed in detail in Chapter 9. Specific construction risks to ecology, including aquatic and terrestrial species and habitats, are addressed in detail in Chapter 8.

Increased sediment loads

Site runoff containing elevated suspended sediment levels can result from land clearance, excavation, dewatering of excavations, stockpiles, wheel washings and movement of materials to and from the site. Runoff with high sediment loads can have direct adverse effects on adjacent water bodies through increasing turbidity (thus reducing light penetration and reducing plant growth and affecting aesthetics), and by smothering vegetation and bed substrates (thus impacting on invertebrate and fish communities through the destruction of feeding areas, refuges and breeding / spawning areas). Indirect adverse effects can also be associated with suspended sediments that have inorganic or organic contaminants (e.g. heavy metals and pesticides, respectively).

The magnitude of the impact is likely to be most significant when working in areas adjacent to a water body and in periods of heavy rainfall. The impacts will be direct and temporary - water quality within the affected water body will improve over time and distance from the Scheme as sediments settle or are trapped by vegetation. Refer to Chapter 8 (Nature conservation) for an assessment of any specific impacts of increased sediment loads on protected species.

Table 14.4.1 summarises the magnitude of the impacts on receptors identified in Table 14.3.10 of this report.

Table 14.4.1 Magnitude and significance of increased sediment loading impacts on receptors

Feature	Impact Description	Impact Magnitude
Afon Carrog	Construction works c.450m from works, hence no discharge likely.	Negligible
Unnamed ditches in the Carrog catchment at CH:17m, 122m	Crossed by scheme, therefore sedimentation likely during construction of crossing and adjacent embankment construction. Impact likely to cause loss in quality or biodiversity due to small scale of watercourse but effect will be temporary.	Moderate Adverse
Unnamed tributary of the Afon Carrog at CH:185m	Crossed by scheme (S101), therefore sedimentation likely during construction of crossing and adjacent embankment construction Impact likely to cause loss in quality or biodiversity due to small scale of watercourse but effect will be temporary..	Moderate Adverse
Afon Rhŷd	Crossed by scheme (S102) and realignment works on watercourse, therefore sedimentation likely during construction of crossing and adjacent embankment construction. Effects will be temporary. Insufficient impact to change the environmental status/classification of large watercourse.	Moderate Adverse

Feature	Impact Description	Impact Magnitude
Unnamed ditches in the Rhŷd catchment crossing Scheme at CH:317m, 1320m	Diversion of ditches likely to cause sedimentation but effect will be temporary.	Moderate Adverse
Afon Plas at CH:1400m	Crossed by scheme (S104), therefore sedimentation likely during construction of crossing and adjacent embankment construction. Impact likely to cause loss in quality or biodiversity due to small scale of watercourse but effect will be temporary...	Moderate Adverse
Afon Gwyrfai	Crossed by scheme (S106), therefore sedimentation likely during construction of crossing and adjacent embankment construction. Effects will be temporary. Insufficient impact to cause loss in quality, fishery productivity or biodiversity of large watercourse.	Minor Adverse
Afon Rhosdican	Watercourse runs c. 5-20m parallel to proposed road and embankment for c.1km. Watercourse crossed by Scheme(S109A, S110A, S110, S111B). Likely to experience heavy sedimentation and make take a few years to recover from impact. Effects will still be temporary however.	Major adverse
Unnamed ditches in Gwyrfai catchment crossing Scheme at CH:1543m, 3162m	Ditches crossed or culverted (S105, S109B) therefore likely to experience sedimentation during construction of crossing and adjacent embankment construction. Impact likely to cause loss in quality or biodiversity due to small scale of watercourse but effect will be temporary.	Moderate adverse
Afon Seiont	Crossed by scheme (S112), therefore sedimentation likely during construction of crossing and adjacent embankment construction. Effects will be temporary. Insufficient impact to cause loss in quality, fishery productivity or biodiversity of large watercourse.	Minor adverse
Unnamed ditches in Seiont catchment crossing Scheme at CH:5852m, 6470m, 6540m,	Ditches culverted (and realigned) adjacent to embankment/roundabout works therefore likely to experience sedimentation during construction of crossing and adjacent embankment construction (S112C, S112B, S112A). Impact likely to cause loss in quality or biodiversity due to small scale of watercourse but effect will be temporary..	Moderate adverse

Feature	Impact Description	Impact Magnitude
Afon Cadnant	Culverted four times (S114, S115C, S115A, S115B) and c.500m length realigned adjacent to demolition of existing road and construction of new roads on embankment. Likely to experience heavy sedimentation; however, effects will be temporary and localised. Sediment will settle in the vicinity of the Scheme therefore not expected to be transported downstream. . Sediments will settle reasonably quickly, may take some time for sediment to fully disperse from river bed however existing bed has reasonable amount oif sediment..	Major adverse
Unnamed tributary of the Afon Cadnant at CH:8180m	Crossed by scheme (S114A), therefore sedimentation likely during construction of crossing and adjacent embankment construction. Effects will be temporary. Insufficient impact to cause loss in quality or biodiversity of large watercourse.	Minor Adverse
Unnamed watercourse that discharges to Menai Strait	Crossed by scheme (S116) and c.300m realigned therefore likely to experience sedimentation. Impact likely to cause loss in quality or biodiversity due to small scale of watercourse. Effects will be temporary.	Moderate Adverse
Menai Strait	Water body minimum of c. 400m from Scheme. Indirect discharge from watercourses likely to have benefitted from settlement and filtration. Any impacts unlikely to affect the integrity of the water environment or visual appearance due to distance, dilution and flow conditions in the MEnai Strait.	Negligible

Release of hydrocarbons

The release of hydrocarbons into on-site drainage systems or from direct runoff and infiltration to groundwater is the second most common form of pollution after increased sediment loading. This is likely to increase during the construction period due to a large number of vehicles, including heavy vehicles, accessing the site, refuelling of vehicles and plant, leakage from oil/fuel storage tanks and accidental spillages.

Hydrocarbons form a film on the surface of the water body, deplete oxygen levels and can be toxic to freshwater fish. Even at very low concentrations, the film can negatively impact on the visual appearance of the water body. The impact will be direct and temporary - water quality within the affected water body will improve over time and distance as pollutants disperse and are treated by natural processes.

The dispersion and impact of hydrocarbons that enter groundwater resources is dependent on the type of overlying geology, depth to groundwater table and characteristics of the aquifer. However, groundwater contamination is difficult to treat

and can have an adverse indirect effect on the quality of abstracted water or rivers that receive groundwater baseflow.

Table 14.4.2 summarises the magnitude of the impacts on receptors identified in Table 14.3.10 of this report.

Use of hazardous materials

The use of hazardous products on site can present a pollution risk because of the potential for accidental spillages, and the uncontrolled release of washdown water and runoff. If materials and activities are not stored and carried out in designated areas, runoff and washdown may enter a water body, adversely affect the aquatic environment or contaminate surface and groundwater water abstractions.

The most common source of pollution is from concrete and cement products. These products are highly alkaline and corrosive - fish can be physically damaged and their gills blocked, and both vegetation and the bed of the receiving water body can be smothered.

The dispersion and impact of hazardous products that enter groundwater resources is dependent on the type of overlying geology, depth to groundwater table and characteristics of the aquifer. However, groundwater contamination is difficult to treat and can have an adverse indirect effect on the quality of abstracted water or rivers that receive groundwater baseflow.

During construction, there is an elevated risk of potential leaks or accidental spillage of hazardous chemicals used on site infiltrating to groundwater or migrating to nearby water bodies and resulting in an adverse impact.

For the most part, it is only when large quantities of hazardous substances are spilled, or the spillage is directly into the water body, that a significant risk of acute toxicity would arise in the receiving water. The magnitude of any impact would depend on the scale and nature of any potential incident and is therefore difficult to predict.

For the most part, impacts would be direct and/or indirect and temporary to long term - water quality within the affected water body would improve over time as pollutants are dispersed and diluted. However, a significant direct spillage of a toxic substance could cause long term damage to the receiving water body.

Because hazardous materials are most likely to be associated with works in the same areas where construction traffic would occur, the magnitude and significance of the impacts of the use of hazardous materials in construction on receptors in the Scheme area are the same as the magnitude and significance of the impacts of hydrocarbon release on the same receptors. These are listed in Table 14.4.2.

Table 14.4.2 Magnitude and significance of hydrocarbon and hazardous materials release impacts on receptors

Feature	Impact Description	Impact Magnitude
Afon Carrog	Construction works c.450m from works, hence no discharge likely	Negligible

Feature	Impact Description	Impact Magnitude
Afon Rhŷd	Crossed by scheme (S102), therefore potential for any hydrocarbons released during construction to enter watercourse. Relatively limited extent of works at this location, therefore impact unlikely to be sufficient to cause loss in quality or biodiversity of watercourse.	Minor Adverse
Afon Gwyrfai	Crossed by scheme (S106), therefore potential for any hydrocarbons released during construction to enter watercourse. Relatively limited extent of works at this location, therefore impact unlikely to be sufficient to cause loss in quality or biodiversity of watercourse.	Minor Adverse
Afon Rhosdican	Watercourse runs c. 5-20m parallel to proposed road and embankment for c.1km and watercourse crossed by Scheme (S109A, S110A, S110, S111B). Larger extent of works at this location likely to cause loss in quality or biodiversity due to increased hydrocarbon discharge into small scale watercourse.	Moderate adverse
Afon Seiont	Heavy machinery use adjacent to watercourse to construct free span crossing (S112) poses risk of hydrocarbon spillage. Large size of watercourse at this location will dilute discharge however, therefore impact unlikely to be sufficient to cause loss in quality, fishery productivity or biodiversity of watercourse.	Minor Adverse
Afon Cadnant	Culverted four times (S114, S115C, S115A, S115B) and c.500m length realigned adjacent to demolition of existing road and construction of new roads on embankment, therefore significant plant operation adjacent to and above watercourse.	Moderate adverse

Feature	Impact Description	Impact Magnitude
Unnamed watercourses and tributaries that are crossed by the Scheme	Crossed by scheme, therefore potential for any hydrocarbons released during construction to enter watercourse. Relatively limited extent of works at this location therefore impact unlikely to be sufficient to cause loss in quality, fishery productivity or biodiversity of watercourse. Applies to: Unnamed ditches in the Carrog catchment at CH:17m, 122m Unnamed tributary of the Afon Carrog at CH:185m (S101) Unnamed ditches in the Rhŷd catchment crossing Scheme at CH:317m, 1320m Afon Plas at CH:1400m (S104) Unnamed ditches in Gwyrfai catchment crossing Scheme at CH:1543m, 3162m (S105, S109B) Unnamed ditches in Seiont catchment crossing Scheme at CH:5852m, 6470m, 6540m (S112C, S112B, S112A) Unnamed tributary of the Afon Cadnant at CH:8180m (S114A)	Minor Adverse
Unnamed watercourse that discharges to Menai Strait	Crossed twice by scheme (S116) and c.300m realigned therefore potential for any hydrocarbons released during construction to enter watercourse. Larger extent of works increases potential for hydrocarbons from leakage or spillage. Extent of works at this location unlikely to result in discharge sufficient to cause loss in quality or biodiversity of watercourse.	Minor Adverse
Menai Strait	Water body minimum of c. 400m from Scheme. Indirect discharge from watercourses likely to have benefitted from filtration and dilution. Significant spillages into upstream watercourses may be carried to Menai Strait but relative size, flow conditions in the Menai Strait and current uses mean that any impacts are unlikely to affect the integrity of the water environment or visual appearance.	Negligible

Feature	Impact Description	Impact Magnitude
Groundwater in Scheme Area	Site-specific GI indicates very low infiltration rates along route alignment. However, in some locations, cuttings are indicated to extend into groundwater providing direct connectivity with groundwater receptor. There is potential for pollution of water body therefore, but unlikely to be sufficient to change water quality. There are two springs within 100m of the route alignment in the locations where cuttings are proposed and there is potential to impact groundwater. Unlikely to change water quality at springs though.	Minor Adverse

Dust and debris

Construction activities located on site have the potential to release dust and debris that may be blown into adjacent water features. Demolition activities would pose the greatest risk by creating the greatest volumes of dust and debris. The absence of demolition works through the majority of the Scheme would aid in reducing the potential for dust.

Increased dust levels in water bodies may reduce the levels of light reaching aquatic plant and animal species. Debris blown into water bodies can decrease the recreational and aesthetic quality of the water body. Impacts would be direct and temporary.

Table 14.4.3 summarises the magnitude and significance of the impacts of dust and debris on receptors in the Scheme area.

Table 14.4.3 Magnitude and significance of dust and debris impacts on receptors

Feature	Impact Description	Impact Magnitude
Afon Carrog	Construction works c.450m from works, hence no dust or debris likely to enter watercourse	Negligible
Unnamed ditches in the Rhŷd catchment crossing Scheme at CH:317m, 1320m	Watercourses are crossed perpendicularly by the scheme but also diverted adjacent to the Scheme for c.<80m. Therefore, there is a minor risk of dust and debris from the adjacent road construction affecting the watercourses. Dust and debris in these watercourses is not considered likely to be sufficient to cause loss in quality or biodiversity of the watercourses.	Minor Adverse

Feature	Impact Description	Impact Magnitude
Afon Rhosdican	Watercourse runs c. 5-20m parallel to proposed road and embankment for c.1km and watercourse crossed by Scheme (S109A, S110A, S110, S111B). Length of watercourse adjacent to Scheme likely to result in increased dust and debris entering the watercourse. Demolition of roads at CH:2950m and CH: 3480m likely to increase dust and debris entering the watercourse. Volumes of dust and debris unlikely to change the environmental status/classification of the watercourse.	Moderate adverse
Unnamed ditches in Seiont catchment crossing Scheme at CH:6470m, 6540m,	Crossings at CH:6470m and 6540m are perpendicular to the Scheme (S112B, S112A)but demolition of an existing road in this location will result in increased dust and debris loading on the watercourses. Dust and debris in these watercourses is not considered likely to be sufficient to cause loss in quality or biodiversity of the watercourses.	Minor Adverse
Afon Cadnant	Culverted four times (S114, S115C, S115A, S115B) and c.500m length realigned. Demolition of existing road and culvert, and construction of new roads on embankment likely to increase dust and debris entering the watercourse. Volumes of dust and debris unlikely to change the environmental status/classification of the watercourse.	Moderate adverse
Unnamed watercourse that discharges to Menai Strait	Watercourse realigned and crossing at location of demolition of existing road.at CH:8880m likely to increase dust and debris entering the watercourse (S116). Dust and debris in the watercourses is not considered likely to be sufficient to cause loss in quality or biodiversity of the watercourses.	Minor Adverse
Menai Strait	Water body minimum of c. 400m from Scheme. Indirect discharge from watercourses likely to have benefitted from settlement and filtration Any impacts unlikely to affect the integrity of the water environment	Negligible

Feature	Impact Description	Impact Magnitude
All other watercourses crossing scheme	Watercourse crossings, where the watercourse and road are perpendicular, will deposit limited volumes of dust and debris into the watercourse, especially where there is no demolition work. Applied to watercourses including: including: Unnamed ditches in the Carrog catchment at CH:17m, 122m Unnamed tributary of the Afon Carrog at CH:185m (S101) Afon Rhŷd (S102) Afon Plas at CH:1400m (S104) Afon Gwyrfai (S106) Unnamed ditches in Gwyrfai catchment crossing Scheme at CH:1543m, 3162m Afon Seiont (S112) Unnamed ditches in Seiont catchment crossing Scheme at CH:5852m (S112C) Unnamed tributary of the Afon Cadnant at CH:8180m (S114A)	Negligible

14.4.2 Summary of impacts during construction

Table 14.4.4 provides a summary of key risks to the water environment during construction and the associated magnitude and significance of these risks to identified receptors.

Table 14.4.4 Summary of impacts during construction

Receptor	Importance	Impact	Magnitude	Significance
Afon Carrog	High	Sediment release	Negligible	Neutral
		Hydrocarbon and hazardous substances release	Negligible	Neutral

Receptor	Importance	Impact	Magnitude	Significance
		Dust and debris	Negligible	Neutral
Unnamed ditches in the Carrog catchment at CH:17m, 122m	Low	Sediment release	Moderate Adverse	Slight Adverse
		Hydrocarbon and hazardous substances release	Minor Adverse	Neutral
		Dust and debris	Negligible	Neutral
Unnamed tributary of the Afon Carrog at CH:185m	Medium	Sediment release	Moderate Adverse	Moderate Adverse
		Hydrocarbon and hazardous substances release	Minor Adverse	Slight Adverse
		Dust and debris	Negligible	Neutral
Afon Rhŷd	Medium	Sediment release	Moderate Adverse	Moderate Adverse
		Hydrocarbon and hazardous substances release	Minor Adverse	Slight Adverse
		Dust and debris	Negligible	Neutral
Unnamed ditches in the Rhŷd catchment crossing Scheme at CH:317m, 1320m	Low	Sediment release	Moderate Adverse	Slight Adverse
		Hydrocarbon and hazardous substances release	Minor Adverse	Neutral
		Dust and debris	Minor Adverse	Neutral
Afon Plas at CH:1400m	Medium	Sediment release	Moderate Adverse	Moderate Adverse
		Hydrocarbon and hazardous substances release	Minor Adverse	Slight Adverse
		Dust and debris	Negligible	Neutral
Afon Gwyrfai	Very High	Sediment release	Minor Adverse	Moderate to Large Adverse
		Hydrocarbon and hazardous substances release	Minor Adverse	Moderate to Large Adverse
		Dust and debris	Negligible	Neutral
Afon Rhosdican	Medium	Sediment release	Major adverse	Large Adverse
		Hydrocarbon and hazardous substances release	Moderate adverse	Moderate Adverse
		Dust and debris	Moderate adverse	Moderate Adverse
Unnamed ditches in Gwyrfai catchment	Medium	Sediment release	Moderate adverse	Moderate Adverse
		Hydrocarbon and hazardous substances release	Minor Adverse	Slight Adverse

Receptor	Importance	Impact	Magnitude	Significance
crossing Scheme at CH:1543m, 3162m		Dust and debris	Negligible	Neutral
Afon Seiont	Medium	Sediment release	Minor	Slight Adverse
		Hydrocarbon and hazardous substances release	Minor Adverse	Slight Adverse
		Dust and debris	Negligible	Neutral
Unnamed ditches in Seiont catchment crossing Scheme at CH:5852m, 6470m, 6540m	Low	Sediment release	Moderate adverse	Slight Adverse
		Hydrocarbon and hazardous substances release	Minor Adverse	Neutral
		Dust and debris	Minor Adverse at CH: 6470m, 6540m Negligible at CH:5852m	Neutral
Afon Cadnant	Medium	Sediment release	Major adverse	Large Adverse
		Hydrocarbon and hazardous substances release	Moderate adverse	Moderate Adverse
		Dust and debris	Moderate adverse	Moderate Adverse
Unnamed tributary of the Afon Cadnant at CH:8180m	Medium	Sediment release	Minor Adverse	Slight Adverse
		Hydrocarbon and hazardous substances release	Minor Adverse	Slight Adverse
		Dust and debris	Negligible	Neutral
Unnamed watercourse that discharges to Menai Strait	Medium	Sediment release	Moderate Adverse	Moderate Adverse
		Hydrocarbon and hazardous substances release	Minor Adverse	Slight Adverse
		Dust and debris	Minor Adverse	Slight Adverse
Menai Strait	Very High	Sediment release	Negligible	Neutral
		Hydrocarbon and hazardous substances release	Negligible	Neutral
		Dust and debris	Negligible	Neutral
Groundwater in the Scheme area	High	Hydrocarbon and hazardous substances release	Minor Adverse	Slight to Moderate Adverse

14.4.3 The receptors where the most significant construction phase impacts occur are those where watercourses are being diverted or culverted resulting in significant sedimentation, those watercourses where adjacent works continue for a large length of the watercourse resulting in significant impacts from sediment, hydrocarbon and hazardous material runoff, and those watercourses where significant demolition work will occur adjacent to watercourses. The receptors at greatest risk during construction are:

- Unnamed tributary of the Afon Carrog at chainage 185m (S101) and the Afon Rhŷd from sedimentation occurring as a result of culverting (S102) and re-alignment of watercourse;
- Afon Plas from sedimentation due to culverting (S104) of the watercourse;
- Afon Gwyrfai (S106) from sedimentation and hydrocarbon and hazardous substances release due to receptor importance (designated a SSSI and a SAC);
- Unnamed ditches discharging into the Afon Gwyrfai at chainages 1543m and 3162m from sedimentation due to culverting (S105, S109B) of the watercourse and the receptor importance of the downstream Afon Gwyrfai (designated a SSSI and a SAC);
- Afon Rhosdican from sedimentation, hydrocarbon and hazardous substances release and dust and debris due to realignment and culverting (S109A, S110A, S110, S111B) of the watercourse as well as c. 1km length of Scheme works adjacent to the watercourse;
- Afon Cadnant from sedimentation, hydrocarbon and hazardous substances release and dust and debris due to significant re-alignment of watercourse, culverting (S114, S115C, S115A, S115B) and demolition works occurring adjacent to the watercourse;
- Unnamed watercourse that discharges to Menai Strait from sedimentation due to re-alignment of the watercourse and culverting (S116);

All of these impacts are temporary and the magnitude of the impacts on these receptors are not considered great enough to have permanent effects.

14.4.4 Operation phase

This section considers the potential impacts that the proposed development would have on the water environment after construction and during occupation prior to the implementation of mitigation measures. Mitigation measures are considered to be those that are not embedded in the design of the Scheme.

The key risks to the water environment during the operation of the proposed development include:

- Pollutants contained within surface water runoff that will be discharged to water bodies through the proposed surface water drainage system;
- Pollutants contained within surface water runoff that will be discharged to ground via infiltration;
- Impacts to water quality as a result of a hydromorphological changes through realignment, culverting and crossing watercourses.

Specific risks related to the water environment as a result of the Scheme are discussed below. The magnitude of these impacts would be significantly reduced through measures embedded in the design of the surface water drainage systems and watercourse crossings / diversions. A summary of these key elements is provided below and must be taken into consideration before the impact magnitude and resultant impact significance can be assessed.

A FCA and a drainage strategy for the Scheme have been prepared and are included as a technical appendix (K.1) to this report.

Specific risks to hydrogeology are addressed in detail in Chapter 9. Specific risks to ecology, including aquatic and terrestrial species and habitats, are addressed in detail in Chapter 8.

Pollutants contained in surface water runoff

Surface water runoff has the potential to contain silts and hydrocarbons that are washed off hard paved areas and vehicular areas. These can increase water turbidity, deplete oxygen levels and be toxic to the aquatic environment. Uncontrolled discharge via infiltration to ground can also cause permanent deterioration of groundwater quality.

Pollution of water bodies from surface water runoff containing silts and hydrocarbons is considered a direct permanent impact. Although pollutants can be treated by natural processes in the water body the absence of adequate mitigation would result in a continuous discharge of polluting substances to water bodies.

Runoff from the Scheme will be managed in the following manner:

- Carriageway runoff will drain 'over the edge' to vegetated swales of Scheme-standard dimensions;
- In-line outlet chambers will be provided along the swales as intermediate outfall points, discharging to combined filter/carrier drains running directly beneath the swales;
- Viaducts will drain via combined kerb and drainage bridge-deck compatible units into carrier drains;
- Roundabouts will drain via traditional kerb and gully systems into carrier drains;
- Carrier drains will discharge into attenuation ponds, limiting discharge via vortex control units, to greenfield equivalent peak runoff rates for all events up to and including the 100 year return period rainfall event;
- Attenuation ponds will be provided with Penstock valves to mitigate potential spillage;
- 'First-flush' flows will be contained and treated within permanently wet sump areas of the attenuation ponds or the use of pre-treatment chambers if the maintaining authority (North and Mid-Wales Trunk Road Agency [NMWTRA]) require that the pond remain dry as a maintenance preference.

The proposed ponds have adequate access provided to facilitate maintenance. Water quality impacts associated with leachate from new embankments are not considered significant. It is expected that material for embankments will generally be sourced locally and is therefore likely to have similar characteristics to existing soils and geology. It is assumed contaminated material will not be used. Some natural

infiltration of runoff to embankments could occur but any runoff entering local water bodies, if it does have different characteristics to natural runoff, will be diluted.

In accordance with DMRB Volume 11, Part 10, Section 3[14.18] methodology A, the Highways Agency [now Highways England] Water Risk Assessment Tool (HAWRAT) tool has been used to assess the pollution risks to watercourses in the vicinity of the Scheme.

Rather than undertake assessments at all 14 outfalls from the road drainage system, assessments have been undertaken at the outfalls considered to be the most critical to the assessment. These have been selected as those where the highest pollutant concentrations are anticipated due to the drained area and watercourse flows (based on watercourse size), or where the watercourse may be particularly sensitive such as the Afon Gwyrfai. The predicted traffic flows along the scheme (AADT) all fall within the <50,000 category and therefore variation along the Scheme does not affect the outcomes of the HAWRAT assessments of runoff and the AADT values are all small enough that they will make little difference to the HAWRAT spillage assessments either. In addition to these locations, assessments have also undertaken to quantify cumulative impacts. In accordance with DMRB methodology, only discharges from outfalls within 1km of each other, and on the same watercourse, have been aggregated for cumulative assessment. The effects of dilution and filtration along stretches of watercourse greater than 1km are considered to prevent the accumulation of soluble pollutants. In a similar manner, the accumulation of sediment from multiple outfalls separated by more than 100m is considered negligible.

The spillage risk to each watercourse has been assessed in accordance with DMRB methodology D. The spillage risk assessment for each watercourse is based on the worst case individual outfall scenario.

The worst-case scenarios have been assessed using the information shown in Table 14.4.4a and are described below. Volume 2 Figure 14.2 shows the outfall locations.

Table 14.4.4a Road areas draining to watercourses, sorted in descending order

Outfall	Drained Road Area (m^2)	24hr 2033 AADT	24hr 2033 % Heavies	Watercourse affected
13	14,445	12,525 13,705	12.81% 14.20%	Unnamed tributary of Menai Strait
4a	13,365	116,988 18,560	12.31% 13.67%	Afon Rhodsican
2	10,733	16,988 18,560	12.31% 13.67%	Unnamed tributary of Afon Rhyd
6	10,328	14,738 16,132	13.32% 14.77%	Afon Rhodsican

4	9,518	16,988 18,560	12.31% 13.67%	Afon Gwyrfai*
3	9,383	16,988 18,560	12.31% 13.67%	Afon Gwyrfai*
9	8,708	12,525 13,705	12.81% 14.20%	Afon Seiont
7	8,573	14,738 16,132	13.32% 14.77%	Afon Seiont
11	7,155	12,525 13,705	12.81% 14.20%	Afon Cadnant
1	6,953	16,988 18,560	12.31% 13.67%	Afon Rhyd
12	6,615	12,525 13,705	12.81% 14.20%	Afon Cadnant
8	6,413	14,738 16,132	13.32% 14.77%	Afon Seiont
14	6,075	12,525 13,705	12.81% 14.20%	Afon Cadnant
5	5,738	14,738 16,132	13.32% 14.77%	Afon Rhodsican
8a	5,535	14,738 16,132	13.32% 14.77%	Afon Seiont
10	1,418	14,738 16,132	13.32% 14.77%	Afon Seiont

** Environmentally Designated Watercourse*

As shown in Table 14.4.4a, the largest drained areas occur to the unnamed tributary of the Menai Strait, the Afon Rhosdican and the unnamed tributary of the Afon Rhyd. These are the smallest watercourses receiving surface water discharge from the Scheme and therefore would have the smallest flows. Pollution concentrations will therefore be highest for these watercourses. If the HAWRAT assessment shows that pollution impacts in these watercourse are acceptable, it can safely be assumed that the impacts of individual outfalls to watercourses at all other locations would also be acceptable. The exception to this is the Afon Gwyrfai, which is designated as a SSSI and therefore much more sensitive to pollutant impacts.

On this basis, HAWRAT assessments of pollution risks from highway runoff at the following individual locations have been undertaken:

- Unnamed tributary of the Afon Rhŷd (Discharge location ref: 2)
- Unnamed tributary to Menai Strait (Discharge location ref: 13)
- Afon Rhosdican (Discharge location ref: 4a)
- Afon Gwyrfai (Discharge location ref: 4)

Table 14.4.4b summarises the locations of potential cumulative impacts in receiving watercourses. The table indicates that the largest road area discharging to a single

cumulative location, where soluble pollutants have potential to accumulate, is on the Afon Seiont, followed by the Afon Rhosdican. These two cumulative assessments have been undertaken as the worst case scenarios. Given the size of other watercourses relative to the Afon Rhosdican, if impacts on the Afon Rhosdican are acceptable, it is considered that impacts elsewhere are acceptable. The exception to this is where there is potential for cumulative impacts on the Afon Gwyrfai, which is environmentally designated and therefore more sensitive to pollutants.

With regards to non-soluble pollutant accumulation, the potential impacts in the Afon Seiont and Afon Cadnant have been assessed as the largest road area draining to a watercourse occurs into the Afon Seiont, but flows in the Afon Cadnant are expected to be less than in the Afon Seiont due to the catchment size and therefore pollutant concentration could be higher.

Table 14.4.4b Potential cumulative impact locations

Outfalls	Drained Road Area (m^2)	Outfalls <100m apart	Max 24hr 2033 AADT	Max 24hr 2033 % Heavies	Watercourse affected
7, 8, 8a, 9, 10	30,645	No	14,738 16,132	13.32%14. 77%	Afon Seiont
4a, 5, 6	29,430	No	16,988 18,560	13.67%	Afon Rhodsican
11, 12, 14	19,845	No	12,525 13,705	12.81%14. 20%	Afon Cadnant
3, 4	18,900	No	16,988 18,560	12.31%13. 67%	Afon Gwyrfai*
11, 12	13,770	Yes	12,525 13,705	12.81%14. 20%	Afon Cadnant
9, 10	10,125	Yes	14,738 16,132	13.32%14. 77%	Afon Seiont

** Environmentally Designated Watercourse*

In summary, HAWRAT assessments of cumulative pollution risks from highway runoff have been undertaken at the following locations:

1. *Cumulative outfall assessments (soluble pollutants and sediment):*

   - Afon Seiont (Discharge locations: 9, 10)
   - Afon Cadnant_2 (Discharge locations: 11, 12)

2. *Cumulative outfall assessments (soluble pollutants only):*

   - Afon Gwyrfai (Discharge locations: 3,4)
   - Afon Rhosdican (Discharge locations: 4a, 5, 6)
   - Afon Seiont_1 (Discharge locations: 7, 8, 8a, 9, 10)

Finally, spillage risk assessments in accordance with HAWRAT method D have been undertaken for stretches of road containing junctions where accidents and associated spillage is most likely. The locations of spillage assessments is therefore:

- Afon Rhŷd (Discharge location: 1)
- Afon Rhosdican (Discharge location: 5)

- Unnamed tributary to Menai Strait (Discharge location: 13)

Volume 2, Figure 14.2 illustrates the locations of the drainage outfalls along with the locations of the attenuation ponds.

To enable application of the HAWRAT tool the following information has been used:

- Predicted Annual Average Daily Traffic (AADT) flows for the 2033 scenario and the percentage of this figure constituting Heavy Goods Vehicles (HGVs) is based on the results of the level 3 traffic assessment prepared to inform the Scheme design. Traffic flows along the main road alignment only have been included in the HAWRAT assessment. Given the low values of AADT, it is assumed that side road traffic flows would not increase the AADT to values above the 50,000 threshold used in the HAWRAT assessment.[12]
- Geographical location (using OSGB reference);
- Road shape, based on Scheme layout. Side road areas have not been included in the HAWRAT assessment. These are very small compared to the main road alignment aras and therefore their exclusion from the calculations does not have the potential to alter the results of the assessment.
- Base Flow Index (BFI) for watercourses along which Q95 (95 percentile flow) was required (taken from Wallingford LowFlows2 software);
- Rainfall intensity data has been derived from the rainfall model data contained on the FEH CD-ROM;
- Annual 95 percentile river flow at each assessment location (calculated using the Wallingford LowFlows 2 software). This employs a hydrological model developed jointly by the CEH (Centre for Ecology & Hydrology), SEPA (Scottish Environmental Protection Agency), EA (Environment Agency) and NIEA (Northern Ireland Environment Agency). The model provides annual and monthly flow duration curve (FDC) statistics for ungauged sites from an estimate of annual mean flow based on a 1 km^2 grid of average annual runoff. The method uses a pool of FDC statistics for gauged catchments to derive a weighted FDC for the subject site, standardised by the annual mean flow estimate;
- Water hardness for watercourses is unknown but hard water has been assumed, as the conservative choice for the above watercourses;
- Typical dimensions of watercourses were based on a variety of channel survey, visual inspections during a site visit and satellite imagery as available;

[12] Revised traffic flow estimates have become available since completion of the HAWRAT assessments. Comparison of the updated traffic flow data (as detailed above) with that used in the HAWRAT assessments shows predicted AADT values have decreased between 8% and 9% along the length of the Scheme. Whilst decreased AADT values have the potential to decrease the concentrations of pollutants and sediment in watercourses, based on the results of the completed HAWRAT assessment, the decreases would only make minor changes to the calculated concentrations and would not change the overall conclusions of the assessment. On this basis, the HAWRAT assessments have not been updated with the latest traffic data.

The response time to spillages that might occur on the road is unknown but due to the rural location of the road the worst case scenario was assumed in the assessment (>1 hour response time);

The depth to the groundwater table, as indicated by the GI, is shallow in places and therefore a worst case scenario (<5m) has been assumed in the HAWRAT assessment;

Flow type through the ground, effective soil grain size and lithology has been selected from the categories available in the HAWRAT assessment based on information reviewed from the BGS, EA groundwater maps and Soil Survey of England and Wales mapping.

The results of the assessments undertaken using the HAWRAT tool are summarised in Table 14.4.5.

Table 14.4.5 Summary of HAWRAT assessments of pollution and sedimentation risks to watercourses

	Pollutant impacts		Sedimentation impacts		Spillage risk
Receiving watercourse (Discharge location ref)	Annual average concentration of copper (µg/l) due to road runoff (PASS/FAIL EQSs)	Annual average concentration of zinc (µg/l) due to road runoff (PASS/FAIL EQSs)	Sediment accumulating? (Deposition Index)	Predicted low flow velocity in watercourse (m/s)	Risk of a pollution incident from spillage on road discharging to watercourse
Individual outfall assessments:					
Afon Rhŷd (1)					0.0011 (PASS)
Trib. of Afon Rhŷd (2)	0.44 (PASS)	1.44 (PASS)	No (-)	0.12 (PASS)	
Afon Gwyrfai (4)	0.00 (PASS)	0.01 (PASS)	No (-)	0.53 (PASS)	
Afon Rhosdican (4a)	0.32 (PASS)	1.04 (PASS)	No (-)	0.12 (PASS)	
Afon Rhosdican (5)					0.0090 (PASS)
Unnamed trib. to Menai Strait (13)	0.10 (PASS)	0.32 (PASS)	Yes* (51 – PASS)	0.08 (PASS)	0.0018 (PASS)
Cumulative outfall assessments - separation<100m (soluble pollutants and sediment):					
Afon Seiont (9,10)	0.00 (PASS)	0.01 (PASS)	No (-)	0.58 (PASS)	
Afon Cadnant (11,12)	0.03 (PASS)	0.11 (PASS)	No (-)	0.57 (PASS)	
Cumulative outfall assessments - 100m<separation<1km (soluble pollutants only):					
Afon Gwyrfai (3,4)	0.01 (PASS)	0.02 (PASS)			
Afon Rhosdican (4a,5,6	0.60 (PASS)	1.94 (PASS)			
Afon Seiont (7,8,8a,9,10)	0.00 (PASS)	0.01 (PASS)			

* The HAWRAT assessment indicated that 21% removal of sediment was required from discharges into the unnamed tributary to Menai Strait. CIRIA SUDS Hydraulic structural & water quality advice (C609)[14.23], indicates that swales remove between 40% and 80% of total suspended solids from highway runoff. A value of 60% removal was therefore included in the HAWRAT assessment for outfall 13 to represent the

mitigation embedded in the design against sedimentation, in the form of swales alongside the Scheme.

The HAWRAT tool indicates that concentrations of pollutants in watercourses both at single outfalls and assessed cumulatively from multiple outfalls are well below the Environmental Quality Standards (EQSs) published in the WFD (1μg/l dissolved copper for water hardness <50mg/l $CaCO_3$ and 7.8μg/l dissolved zinc). The results indicate there would be no short term impacts associated with soluble pollutants in road runoff, assessed using the Runoff Specific Threshold values listed in DMRB Volume 11 Section 3 Part 10, for outfalls within 1km or further then 1km from designated waters and of varying hardness The worst case scenarios have been assessed, therefore, it can be concluded that no impacts of greater magnitude than those assessed above will result from single outfall discharges or cumulative discharges on watercourses affected by the Scheme.

On the basis of this assessment, the magnitude of the impacts on surface water receptors from polluted runoff and from accidental spillage is considered to be negligible everywhere.

The risks posed to groundwater have also been assessed according to the risk determination matrix outlined in DMRB Volume 11 Part 3 Section 10 methodology C. Ground conditions across the Scheme area are described in Section 14.3.2. The assessment of pollution risk to groundwater has been based on peak traffic flows along the Scheme (2033 Key Stage 3 results) and typical ground conditions likely along the Scheme alignment. Table 14.22 outlines the risk of polluted runoff finding a pathway to the groundwater receptor.

Table 14.4.6: Summary of DMRB groundwater risk determination matrix score assessing the risk to groundwater from polluted runoff

	DMRB Weighting Factor	Property / Parameter	Property Parameter Value	Associated score listed in table C1.2 (DMRB)	Total Score (weighting x score)
Source	15	Traffic density	Max two way AADT along new road = 18,560	1	15
	15	Rainfall volume (annual averages)	Max SAAR in catchments along road >1060mm	3	45
		Rainfall intensity	100Yr - 1hr rainfall = 43-47mm (FEH Vol II)	2	30
Pathway	15	Soakaway geometry	Continuous linear swales and single point attenuation ponds serving road areas >5000m^2	2	30
	20	Unsaturated zone	GI indicates water is <5m from surface at some locations along road alignment	3	60
	20	Flow type	Bedrock deposits of mudstone, siltstone and sandstone. Superficial till deposits dominated by intergranular flow. Loamy soils with fine particles.	1	20
	7.5	Effective grain size		1	7.5
	7.5	Lithology	GI indicates infiltration rates are very low	1	7.5
					TOTAL SCORE = 215
					(<150: Low risk) (150-250: Medium risk) (>250: High Risk)

Table 14.4.6 indicates that groundwater may be at medium risk of pollution from Scheme runoff, in accordance with methodology C of DMRB Volume 11 Part 3 Section 10.

The above methodology does not consider the risk to groundwater from accidental spillages and therefore a separate assessment has been made of this risk using the HAWRAT tool. This assessment has been undertaken using the greatest length of road discharging to one location where there is also a roundabout so as to estimate the risk at the location where an incident is considered most likely. This occurs at the outfall into the unnamed tributary of the Menai Strait (discharge location 13). Full results of this assessment are provided in Appendix K.4. In summary, the maximum risk of an accidental pollution incident to groundwater is evaluated to be 0.0012 (less

than the threshold value of 0.010) and therefore the risk to groundwater from accidental spillage at this location, and all others along the Scheme, is considered low.

The risk of pollution from runoff to springs in the Scheme area is low. There are four springs located within 50m of the proposed ponds, where infiltration to groundwater will be most concentrated. Given that the HAWRAT assessment indicated no significant pollution risks to watercourses from direct runoff, the risk of indirect pollution from groundwater to these springs is even lower, infiltration of water through soils effectively providing an additional level of treatment prior to discharge to the springs.

The minimum distance between active boreholes/wells to any of the ponds, where infiltration is most concentrated, is approximately 150m. None of these abstractions are used for potable purposes. The minimum distance between domestic abstractions and any of the ponds is approximately 175m. This abstraction is from the superficial aquifer and it is understood is not used for drinking water supply. The general groundwater flow direction from the pond would likely be towards the Afon Seiont, away from the well, however there is potential for soluble contaminants to travel through groundwater to the well. Lining the pond would mitigate this risk. Anecdotal evidence suggests high groundwater levels in the vicinity, in which case the pond would be lined as outlined in the drainage strategy. Where boreholes / wells are located some distance from the ponds the risk is significantly reduced as the concentration of any contaminants is much lower.

Based on this HAWRAT assessment, the magnitude and significance of impacts from pollutants contained in runoff to surface water and groundwater receptors are summarised in Table 14.4.6.

Water bodies into which no direct discharge or indirect discharge greater than 1km from the Scheme is proposed during operation have not been assessed using the HAWRAT tool as there would be negligible pollution impacts at these locations. The 1km distance at which indirect pollution impacts are assumed not to occur is taken from the methodology in DMRB Volume 11 Part 3 Section 10[14.18] and considered appropriate for the watercourses assessed here.

Table 14.4.7 summarises the impacts of pollutants in surface water runoff during Scheme operation

Table 14.4.7 Impacts of pollutants in surface water runoff during operation

Receptor	Description of impact	Magnitude
Afon Carrog	No direct or indirect discharge into watercourse.	Negligible
Afon Rhŷd	No outfall into watercourse within 1km on upstream tributaries.	Negligible
Afon Plas at CH:1400m	No assessment completed but anticipated to be negligible impacts based on comparison with completed assessment.	Negligible
Afon Gwyrfai	No assessment completed but anticipated to be negligible impacts based on comparison with completed assessment.	Negligible

Receptor	Description of impact	Magnitude
Afon Rhosdican	HAWRAT assessment indicates acceptable pollutant concentrations in watercourse from single outfalls and cumulative impacts.	Negligible
Afon Seiont	No assessment completed but anticipated to be negligible impacts based on comparison with completed assessment.	Negligible
Afon Cadnant	No assessment completed but anticipated to be negligible impacts based on comparison with completed assessment.	Negligible
Unnamed watercourse that discharges to Menai Strait	HAWRAT assessment indicates acceptable pollutant concentrations in watercourse from single outfalls and cumulative impacts	Negligible
Menai Strait	HAWRAT assessment indicates acceptable pollutant concentrations in upstream watercourse from single outfall. Therefore, low risk of indirect pollution to Menai Strait assumed.	Negligible
Groundwater across the Scheme	HAWRAT assessment indicates moderate risk of pollution from runoff and low risk from accidental spillage but the magnitude of the impact of this risk is considered insufficient to cause a loss in the quality of groundwater. . Localised mitigation (lined ponds) may be required for ponds in close proximity to borehole / well abstractions	Minor Adverse

Impacts to water quality due to changes in channel hydromorphology

The watercourses that are proposed to be altered as part of the Scheme are listed in Table 14.4.8. The impacts of the Scheme on the water quality of these watercourses due to changes in channel hydromorphology are assessed in this table using the methodology outlined in Section 14.2 of this report. Specific assessment of impacts of the Scheme on mammals and fisheries and appropriate mitigation is included in Chapter 8.

Table 14.4.8 Impacts of Scheme on hydromorphological quality of receptors (references S1XX refers to structure reference as listed on the structure Scheme drawings)

Receptor	Description	Impact Magnitude
Unnamed ditches in the Carrog catchment at CH:17m, 122m	An existing culvert on the watercourse at CH:17m would be extended as part of the Scheme. This would be unlikely to have any measurable impact on hydromorphological quality of the watercourse. The watercourse at CH:122m would be in-filled as part of the Scheme. The watercourse is a ditch with relatively good hydromorphological quality but low rarity. The impact to the wider water environment, especially on ecological value of the catchment is therefore minor.	Negligible Minor Adverse
Unnamed tributary of the Afon Carrog at CH:185m	Watercourse of relatively good hydromorphological value to be culverted with 1.8m diameter pipe with a continuous soft bed through culvert (S101). Loss of bankside pathway but watercourse not known to provide commuter route to any sensitive mammal species*. Watercourse not known to provide amenity value at this location. Impacts unlikely to be sufficient to change the environmental status and the impact to the wider water environment, especially on ecological value of the catchment, is therefore negligible.	Negligible
Afon Rhŷd	Watercourse would be diverted for c. 50m length and culverted in 3.2m wide x 2.4m high box culvert with continuous soft bed and mammal ledge to provide bankside pathway for mammals (S102).). Fish baffles are provided through the culvert to mitigate potential impact on fisheries associated with higher velocities. The watercourse diversion will be designed to mimic the existing channel with meanders and riffles. The impact to the wider water environment is minor due to the limited extent of the works and the ecological value of the watercourse in the wider area.	Minor Adverse
Unnamed ditches in the Rhŷd catchment crossing Scheme at CH:317m, 1320m	The watercourse at CH:317m would be infilled as part of the Scheme. The watercourse is a ditch with relatively good hydromorphological value but the impact to the ecological value of the water habitat through loss of this low rarity receptor is minor. The watercourse at CH: 1320m would be diverted for c. 90m length into Afon Plas. The watercourse is a ditch with low rarity and the impact to the wider ecological value of the water environment is therefore minor.	Minor Adverse Minor Adverse

Afon Plas at CH:1400m	Watercourse would be culverted with 1.8m diameter pipe with a continuous soft bed and mammal ledge through culvert (S104). Watercourse not known to provide amenity value at this location. Impacts unlikely to affect ecological value of watercourse therefore negligible magnitude impact.	Negligible
Afon Gwyrfai	(S106) Piers and embankment in flood plain but free-span structure across the watercourse. No impacts on Otter or Water Vole.	Negligible
Afon Rhosdican	400m diversion of watercourse at existing culvert under road. 1.8m diameter culvert beneath Scheme adjacent to existing culvert. Soft bed maintained through culvert and animal ledge provided to maintain mammal corridor (S109A). 3 x 1.8m diameter culvert beneath Scheme adjacent to existing culverts (S110A, S110, S111B). No amenity value to watercourse at this location. Scheme runs adjacent to otherwise rurally located watercourse for c. 1km. Location of road and new culverts may have some impact on the ecological value of the watercourse therefore considered a moderate impact.	Moderate Adverse
Unnamed ditches in Gwyrfai catchment crossing Scheme at CH:1543m, 3162m	Ditch at CH:1543 maintained beneath Dinas Accomodation Underpass (S105). Ditch at CH:3162 culverted in 0.6m diameter pipe (S109B) with continuous soft bed. Ditch only 100m in length with no known amenity or ecological value.	Negligible Negligible
Afon Seiont	(S112) Piers in flood plain but free-span structure across the watercourse and floodplain. No impact on Otter or Water Vole.	Negligible
Unnamed ditches in Seiont catchment crossing Scheme at CH:5852m, 6470m, 6540m,	(S112C) Ditch culverted in 0.6m diameter pipe with soft bed maintained through culvert. 250m length ditch discharges water from upstream industrial park area. No known amenity or ecological value. (S112A and S112B) Watercourses culverted in 1.5m diameter pipes with soft bed through culverts. Culverts located adjacent to existing culvert at upstream extent of watercourse.	Negligible Negligible

Afon Cadnant	Watercourse realigned along c. 400m length and culverted through three 1.8m diameter pipe (S115A, S115B, S115C) and a 3.4m wide x 2.7m high box culvert (S114) with a naturalised channel and cattle pass maintaining mammal corridor. Existing culverts of similar size adjacent to Scheme culverts. Naturalised bed through culverts. Watercourse has no known significant amenity or ecology value at this location at present but layout of new road and slip road adjacent to watercourse and addition of culverts could impact future ecological value of watercourse.	Moderate Adverse
Unnamed tributary of the Afon Cadnant at CH:8180m	(S114A) Watercourse culverted through 1.8m diameter pipe with soft bed maintained. Watercourse has no known amenity value at this location.	Minor Adverse
Unnamed watercourse that discharges to Menai Strait	Watercourse to be diverted for c.300m and culverted in twin 0.6m diameter pipes adjacent to existing culvert. . Proposed culverts are larger than existing twin 0.45m diameter pipes. No known amenity value at this location and extent of works not as significant as on Cadnant or Rhosdican.	Minor Adverse

**No ecology survey was available at the time of writing of this assessment and this assessment will require review following provision of ecology information.*

Impacts to groundwater quantity

Where the Scheme is in cutting, it is possible that groundwater would emerge. This has potential to draw down the surrounding groundwater level, reducing the groundwater quantity available in the draw-down zone. The Scheme alignment is in cutting at the following locations:

- CH: 650m to 1100m (max depth of cutting is c.10m)
- CH: 4300 to 4450m (max depth of cutting is c.4.5m)
- CH: 4800 to 5000m (max depth of cutting is c.2.5m)
- CH: 5600 to 6500m (max depth of cutting is c.3m)
- CH: 7180m (max depth of cutting is c.3m)
- CH: 8250m to 9700m (max depth of cutting is c.22m)

At the locations where the Scheme is in cutting to shallow depths of less than 5m there is likely to be no significant impact on groundwater quantity. Where the Scheme is in deeper cutting at CH:650m to 1100m and 8250m to 9700m it is more likely that groundwater would be drawn down locally by the Scheme. It is however anticipated that the zone in which groundwater is drawn down would be relatively small.

As part of the Scheme, suitable drainage is provided in areas of cutting as embedded mitigation against groundwater flooding of the Scheme. The drainage would collect groundwater and direct it into the drainage system. The Scheme lies in the Afon Rhŷd catchment between CH:650m and 1100m and groundwater from the cutting at this location would be drained to attenuation ponds within the Afon Rhŷd catchment. The Scheme lies in the catchment to the north-west of the Afon Cadnant catchment

between CH:8250m to 9700m and groundwater from the cutting at this location would be drained to outfalls within the same catchment. In this way, groundwater would not be directed between catchments.

Due to the small draw down zones associated with the two larger areas of cutting along the Scheme alignment, and due to the discharge of drained groundwater within the same catchments from which it is drained, the magnitude of the impacts of cuttings on groundwater quantity is anticipated to be Negligible everywhere in the Scheme area.

14.4.5 Summary of impacts during operation

Table 14.4.9 provides a summary of key risks to the water environment during operation and the associated magnitude and significance of these risks to identified receptors.

Table 14.4.9 Summary of impacts during operation

Receptor	Importance	Impact	Magnitude	Significance
Unnamed ditches in the Carrog catchment at CH:17m, 122m	Low	Reduced water quality due to changes in channel hydromorphology	Negligible at CH:17m Minor Adverse at CH:122m	Neutral
Unnamed tributary of the Afon Carrog at CH:185m	Medium	Reduced water quality due to changes in channel hydromorphology	Negligible	Neutral
Afon Rhŷd	Medium	Pollution in runoff	Negligible	Neutral
		Reduced water quality due to changes in channel hydromorphology	Minor Adverse	Slight Adverse
Unnamed ditches in the Rhŷd catchment crossing Scheme at CH:317m, 1320m	Low	Reduced water quality due to changes in channel hydromorphology	Minor Adverse	Neutral
Afon Plas at CH:1400m	Medium	Pollution in runoff	Negligible	Neutral
		Reduced water quality due to changes in channel hydromorphology	Negligible	Neutral
Afon Gwyrfai	Very High	Pollution in runoff	Negligible	Neutral
		Reduced water quality due to changes in channel hydromorphology	Negligible	Neutral
Afon Rhosdican	Medium	Pollution in runoff	Negligible	Neutral
		Reduced water quality due to changes in channel hydromorphology	Moderate Adverse	Moderate Adverse
Unnamed ditches in Gwyrfai	Medium	Reduced water quality due to changes in channel hydromorphology	Negligible	Neutral

Receptor	Importance	Impact	Magnitude	Significance
catchment crossing Scheme at CH:1543m, 3162m				
Afon Seiont	High	Pollution in runoff	Negligible	Neutral
		Reduced water quality due to changes in channel hydromorphology	Negligible	Neutral
Unnamed ditches in Seiont catchment crossing Scheme at CH:5852m, 6470m, 6540m	Low	Reduced water quality due to changes in channel hydromorphology	Negligible	Neutral
Afon Cadnant	High	Pollution in runoff	Negligible	Neutral
		Reduced water quality due to changes in channel hydromorphology	Moderate Adverse	Moderate to Large Adverse
Unnamed tributary of the Afon Cadnant at CH:8180m	High	Reduced water quality due to changes in channel hydromorphology	Minor Adverse	Slight to Moderate Adverse
Unnamed watercourse that discharges to Menai Strait	High	Pollution in runoff	Negligible	Neutral
		Reduced water quality due to changes in channel hydromorphology	Minor Adverse	Slight to Moderate Adverse
Menai Strait	Very High	Pollution in runoff	Negligible	Neutral
Groundwater in Scheme area	High	Pollution in runoff	Minor Adverse	Slight to Moderate Adverse
		Groundwater quantity reduced due to road cutting	Negligible	Neutral
Farmland surrounding Scheme	Low	Flood risk due to location of Scheme	Moderate Adverse	Slight Adverse
		Downstream flood risk due to Scheme runoff	Negligible	Neutral
		Downstream flood risk due to poor maintenance of drainage systems	Minor Adverse	Neutral
Existing people and property	High	Flood risk due to location of Scheme	Negligible	Neutral
		Downstream flood risk due to Scheme runoff	Negligible	Neutral
		Downstream flood risk due to poor maintenance of drainage systems	Minor Adverse	Moderate to Large Adverse
The Scheme	Medium	Flood risk due to location of Scheme	Minor Adverse	Slight Adverse

Receptor	Importance	Impact	Magnitude	Significance
		Flood risk due to poor maintenance of drainage systems	Minor Adverse	Slight Adverse

In summary, the key risks posed to the water environment during operation of the scheme would be:

- Impacts on water quality due to changes in channel hydromorphology on the Afon Rhŷd, Rhosdican and Cadnant due to watercourse re-alignment and culverting works (S102, S109A, S110A, S110, S111B, S114, S115C, S115A, S115B).
- Impacts on flood risks to existing people and property due to poor maintenance of drainage systems resulting in uncontrolled discharge of runoff to watercourses.

14.5 Proposed Mitigation

This section provides a summary of recommended mitigation measures to control or reduce the potential impacts identified in Section 14.4. The measures recommended in this section are in addition to those discussed prior to assessment of impacts – i.e. measures that are not embedded in the design of the surface water drainage systems and layout of the Scheme.

14.5.1 Construction phase mitigation

The aim of construction phase mitigation is to prevent any polluting discharge from entering watercourses or discharging to groundwater. Only where this is not feasible should mitigation to these occurrences be provided as a second line of defence.

The contractor JV will prepare a Construction Environmental Management Plan (CEMP) that will include mitigation measures to protect the water environment. This will set out how construction activities will be undertaken in accordance with the guidance laid out in the Pollution Prevention Guidelines[14.13] (PPG), originally published by the EA (or their subsequent replacement). Particular attention should be given to PPG1 - General guide to the prevention of water pollution; PPG2 - Above ground oil storage tanks; PPG 5 - Works in, near or liable to affect watercourses; and PPG 6 - Working at construction and demolition sites, and other good construction guidance such as guidance on silt pollution and how to prevent it.

The CEMP will be approved by NRW, as per their request at consultation (listed in Table 14.2.1).

The CEMP will contain construction method statements and work instructions for on-site staff that will inform them of the way that they should work on site to reduce the risk off polluting the surrounding environment. It will include instructions on dealing with certain situations such as general good site practice, adverse weather conditions, environmental incidents and complaints.

There should be inspections and audits along with general monitoring and reporting of effectiveness of control measures. This should include monitoring of water quality against the baseline quality. where there is a significant risk of water quality being affected during the works.

If groundwater is to be pumped out and discharged at any point e.g. to install footings, advice must be sought as to the need for any permits.

Depending upon the timing of the different phases, developers must be mindful of any impacts on the natural environment e.g. spawning in rivers. Reference should be made to mitigation advice in chapter 8 for specifics of ecologically sensitive seasons.

An Emergency Plan will be prepared for any incidents that do take place during construction, including numbers to call at NRW. In addition, measures that should be included in the construction method statements and work instructions for managing risks to the water environment should include:

- Management of water that collects on site or within excavations.
- Management of polluting substances that are being brought on site and used as part of the construction process.
- Working methods for working in close proximity, or within, watercourses and drainage ditches.

The mitigation strategies implemented should be reviewed regularly to best suit the practices currently being undertaken on site.

Recommended measures that should be included in the CEMP are summarised below.

Increased sediment loads

Minimise areas of exposed surface by only removing vegetation when necessary and keep gradients as shallow as possible to prevent large amounts of earth being washed away during periods of heavy rainfall. Areas that are exposed should be reseeded or surfaced as soon as practicable.

Avoid undertaking works during periods of high flow to prevent transportation of sediment downstream.

Enforce tight control of site boundaries including minimal land clearance and restrictions on the use of machinery adjacent to water bodies. Where possible, do not locate stockpiles within 10m of water bodies or drainage lines or areas more susceptible to flooding.

Appropriate measures to reduce sediment transfer off site. Capture site runoff in perimeter cut off ditches, settlement lagoons and/or settlement tanks where possible. These should be located away from areas liable to flood inundation. Any dewatering required from site excavations should be pumped into a settlement tank or lagoon and not discharged directly to a water body or the on-site surface water sewerage network. NRW have stated that 'if settlement is required prior to any discharge, methods of settlement must be discussed with NRW officers e.g. settlement lagoons, filtration, reed beds etc. to ensure appropriate quality of discharge in terms of solids.'

Release of hydrocarbons and oils

Incorporate interceptors into the site drainage system discharging to surface or groundwater from high risk areas (such as hard-surfaced parking areas larger than 800m^2 or for 50 or more parking spaces, or unloading and refuelling areas) with no other treatment provision to remove hydrocarbons and oils from surface water prior to

discharge. Access around containers should be marked clearly to prevent collisions with machinery and rupturing of tanks, as well as any spills.

Other measures including drip trays, under equipment such as generators, and wheel washing facilities should also be implemented to minimise the risk of pollutants infiltrating groundwater or the surface water drainage network. Drip trays used for diesel pumps and standing plant should be regularly maintained to prevent leaks. Spillage containment measures should be used in watercourses where appropriate during high risk activities.

Use of hazardous materials

Provide storage facilities and tanks and conduct refuelling of machinery within bunded areas, which should not be located within 10m of water bodies or drainage lines. Storage and bunded areas should be constructed of impervious floors and walls with the capacity for the contents of the storage tank and an additional 10% safety margin. Access around containers should be marked clearly to prevent collisions with machinery and rupturing of tanks, as well as any spills.

Construction materials, such as cement, should be mixed in designated areas located away from water bodies and drainage lines. Any activities involving the use of concrete that could affect watercourses must be discussed with NRW officers first, and any necessary permits obtained.

Precast culvert sections should be used to minimise the need for in situ concrete pours in close proximity to watercourses.

As a remedial measure, spill containment equipment such as absorbent materials should be stored on site.

Dust and debris

Dust management procedures should be applied which are typically implemented for air quality management issues, such as damping down to suppress the creation of dust. Contractors should also implement good site practice, perimeter fences and tight control of materials and waste to minimise the risk of debris entering water bodies.

Flood risk

For works located within Zone 3 and in close proximity to watercourses it is recommended that the contractor prepares and implements a Flood Emergency Response Plan during the construction phase. The Plan should include arrangements to evacuate the area at flood risk, make safe any static plant, and move any mobile plant. Where possible, construction compounds, spoil heaps and stockpiles and haul roads should be located outside of flood risk areas. The plan should also include measures to maintain flow routes during the construction, such as temporary diversions or overpumping of new culvert crossings.

Construction workers should also be made aware of risks associated with excess surface water caused by overland flows and standing water - for example risks to deep excavations and damage to plant.

14.5.2 Operation phase mitigation

The detailed design of mitigation controls must be considered from the beginning of the detailed design phase in order to avoid, reduce and minimise any significant adverse effects on surface water, groundwater and increased flood risk. This will enable mitigation to be embedded in the design and therefore minimise the need for active controls during occupation.

Many of the potential impacts during operation have already been mitigated through the design process, for example, flood risk has been mitigated through the provision of a robust surface water drainage system, adherence to NRW and GC requirements, and the use of SUDS techniques.

It is recommended that new and existing surface water management features be maintained to remove any debris, blockages or overgrown vegetation. Maintenance of onsite drainage systems will be the responsibility of NMWTRA as part of their asset management duties.

Maintenance of highway drainage including any swales, silt traps, gully pots and filter drains will ensure efficient removal of sediment, hydrocarbons and other pollutants, which will reduce the risk of pollution posed to surface water and groundwater. Effective maintenance of the attenuation basins will also maximise the removal of pollutants by vegetation and bacteria and this will protect both surface water and groundwater resources.

Ground investigation indicates that infiltration is not a viable means of discharging surface water. However, swales and attenuation ponds are proposed to be unlined to maximise infiltration where possible. Where groundwater levels are less than 1m below the base of unlined conveyance or storage structures (or there is a specific risk to a nearby borehole / well), these will be lined with an impermeable layer to prevent pollution of groundwater or groundwater emergence into the structure. In addition, spillage containment will be provided in carrier drains upstream of swales. A clear access corridor of approximately 4m, or another suitable distance agreed with NMWTRA, will be provided adjacent to all surface water management features to enable maintenance. No trees, vegetation or fencing will be placed within the designated maintenance access corridor.

Maintenance of drainage infrastructure, new culvert crossings and watercourse diversions should be undertaken as required to maintain their design capacity and ensure that other embedded mitigation, such as natural beds, mammal ledges and freeboard allowances remain effective. The owners and future maintainers of these features should be made aware of the mitigation embedded in the design.

14.6 Residual Environmental Effects (following mitigation)

14.6.1 Construction phase residual effects

The implementation of a CEMP and measures described above is considered adequate to reduce the impact of normal construction risks including:

- Sediment loading to due construction of embankments adjacent to a watercourse;

- Hydrocarbons released to a watercourse as a result of minor plant and equipment leaks, minor spillages and general traffic of plant adjacent to a watercourse;
- Dust and debris entering a watercourse due to crossings or culverts above a watercourse;
- Dust and debris due construction of embankments adjacent to a watercourse;
- Dust and debris due to demolition works in the vicinity of a watercourse;

The implementation of a CEMP is not likely to change the magnitude of impacts arising due to:

- Sediment loading due to re-alignment or in-filling of a watercourse;
- Sediment loading due to construction of crossings or culverts on a watercourse;
- Dust arising due to re-alignment or infilling of a watercourse;
- Dust and debris arising due to demolition of an existing culvert on a watercourse.

These activities will tend to disturb sediment, or produce dust / debris that could fall into water. Whilst appropriate mitigation can be provided, through the CEMP (such as silt traps) to reduce the release of sediment, these tend not to be 100% effective when work takes place in or directly above the channel. The installation and removal of the mitigation measures can also in itself lead to the release of sediment. Table 14.6.1 summarises the residual risks to receptors during construction of the Scheme. Changes to magnitude and significance of impact have been highlighted in bold.

Table 14.6.1 Summary of impacts during construction following implementation of mitigation measures

Receptor	Importance	Impact	Magnitude	Significance
Afon Carrog	High	Sediment release	Negligible	Neutral
		Hydrocarbon and hazardous substances release	Negligible	Neutral
		Dust and debris	Negligible	Neutral
Unnamed ditches in the Carrog catchment at CH:17m, 122m	Low	Sediment release	Moderate Adverse	Slight Adverse
		Hydrocarbon and hazardous substances release	***Negligible***	Neutral
		Dust and debris	Negligible	Neutral
Unnamed tributary of the Afon Carrog at CH:185m	Medium	Sediment release	Moderate Adverse	Moderate Adverse
		Hydrocarbon and hazardous substances release	***Negligible***	Neutral
		Dust and debris	Negligible	Neutral
Afon Rhŷd	Medium	Sediment release	Moderate Adverse	Moderate Adverse
		Hydrocarbon and hazardous substances release	***Negligible***	***Neutral***

Receptor	Importance	Impact	Magnitude	Significance
		Dust and debris	Negligible	Neutral
Unnamed ditches in the Rhŷd catchment crossing Scheme at CH:317m, 1320m	Low	Sediment release	Moderate Adverse	Slight Adverse
		Hydrocarbon and hazardous substances release	***Negligible***	Neutral
		Dust and debris	Minor Adverse	Neutral
Afon Plas at CH:1400m	Medium	Sediment release	Moderate Adverse	Moderate Adverse
		Hydrocarbon and hazardous substances release	***Negligible***	Neutral
		Dust and debris	Negligible	Neutral
Afon Gwyrfai	Very High	Sediment release	***Negligible***	***Neutral***
		Hydrocarbon and hazardous substances release	***Negligible***	***Neutral***
		Dust and debris	Negligible	Neutral
Afon Rhosdican	Medium	Sediment release	Major Adverse	Large Adverse
		Hydrocarbon and hazardous substances release	***Minor adverse***	***Slight Adverse***
		Dust and debris	***Minor Adverse***	***Slight Adverse***
Unnamed ditches in Gwyrfai catchment crossing Scheme at CH:1543m, 3162m	Medium	Sediment release	Moderate Adverse	Moderate Adverse
		Hydrocarbon and hazardous substances release	***Negligible***	Neutral
		Dust and debris	Negligible	Neutral
Afon Seiont	Medium (2015 scenario)	Sediment release	***Negligible***	***Neutral***
		Hydrocarbon and hazardous substances release	***Negligible***	***Neutral***
		Dust and debris	Negligible	Neutral
Unnamed ditches in Seiont catchment crossing Scheme at CH:5852m, 6470m, 6540m	Low	Sediment release	Moderate Adverse	Slight Adverse
		Hydrocarbon and hazardous substances release	***Negligible***	Neutral
		Dust and debris	Minor Adverse at CH: 6470m, 6540m Negligible at CH:5852m	Neutral

Receptor	Importance	Impact	Magnitude	Significance
Afon Cadnant	Medium (2015 scenario)	Sediment release	Major Adverse	Large Adverse
		Hydrocarbon and hazardous substances release	***Minor Adverse***	***Slight Adverse***
		Dust and debris	Moderate adverse	Moderate Adverse
Unnamed tributary of the Afon Cadnant at CH:8180m	Medium (2015 scenario)	Sediment release	Minor Adverse	Slight Adverse
		Hydrocarbon and hazardous substances release	***Negligible***	Neutral
		Dust and debris	Negligible	Neutral
Unnamed watercourse that discharges to Menai Strait	Medium (2015 scenario)	Sediment release	Moderate Adverse	Moderate Adverse
		Hydrocarbon and hazardous substances release	***Negligible***	***Neutral***
		Dust and debris	Minor Adverse	Slight Adverse
Menai Strait	Very High	Sediment release	Negligible	Neutral
		Hydrocarbon and hazardous substances release	Negligible	Neutral
		Dust and debris	Negligible	Neutral
Groundwater in the Scheme area	High	Hydrocarbon and hazardous substances release	***Negligible***	***Neutral***

In summary, the implementation of the measures and methods of the CEMP reduces almost all construction impacts to neutral significance. However, residual risks remain. These are:

Where watercourses are being re-aligned and culverted there will be sediment release associated with this that cannot feasibly be mitigated fully. This results in a Slight Adverse to Moderate Adverse residual risk on the following watercourses:

- Unnamed ditches in the Carrog catchment at Ch:17m, 122m
- Unnamed tributary of the Afon Carrog at Ch:185m (S101)
- Afon Rhŷd (S102)
- Unnamed ditches in the Rhŷd catchment crossing Scheme at Ch:317m, 1320m
- Afon Plas at Ch:1400m (S104)
- Unnamed ditches in Gwyrfai catchment crossing Scheme at Ch:1543, 3162m (S105, S109B)
- Unnamed ditches in Seiont catchment crossing Scheme at Ch:5852m, 6470m, 6540m (S112C, S112B, S112A)

- Unnamed tributary of the Afon Cadnant at Ch:8180m (S114A)
- Unnamed watercourse that discharges to Menai Strait (S116)
- Extensive works adjacent to and along the Afon Rhosdican, including re-alignment and culverting (S109A, S110A, S110, S111B), resulting in Large Adverse significance impacts due to sediment release from re-alignment and adjacent construction and Slight Adverse significance impacts due to hydrocarbon and hazardous substances release and dust and debris arising from extensive works adjacent to the watercourse and along the watercourse;
- Extensive works adjacent to and along the Afon Cadnant, including re-alignment and culverting (S114, S115C, S115A, S115B), resulting in Large Adverse significance impacts due to sediment release from re-alignment and adjacent construction, Slight Adverse significance impacts due to hydrocarbon and hazardous substances release from extensive works adjacent to the watercourse and along the watercourse and Moderate Adverse impacts due to demolition of the existing road adjacent to the watercourse;
- Slight Adverse impacts from dust and debris due to re-alignment and culverting works (S116) on the Medium importance unnamed watercourse that discharges to Menai Strait;

All of these impacts would be temporary. The effects of filtration, settlement, and dilution, which occur naturally, would reduce concentrations of pollutants in water bodies and floodwaters would subside such that there would be no long term impacts on the water environment.

14.6.2 Operation phase residual effects

The provision of impermeable bed layers in swales and attenuation ponds where further site investigation indicates groundwater is located near to the base of unlined surface water conveyance and attenuation features will reduce the operational impact of polluted runoff to groundwater receptors to Negligible, as the pathway for pollutants will be removed where the risk is deemed unacceptable.

Table 14.6.2 summarises the residual risks to receptors during operation of the Scheme. Changes to magnitude and significance of impact have been highlighted in bold.

Table 14.6.2 Summary of impacts during operation after mitigation

Receptor	Importance	Impact	Magnitude	Significance
Unnamed ditches in the Carrog catchment at CH:17m, 122m	Low	Reduced water quality due to changes in channel hydromorphology	Negligible at CH:17m Minor Adverse at CH:122m	Neutral
Unnamed tributary of the Afon Carrog at CH:185m	Medium	Reduced water quality due to changes in channel hydromorphology	Negligible	Neutral
Afon Rhŷd	Medium	Pollution in runoff	Negligible	Neutral
		Reduced water quality due to changes in channel hydromorphology	Minor Adverse	Slight Adverse
Unnamed ditches in the Rhŷd catchment crossing Scheme at CH:317m, 1320m	Low	Reduced water quality due to changes in channel hydromorphology	Minor Adverse	Neutral
Afon Plas at Ch:1400m	Medium	Pollution in runoff	Negligible	Neutral
		Reduced water quality due to changes in channel hydromorphology	Negligible	Neutral
Afon Gwyrfai	Very High	Pollution in runoff	Negligible	Neutral
		Reduced water quality due to changes in channel hydromorphology	Negligible	Neutral
Afon Rhosdican	Medium	Pollution in runoff	Negligible	Neutral
		Reduced water quality due to changes in channel hydromorphology	Moderate Adverse	Moderate Adverse
Unnamed ditches in Gwyrfai catchment crossing Scheme at CH:1543m, 3162m	Medium	Reduced water quality due to changes in channel hydromorphology	Negligible	Neutral
Afon Seiont	High (2033 scenario)	Pollution in runoff	Negligible	Neutral
		Reduced water quality due to changes in channel hydromorphology	Negligible	Neutral

Receptor	Importance	Impact	Magnitude	Significance
Unnamed ditches in Seiont catchment crossing Scheme at CH:5852m, 6470m, 6540m	Low	Reduced water quality due to changes in channel hydromorphology	Negligible	Neutral
Afon Cadnant	High (2033 scenario)	Pollution in runoff	Negligible	Neutral
		Reduced water quality due to changes in channel hydromorphology	Moderate Adverse	Moderate to Large Adverse
Unnamed tributary of the Afon Cadnant at CH:8180m	High	Reduced water quality due to changes in channel hydromorphology	Minor Adverse	Slight to Moderate Adverse
Unnamed watercourse that discharges to Menai Strait	High (2033 scenario)	Pollution in runoff	Negligible	Neutral
		Reduced water quality due to changes in channel hydromorphology	Minor Adverse	Slight to Moderate Adverse
Menai Strait	Very High	Pollution in runoff	Negligible	Neutral
Groundwater in the Scheme area	High	Pollution in runoff	***Negligible***	***Neutral***
		Groundwater quantity reduced due to road cutting	Negligible	Neutral
Farmland surrounding Scheme	Low	Flood risk due to location of Scheme	Moderate Adverse	Slight Adverse
		Downstream flood risk due to Scheme runoff	Negligible	Neutral
		Downstream flood risk due to poor maintenance of drainage systems	***Negligible***	***Neutral***
Existing people and property	High	Flood risk due to location of Scheme	Negligible	Neutral
		Downstream flood risk due to Scheme runoff	Negligible	Neutral
		Downstream flood risk due to poor maintenance of drainage systems	***Negligible***	***Neutral***
The Scheme	Medium	Flood risk due to location of Scheme	Minor Adverse	Slight Adverse
		Flood risk due to poor maintenance of drainage systems	***Negligible***	***Neutral***

In summary, the following residual impacts are anticipated during operation of the Scheme:

- Slight Adverse impacts on the Afon Rhŷd due to permanent impacts on channel hydromorphology a result of re-alignment and culverting (S102) of the watercourse with potential impacts on ecology.
- Moderate Adverse impact on the Afon Rhosdican due to permanent impacts on channel hydromorphology a result of re-alignment and culverting (S109A, S110A, S110, S111B) of the watercourse with potential impacts on ecology.
- Moderate to Large Adverse impact on the Afon Cadnant due to permanent impacts on channel hydromorphology a result of re-alignment and culverting (S114, S115C, S115A, S115B) of the watercourse with potential impacts on ecology.
- Slight to Moderate Adverse impact on the unnamed tributary of the Afon Cadnant at CH:8180m due to permanent impacts on channel hydromorphology a result of culverting (S114A) of the watercourse with potential impacts on ecology.
- Slight to Moderate Adverse impact on the unnamed watercourse that discharges to Menai Strait due to permanent impacts on channel hydromorphology as a result of re-alignment and culverting (S116) of the watercourse with potential impacts on ecology.
- WFD Assessment

This section provides an assessment of the likely impacts of the Scheme on the water environment with specific reference to the objectives of the WFD.

The overall objective of the WFD (together with its two daughter directives, the Groundwater Directive[14.3] (2006/118/EC) and the Priority Substances Directive (2008/105/EC)) is to bring about the effective co-ordination of water environment regulation and policy across Europe. The main aims of the legislation are to ensure that all surface water and groundwater bodies reach 'good' status (in terms of ecological and chemical quality and water quantity, as appropriate). Other aims of the WFD are to:

- prevent further deterioration and protect and enhance the status of water bodies;
- promote sustainable water use based on long-term protection of available water resources;
- enhance protection and improvement of the aquatic environment through specific measures for the progressive reduction of discharges, emissions and losses of priority substances and the cessation or phasing-out of discharges, emissions and losses of the priority hazardous substances;
- ensure the progressive reduction of pollution of groundwater and prevent its further pollution; and
- contribute to mitigating the effects of floods and droughts.

The WFD also contains provisions for controlling discharges of dangerous substances to surface waters and groundwater. Various substances are listed as (i) hazardous substances which are considered the most harmful to human health and the aquatic environment and which, under the WFD, are to be eliminated; and (ii) other pollutants which, under the WFD, are to be reduced.

The WFD assessment considers the current status and objectives of the water bodies affected by the Scheme, detailed in the following tables. The likely impacts of the Scheme on the various elements making up the overall status of the waterbody has been assessed and the potential of the water bodies to achieve the objectives laid out for each management catchment under the WFD.

The status of each water body has been assessed using information in the Western Wales River Basin Management Plan, and has been supported by the ecology assessment undertaken for the Scheme and reported in chapter 8.

Other than the Afon Gwyrfai and Afon Seiont, the ecology assessment notes that "The majority of [other watercourses crossed by the Scheme] are small streams or seasonally wet ditches which do not support distinctive or important communities of aquatic, semi-aquatic or marginal plants." Where no additional ecological information has been provided in the table below, it can be assumed that this description is applicable to the ecological value of the watercourses.

Table 14.7.1 Menai Strait Current status

Water body reference	GB681010120000
Name	Menai Strait
Type	Coastal
Size	72.085 km^2
% of water body in catchment	N/A
Description	Sheltered, Mesotidal
Hydromorphological Designation	Heavily Modified (Shellfisheries)
2009 Overall status	Moderate
Current Chemical status (2013)	Good
Current Ecological status (2013)	Moderate
Current Overall status (2013)	Moderate
Supporting Conditions	
Biological Elements	Phytoplankton - High
Physio-chemical Elements	Generally high / good Y Fenai a Bae Conwy / Menai Strait and Conwy Bay SAC designated for its sandbanks, mudflats, sandflats, reefs, large shallow inlets, bays and caves.
Hydromorphological Elements	Y Fenai a Bae Conwy / Menai Strait and Conwy Bay SAC designated for its sandbanks, mudflats, sandflats, reefs, large shallow inlets, bays and caves.
Morphology	N/A
Hydrology	N/A
Chemical Elements	N/A
Overall Objective	Good status by 2027
Ecological Status Objective	Good Ecological Potential by 2027
Reasons for failure	Disproportionately expensive (mitigation measures - modify structures, managed realignment, removal of hard bank)
Chemical Status Objective	N/A

Protected area & type?	Bathing Water Directive, Natura 2000 (Habitats and/or Birds Directive), Shellfish Water Directive

Table 14.7.2 Menai Strait Scheme impacts

	Scheme element
Water quality element	Indirect drainage discharges via unnamed tributary to Menai Strait <1km upstream and via Afon Rhyd, Gwyrfai, Seiont and Cadnant >1km upstream
Biological elements (phytoplanckton, Macrophytes & phytobenthos, Benthic invertebrate fauna, fish fauna)	No impacts.
Hydromorphological elements (hydrological regime, water body continuity, morphological conditions)	No impacts.
Physio-chemical Elements	The HAWRAT assessment indicates that concentrations of pollutants in the watercourses upstream are well below the Environmental Quality Standards (EQSs) published in the WFD. Therefore, no impacts on ecological quality of water body due to indirect discharge.
Chemical elements	The HAWRAT assessment indicates that concentrations of pollutants in the watercourses upstream are well below the Environmental Quality Standards (EQSs) published in the WFD. Therefore, no impacts on chemical quality of water body due to indirect discharge.
Critical sensitive habitats	No impacts
Overall assessment	The Scheme will not have an impact on the status of the waterbody or achievement of the WFD objectives.

Table 14.7.3 Un-named to Menai Strait Current status

Water body reference	GB110065054050
Name	Un-named to Menai Strait south
Type	River
Length	1.0 km
% of water body in catchment	99.87
Water Typology	Low, Extra Small, Siliceous
A HMWB?	No
2009 Overall status	Moderate
Current Chemical status (2013)	DNRA
Current Ecological status (2013)	Moderate (Expert judgment)
Current Overall status (2013)	Moderate
Supporting Conditions	
Biological Elements	N/A
Physio-chemical Elements	N/A
Hydromorphological Elements	Supports Good
Morphology	Supports Good
Hydrology	Supports Good
Chemical Elements	N/A
Overall Objective	Good status by 2027
Ecological Status Objective	Good Ecological Status by 2027
Reasons for failure	Disproportionately expensive, technically infeasible
Chemical Status Objective	N/A
Protected area & type?	Shellfish Water

Table 14.7.4 Unnamed to Menai Strait Scheme impacts

	Scheme element		
Water quality element	Diversion of ~ 315m of watercourse at Scheme crossing . Length affected ~30% waterbody length. ~10% of catchment watercourse length affected. Assumed diverted watercourse design similar to existing (gabion banks are required for part of the diversion for stability however this affects only a short length)	Twin culvert total length 47m on watercourse, replacing existing single culvert of 23m length. Length affected v small % of catchment watercourse length. Culverts designed with 100mm natural bed	1 no.indirect drainage discharge via ~19m length of ditch
Biological elements (phytoplanckton, Macrophytes & phytobenthos, Benthic invertebrate fauna, fish fauna)	Nominal. No significant change to physical characteristics or hydrological regime, continuity maintained. No fish known to be present in this location (upper catchment)	Slight impact but very localised. Substrate maintained, possible slight increase in sediment loading for higher velocities but very localised, reduced light at culverts but relatively short. Impacts affect very small % of total watercourse length in upper catchment Culverts replace existing culverts with smaller diameter therefore effects similar to existing.	No impacts
Hydromorphological elements (hydrological regime, river continuity, morphological conditions)	Nominal. No change to hydrological regime. River continuity maintained. No significant change to morphological conditions as diversions similar to existing.	Slight impact - potential for slight increase in velocities, restriction on channel movement at culverts but natural bed maintained through culvert. Length affected v small % of watercourse length. Localised impact. Smaller existing culverts are present therefore effects similar to existing. Scheme results in increased flows in watercourtse however channel has capacity for these flows therefore significant impacts on morphology not expected.	No impacts
Physico-chemical elements	No impacts	No impacts	The HAWRAT assessment indicates that concentrations of pollutants in the watercourse are well below the Environmental Quality Standards (EQSs) published in the WFD. Therefore, no impacts on ecological quality of water body due to indirect discharge.

Chemical elements	No impacts	No impacts	The HAWRAT assessment indicates that concentrations of pollutants in the watercourse are well below the Environmental Quality Standards (EQSs) published in the WFD. Therefore, no impacts on chemical quality of water body due to indirect discharge.
Critical sensitive habitats	None identified		
Overall assessment	Scheme will have some effects on hydromorphology where new culverts proposed, the effects will be localised and are not considered sufficient to affect the quality elements for the designated waterbody downstream or the wider catchment. The proposed works affect a very small proportion of the catchment waterbody length. The Scheme will not have an impact on the status of the waterbody or achievement of the WFD objectives.		

Table 14.7.5 Afon Cadnant Current status

Water body reference	GB110065054030
Name	Cadnant
Type	River
Length	4.3 km
% of water body in catchment	99.98
Water Typology	Low, Extra Small, Siliceous
A HMWB?	No
2009 Overall status	Moderate
Current Chemical status (2013)	DNRA
Current Ecological status (2013)	Good
Current Overall status (2013)	Good
Supporting Conditions	
Biological Elements	Good (Current)
Physio-chemical Elements	N/A
Hydromorphological Elements	Supports Good
Morphology	Supports Good
Hydrology	Supports Good
Chemical Elements	N/A
Overall Objective	Good status by 2027, disproportionately expensive, technically infeasible
Ecological Status Objective	Good Ecological Status by 2027
Reasons for failure	Disproportionately expensive, technically infeasible
Chemical Status Objective	N/A
Protected area & type?	Shellfish Water

Table 14.7.6 Afon Cadnant Scheme impacts

	Scheme element		
Water quality element	Diversion of ~ 370m of Cadnant watercourse upstream of waterbody. Length affected <10% waterbody length and v small % of catchment watercourse length. Assumed diverted watercourse design similar to existing	3 no culverts total length ~135m on Cadnant upstream of waterbody. Length affected v small % of catchment watercourse length. Culverts designed with 300mm natural bed & freeboard for 100cc event	Direct discharges at 3 no. locations, of which, 2 no within 100m of each other
Biological elements (phytoplanckton, Macrophytes & phytobenthos, Benthic invertebrate fauna, fish fauna)	Nominal. No significant change to physical characteristics or hydrological regime, continuity maintained. No fish known to be present in this location (upper catchment)	Slight impact but very localised. Substrate maintained, possible slight increase in sediment loading for higher velocities but very localised, reduced light at culverts but relatively short. Impacts affect very small % of total watercourse length in upper catchment	No impacts
Hydromorphological elements (hydrological regime, river continuity, morphological conditions)	Nominal. No change to hydrological regime. River continuity maintained. No significant change to morphological conditions as diversions similar to existing	Slight impact - potential for slight increase in velocities, restriction on channel movement at culverts but natural bed and oversized to allow some movement, natural bed maintained through culvert. Length affected v small %. Localised impact	No impacts
Physico-chemical elements	No impacts	No impacts	The HAWRAT assessment indicates that concentrations of pollutants in the watercourse are well below the Environmental Quality Standards (EQSs) published in the WFD (individual and cumulative assessment). Therefore, no impacts on ecological quality of water body due to direct discharge.
Chemical elements	No impacts on water quality	No impacts on water quality	The HAWRAT assessment indicates that concentrations of pollutants in the watercourse are well below the Environmental Quality Standards (EQSs) published in the WFD (individual and cumulative assessment). Therefore, no impacts on chemical quality of water body due to direct discharge.
Critical sensitive habitats	None identified		
Overall assessment	Scheme will have some effects on hydromorphology where new culverts proposed, the effects will be localised and are not considered sufficient to affect the quality elements for the designated waterbody downstream or the wider catchment. The proposed works affect a very small proportion of the catchment waterbody length. The Scheme will not have an impact on the status of the waterbody or achievement of the WFD objectives.		

Table 14.7.7 Afon Seiont Current status

Water body reference	GB110065054040
Name	Seiont - lower
Type	River
Length	12.0 km
% of water body in catchment	98.65
Water Typology	Mid, Small, Siliceous
A HMWB?	Yes – Water Storage
2009 Overall status	Moderate
Current Chemical status (2013)	DNRA
Current Ecological status (2013)	Moderate
Current Overall status (2013)	Moderate
Supporting Conditions	
Biological Elements	Good (Current) Fish – Good (2009) Invertebrates – Good (2009) Afon Seiont (Middle) locally designated Wildlife Site consisting of aquatic habitats. Otter activity noted in Sep 2015 survey report but no resting up sites or holts recorded.
Physio-chemical Elements	Generally High, Temperature Good, Copper Moderate
Hydromorphological Elements	Supports Good
Morphology	N/A
Hydrology	Supports Good
Chemical Elements	N/A
Overall Objective	Good Potential by 2027
Ecological Status Objective	Good Ecological Potential by 2027 (technically infeasible)

Reasons for failure	(Failing elements mitigation measures assessment, copper)
Chemical Status Objective	N/A
Protected area & type?	Drinking Water, Fresh Water Fish, Shellfish Water

Table 14.7.8 Afon Seiont Scheme impacts

	Scheme element	
Water quality element	Clear span crossing over Afon Seiont watercourse and flood plain	Indirect and direct drainage discharges at 5 no. locations within 1km of each other, of which, 2 no within 100m of each other
Biological elements (phytoplanckton, Macrophytes & phytobenthos, Benthic invertebrate fauna, fish fauna)	Nominal. No significant change to physical characteristics or hydrological regime, continuity maintained. No impacts on aquatic habitats.	No impacts
Hydromorphological elements (hydrological regime, river continuity, morphological conditions)	No change to hydrological regime due to clear span crossings. River continuity maintained. No change to morphological conditions. No impacts on Otter.	No impacts
Physico-chemical elements	No impacts	The HAWRAT assessment indicates that concentrations of pollutants in the watercourse are well below the Environmental Quality Standards (EQSs) published in the WFD (individual and cumulative assessment). Therefore, no impacts on ecological quality of water body due to direct discharge.
Chemical elements	No impacts	The HAWRAT assessment indicates that concentrations of pollutants in the watercourse are well below the Environmental Quality Standards (EQSs) published in the WFD (individual and cumulative assessment). Therefore, no impacts on chemical quality of water body due to direct discharge.
Critical sensitive habitats	None identified	

Overall assessment	The use of a clear span crossing to bridge the Afon Seiont will result in no significant impacts on any elements of water quality. The Scheme will not have an impact on the status of the waterbody or achievement of the WFD objectives.

Scheme impacts have been assessed for the Gwyrfai and Un-named to Foryd estuary-east together as the Afon Rhsodican outfalls into the Gwyrfai catchment and the impacts are best assessed together therefore.

Table 14.7.9 Afon Gwyrfai Current status

Water body reference	GB110065054190
Name	Gwyrfai
Type	River
Length	18.6 km
% of water body in catchment	99.51
Water Typology	Mid, Small, Siliceous
A HMWB?	Yes – Water Storage
2009 Overall status	Good
Current Chemical status (2013)	Good
Current Ecological status (2013)	Good
Current Overall status (2013)	Good
Supporting Conditions	
Biological Elements	Good (Current) Fish – Moderate (Uncertain) (2009) Invertebrates – High (2009) Afon Gwyrfai a Llyn Cwellyn SAC designated for its oligotrophic standing waters and for its populations of Atlantic salmon, floating water-plantain and Otter. Afon Gwyrfai a Llyn Cwellyn SSSI designated for its running and standing water, aquatic plant assemblage, floating water plantain, Arctic charr (not in river section in close proximity to Scheme), Atlantic salmon and Otter. 2015 survey noted no confirmed resting up sites or Otter holts. Only two spraints found along the Afon Gwyrfai
Physio-chemical Elements	High

Hydromorphological Elements	Heavily Modified – water storage
Morphology	N/A
Hydrology	N/A
Chemical Elements	High
Overall Objective	Good Potential by 2015
Ecological Status Objective	Good Ecological Potential by 2015
Reasons for failure	Fish - morphology: Barriers to fish migration Impoundments The Core Management Plan (CMP) for the Afon Gwyrfai SAC highlighted that the oligotrophic standing waters are unfavourable (recovering) due to historic moderate acidification, Atlantic salmon is unfavourable due to a precautionary assessment of survey results and the presence of adverse factors and Otter populations are unfavourable due to the number and distribution of breeding sites. The watercourse of plain to montane levels and floating water-plantain were noted to be in favourable condition.
Chemical Status Objective	Good Chemical Status by 2015
Protected area & type?	Drinking Water, Fresh Water Fish, Habitats & Species, Natura 2000 (Habitats and/or Birds Directive), Shellfish Water Directive

Table 14.7.10 Un-named to Foryd estuary east Current status

Water body reference	GB110065054000
Name	Gwyrfai
Type	River
Length	5.7km
% of water body in catchment	81.11
Water Typology	Low, Extra Small, Siliceous
A HMWB?	No
2009 Overall status	Moderate

Current Chemical status (2013)	DNRA
Current Ecological status (2013)	Moderate
Current Overall status (2013)	Moderate
Supporting Conditions	N/A
Biological Elements	N/A
Physio-chemical Elements	N/A
Hydromorphological Elements	Supports Good
Morphology	Supports Good
Hydrology	High
Chemical Elements	N/A
Overall Objective	Good Status by 2027
Ecological Status Objective	N/A
Reasons for failure	Disproportionately expensive, Technically infeasible
Chemical Status Objective	N/A
Protected area & type?	Natura 2000 (Habitats and/or Birds Directive), Shellfish Water Directive

Table 14.7.11 Afon Gwyrfai and Un-named to Foryd estuary-east Scheme impacts:

	Scheme element			
Water quality element	Clear span crossing over Afon Gwyrfai watercourse and flood plain	Diversion of ~ 421m of Rhosdican watercourse upstream of waterbody. Length affected <10% waterbody length Assumed diverted watercourse design similar to existing.	4 no. culverts total length ~120m on Afon Rhosdican upstream of Gwyrfai. Length affected v small % of catchment watercourse length. Culverts designed with 300mm natural bed & freeboard for 100cc event	5 no. direct drainage discharges into Afon Gwyrfai and Afon Rhosdican at 2 locations within 1km of each other

Biological elements (phytoplanckton, Macrophytes & phytobenthos, Benthic invertebrate fauna, fish fauna)	Nominal. No significant change to physical characteristics or hydrological regime, continuity maintained.	Nominal. No significant change to physical characteristics or hydrological regime, continuity maintained. No fish known to be present in this location, although watercourse discharges into Gwyrfai, which has been noted for Otter presence, and is designated a SAC and SSSI for presence of Arctic chubb and Atlantic salmon and floating water-plantain	Slight impact but very localised. Existing culverts on watercourse limiting biological quality, specifically limiting continuous green corridor for Otter. Substrate maintained, possible slight increase in sediment loading for higher velocities but very localised, reduced light at culverts but relatively short. Impacts affect small % of total watercourse length	No impacts
Hydromorphological elements (hydrological regime, river continuity, morphological conditions)	No change to hydrological regime due to clear span crossings. River continuity maintained. No change to morphological conditions. No impacts on Otter, Water Vole , Arctic charr or Altantic salmon due to clear span crossings.	Nominal. No change to hydrological regime. River continuity maintained. No significant change to morphological conditions as diversions similar to existing	Slight impact - potential for slight increase in velocities, restriction on channel movement at culverts but natural bed and oversized to allow some movement, natural bed maintained through culvert. Length affected v small %. Existing culverts on watercourse limiting hydromorphological quality. Localised impact	No impacts

Physico-chemical elements	No impacts	No impacts	No impacts	The HAWRAT assessment indicates that concentrations of pollutants in the watercourse are well below the Environmental Quality Standards (EQSs) published in the WFD (individual and cumulative assessment). Therefore, no impacts on ecological quality of water body due to direct discharge.
Chemical elements	No impacts	No impacts	No impacts	The HAWRAT assessment indicates that concentrations of pollutants in the watercourse are well below the Environmental Quality Standards (EQSs) published in the WFD (individual and cumulative assessment). Therefore, no impacts on chemical quality of water body due to direct discharge.
Critical sensitive habitats	No significant impacts on Atlantic Salmon, floating water-plantain or Otter in Afon Gwyrfai a Llyn Cwellyn SAC No significant impacts on aquatic plant assemblage, floating water plantain, Arctic charr, Atlantic salmon and Otter in the Afon Gwyrfai a Llyn Cwellyn SSSI.			
Overall assessment	No significant impacts on any aspect of water quality on Afon Gwyrfai due to open span crossing over watercourse. Some impacts on ecological and hydromorphological elements of water quality on Afon Rhosdican due to culverting and re-alignment but existing culverts on the watercourse limit ecological quality of watercourse and proposed realignments and culverting affects small % of total watercourse length. Impacts not enough to alter ability of watercourses to achieve respective objectives.			

Table 14.7.12 Afon Carrog Current status

Water body reference	GB110065053990
Name	Carrog
Type	River
Length	5.8km
% of water body in catchment	99.99
Water Typology	Low, Extra Small, Siliceous
A HMWB?	No
2009 Overall status	Good
Current Chemical status (2013)	DNRA
Current Ecological status (2013)	Good
Current Overall status (2013)	Good
Supporting Conditions	
Biological Elements	N/A
Physio-chemical Elements	N/A
Hydromorphological Elements	Supports Good
Morphology	Supports Good
Hydrology	Supports Good
Chemical Elements	N/A
Overall Objective	Good status by 2015
Ecological Status Objective	Good Ecological Status by 2015
Reasons for failure	N/A
Chemical Status Objective	N/A
Protected area & type?	Bathing Waters, Shellfish Water Directive

Table 14.7.13 Afon Carrog Scheme impacts

	Scheme Element		
Water quality element	Diversion of ~ 74m of Afon Rhyd watercourse upstream of Afon Carrog. Length affected <10% waterbody length Assumed diverted watercourse design similar to existing. Riffles, meanders, naturalised bed.	2 no. culverts total length: ~55m on Afon Rhyd and ~30m on Afon Plas, both upstream of Afon Carrog. Lengths affected v small % of catchment watercourse lengths. Afon Plas culverts designed with 300mm natural bed Afon Rhyd culvert designed with 200mm natural bed and fish baffles. Both have freeboard for 100cc event	2 no. direct drainage discharges into Afon Plas and Afon Rhyd
Biological elements (phytoplanckton, Macrophytes & phytobenthos, Benthic invertebrate fauna, fish fauna)	Nominal. No significant change to physical characteristics or hydrological regime, continuity maintained. No fish known to be present in this location (upper catchment) however the channel design provides for suitable conditions for migratory fish if they are found to be present.	Slight impact but very localised. Substrate maintained, possible slight increase in sediment loading for higher velocities but very localised, reduced light at culverts but relatively short. . Fish baffles included in Rhyd culvert to maintauin appropriate flow velocities for any migratory fish. Impacts affect very small % of total watercourse length in upper catchment	No impacts
Hydromorphological elements (hydrological regime, river continuity, morphological conditions)	Nominal. No change to hydrological regime. River continuity maintained. No significant change to morphological conditions as diversions similar to existing. Scour protection will be provided at the culvert as determined necessary at detailed design.	Slight impact - potential for slight increase in velocities, restriction on channel movement at culverts but natural bed and oversized to allow some movement, natural bed maintained through culvert. Length affected v small %. Localised impact	No impacts
Physico-chemical elements	No impacts	No impacts	The HAWRAT assessment indicates that concentrations of pollutants in the watercourse are well below the Environmental Quality Standards (EQSs) published in the WFD. Therefore, no impacts on ecological quality of water body due to direct discharge.

Chemical elements	No impacts	No impacts	The HAWRAT assessment indicates that concentrations of pollutants in the watercourse are well below the Environmental Quality Standards (EQSs) published in the WFD . Therefore, no impacts on chemical quality of water body due to direct discharge.
Critical sensitive habitats	None identified		
Overall assessment	Scheme will have some effects on hydromorphology where new culverts proposed, the effects will be localised and are not considered sufficient to affect the quality elements for the designated waterbody downstream or the wider catchment. The proposed works affect a very small proportion of the catchment waterbody length. The Scheme will not have an impact on the status of the waterbody or achievement of the WFD objectives. In consultation with a fisheries expert, specific measures have been included in the Afon Rhyd culvert design, including enlargement of the culvert and fish baffles, to maintain suitable flow velocities and conditions for migratory fish.		

Table 14.7.14 Llyn & Eryi Current status:

Water body reference	GB41002G204600
Name	Llyn & Eryri
Type	Groundwater
Size	1317.2km^2
2009 Overall status	Good
Current Chemical status (2013)	Poor
Current Quantitative status (2013)	Good
Current Overall status (2013)	Poor
Supporting Conditions	
Quantitative Elements (wetlands, surface waters, saline intrusion, water balance)	Good (2009)
Chemical Elements (wetlands, surface waters, saline intrusion, water balance)	Good (2009)
Overall Objective	Good status by 2015
Quantitative Status Objective	Good status by 2015
Reasons for failure	N/A
Chemical Status Objective	Good status by 2015
Protected area & type?	Drinking Water

Table 14.7.15 Llyn & Eryi Scheme impacts:

	Scheme element	
Water quality element	14 no. point discharges from Scheme drainage via shallow unlined attenuation ponds. Discharges from Scheme drainage via unlined swales adjacent to either side of 9.7km Scheme	Scheme in cutting up to depths of 21m in areas with shallow groundwater
Quantity elements	No impacts	Zone of groundwater draw down will be small. Drainage provided to drain groundwater and return to surface water bodies within same catchment therefore not expected to affect groundwater quantity.
Chemical elements	The HAWRAT assessment indicates a medium risk of pollution to groundwater. However, where groundwater is within 1m of the underside of swales or ponds, an impermeable barrier will be used to prevent infiltration. The nature and quantity of any pollutants which enter the groundwater are not considered sufficient to affect the chemical status.	Potential for slight contamination from explosives during blasting works but any impacts likely to be short term. Quantity of explosives unlikely to be sufficient to affect the chemical status of groundwater.
Critical sensitive habitats	None identified	
Overall assessment	Prevention of direct discharge of Scheme runoff to groundwater by use of barrier layers prevents any impacts to water quality from drainage. Will not prevent achievement of Good chemical status objective. Zone of draw down associated with Scheme cutting anticipated to be small therefore impacts to quantitative quality of Scheme not large enough to impact ability of water body to achieve quantitative objectives.	

14.6.3 WFD Summary and conclusions

In summary, the Scheme would not affect the ability of any water body to achieve the specific objectives of the WFD for that water body.

The greatest risks to the ability of water bodies arise from:

- Realignment of watercourses, impacting biological and hydromorphogical elements of water quality;
- Culverting of watercourses, impacting biological and hydromorphogical elements of water quality;
- Discharge of Scheme runoff to infiltration features, impacting chemical elements of water quality;
- Scheme cuttings into ground with shallow groundwater, impacting the quantitative and chemical elements of water quality.
- These impacts are not considered sufficient to affect the abilities of water bodies to achieve the objectives of the WFD for each water body respectively. Key mitigation embedded in the design to ensure this includes:
- Inclusion of diversions and culverts to maintain existing drainage routes hence no impacts on the hydrological regime;
- Diverted watercourse design similar to existing therefore significant long term impacts are not expected. The impacts will primarily be short term whilst habitat establishes.
- Culverts designed with 300mm natural bed & freeboard for 100cc event which maintains some habitat continuity through the culvert and allows for some continued morphological change. Some residual, localised effects are expected;
- Where groundwater is within 1m of the underside of swales or ponds, features designed with an impermeable barrier to prevent infiltration.

14.7 Summary and Conclusions

14.7.1 Introduction

This chapter assesses the potential environmental impacts of the A487 Caernarfon and Bontnewydd Scheme on the water environment. The assessment has been undertaken in accordance with relevant legislation and in consultation with GC and NRW.

The receptors that have the potential to be impacted, which are the subject of this chapter, include the coastal waters, surface water features and groundwater near the Scheme.

A FCA has been prepared to support this chapter. The FCA assesses the existing flood risks posed to the Scheme and any changes to the flood risk posed to the Scheme or elsewhere because of the Scheme. The FCA is appended to this report (Volume 3, Appendix K.1).

14.7.2 Methodology

Due to the size of the Scheme area, water environment receptors have been grouped by type and catchment where possible. Assessments have been completed for construction impacts in the baseline year (2015) and operational impacts in the year 2033.

The methodology adopted for the assessment of impacts of the proposed development on the water environment is based on the methodology outlined within DMRB Volume 11, Section 3, Part 10: Road Drainage and the Water Environment HD 45/09, November 2009.

In accordance with the DMRB's quantitative methodology, the operational pollution impacts from surface water runoff and accidental spillages have been assessed using HAWRAT. The risk of pollution to groundwater from routine runoff has been quantified using the matrix provided within the same DMRB volume.

A qualitative assessment has been adopted to assess the potential impacts of construction works on the water environment.

14.7.3 Baseline

Two baseline scenarios have been considered:

- 2015 (construction impacts) - reflects the current status of the receptors.
- 2033 (operational impacts) - reflects the expected future status of receptors in 2033, including any targeted improvements in the quality of water bodies as set out in the Western Wales RBMP.

The receptors with potential to be impacted by the scheme consist of main rivers, ordinary watercourses, ditches, groundwater and people, land and property at risk of flooding. The Scheme area used to identify these features is based on the Scheme alignment and a 500m buffer zone. Other features more distant from the Scheme, which are in direct hydraulic connectivity, have been included as appropriate.

14.7.4 Construction impacts prior to mitigation

The receptors where the most significant construction phase impacts occur are those where watercourses are being diverted or culverted resulting in significant sedimentation, those watercourses where adjacent works continue for a large length of the watercourse resulting in significant impacts from sediment, hydrocarbon and hazardous material runoff, and those watercourses where significant demolition work will occur adjacent to watercourses. The receptors at greatest risk during construction are:

- Unnamed tributary of the Afon Carrog at chainage 185m and the Afon Rhŷd (S102) from sedimentation occurring as a result of culverting and re-alignment of watercourse;
- Afon Plas from sedimentation due to culverting (S104) of the watercourse;
- Afon Gwyrfai from sedimentation and hydrocarbon and hazardous substances release due to receptor importance (designated a SSSI and a SAC);
- Unnamed ditches discharging into the Afon Gwyrfai at chainages 1543m and 3162m from sedimentation due to culverting (S105, S109B) of the watercourse and the receptor importance of the downstream Afon Gwyrfai (designated a SSSI and a SAC);
- Afon Rhosdican from sedimentation, hydrocarbon and hazardous substances release and dust and debris due realignment and culverting (S109A, S110A, S110, S111B) of the watercourse as well as c. 1km length of Scheme works adjacent to the watercourse;
- Afon Cadnant from sedimentation, hydrocarbon and hazardous substances release and dust and debris due to significant re-alignment of watercourse, culverting (S114, S115C, S115A, S115B) and demolition works occurring adjacent to the watercourse;
- Unnamed watercourse that discharges to Menai Strait from sedimentation due to re-alignment of the watercourse and culverting (S116);

All of these impacts are temporary and the magnitude of the impacts on these receptors are not are considered great enough to have permanent effects.

14.7.5 Operational impacts prior to mitigation

The key risks posed to the water environment during operation of the scheme are:

Impacts on water quality due to changes in channel hydromorphology on the Afon Rhŷd, Rhosdican and Cadnant due to watercourse re-alignment and culverting works (S102, S109A, S110A, S110, S111B, S114, S115C, S115A, S115B).

14.7.6 Construction Mitigation measures and residual risks

It is recommended that the contractor be required to prepare a Construction Environmental Management Plan (CEMP) that will include mitigation measures to protect the water environment.

The implementation of the measures and methods of the CEMP reduces almost all construction impacts to neutral significance. However, residual risks remain. These are:

Where watercourses are being re-aligned and culverted there will be sediment release associated with this that cannot feasibly be mitigated fully. This results in a Slight Adverse to Moderate Adverse residual risk on the following watercourses:

- Unnamed ditches in the Carrog catchment at Ch:17m, 122m
- Unnamed tributary of the Afon Carrog at Ch:185m (S101)
- Afon Rhŷd (S102)
- Unnamed ditches in the Rhŷd catchment crossing Scheme at Ch:317m, 1320m
- Afon Plas at Ch:1400m (S104)
- Unnamed ditches in Gwyrfai catchment crossing Scheme at Ch:1543, 3162m (S105, S109B)
- Unnamed ditches in Seiont catchment crossing Scheme at Ch:5852m, 6470m, 6540m (S112C, S112B, S112A)
- Unnamed tributary of the Afon Cadnant at Ch:8180m (S114A)
- Unnamed watercourse that discharges to Menai Strait (S116)
- Extensive works adjacent to and along the Afon Rhosdican, including re-alignment and culverting (S109A, S110A, S110, S111B), resulting in Large Adverse significance impacts due to sediment release from re-alignment and adjacent construction and Slight Adverse significance impacts due to hydrocarbon and hazardous substances release and dust and debris arising from extensive works adjacent to the watercourse and along the watercourse;
- Extensive works adjacent to and along the Afon Cadnant, including re-alignment and culverting (S114, S115C, S115A, S115B), resulting in Large Adverse significance impacts due to sediment release from re-alignment and adjacent construction, Slight Adverse significance impacts due to hydrocarbon and hazardous substances release from extensive works adjacent to the watercourse and along the watercourse and Moderate Adverse impacts due to demolition of the existing road adjacent to the watercourse;
- Slight Adverse impacts from dust and debris due to re-alignment and culverting works (S116) on the Medium importance unnamed watercourse that discharges to Menai Strait;

All of these impacts would be temporary. The effects of filtration, settlement, and dilution, which occur naturally, would reduce concentrations of pollutants in water bodies and floodwaters would subside such that there would be no long term impacts on the water environment.

14.7.7 Operational mitigation measures and residual risks

The implementation of a maintenance schedule by NMWTRA is anticipated to reduce the magnitude of flood risks resulting from lack of maintenance to ‘Negligible’.

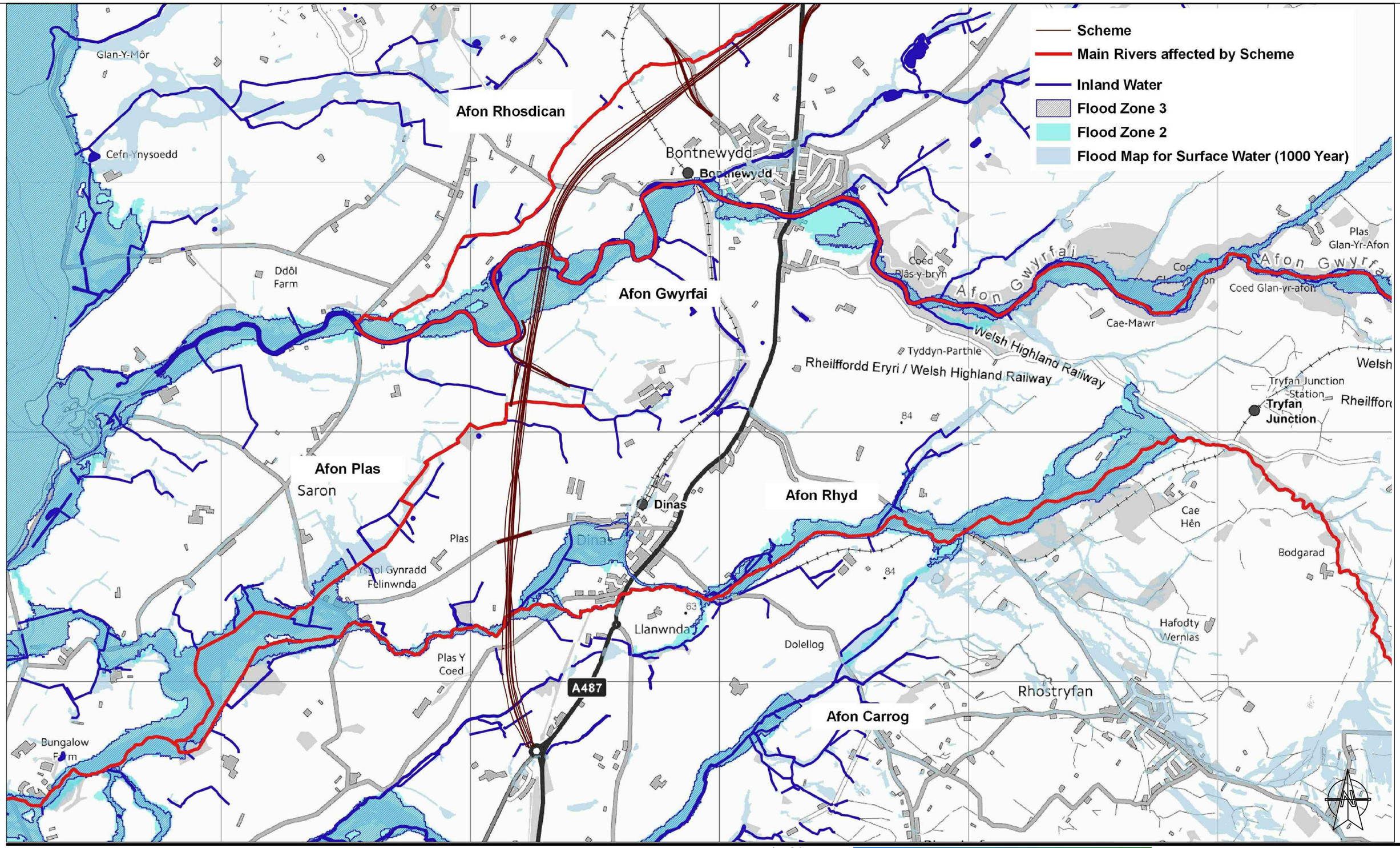
The provision of impermeable bed layers in swales and attenuation ponds where further site investigation indicates groundwater is within 1m of the base of unlined surface water conveyance and attenuation features, and spillage containment provision in carrier drains upstream of swales, would reduce the operational impact of polluted runoff to groundwater receptors to Negligible, as the pathway for pollutants would be removed where the risk is deemed unacceptable.

Following implementation of mitigation measures, the following residual impacts are anticipated during operation of the Scheme:

- Slight Adverse impacts on the Afon Rhŷd due to permanent impacts on channel hydromorphology a result of re-alignment and culverting (S102) of the watercourse with impacts on ecology.
- Moderate Adverse impact on the Afon Rhosdican due to permanent impacts on channel hydromorphology a result of re-alignment and culverting (S109A, S110A, S110, S111B) of the watercourse with impacts on ecology.
- Moderate to Large Adverse impact on the Afon Cadnant due to permanent impacts on channel hydromorphology a result of re-alignment and culverting (S114, S115C, S115A, S115B) of the watercourse with impacts on ecology.
- Slight to Moderate Adverse impact on the unnamed tributary of the Afon Cadnant at CH:8180m due to permanent impacts on channel hydromorphology a result of culverting (S114A) of the watercourse with impacts on ecology.
- Slight to Moderate Adverse impact on the unnamed watercourse that discharges to Menai Strait due to permanent impacts on channel hydromorphology a result of re-alignment and culverting (S116) of the watercourse with impacts on ecology.

14.7.8 Water Framework Directive Assessment

The Scheme would not affect the ability of any water body to achieve the specific objectives of the WFD for that water body.



REV	DATE	DESCRIPTION	BY	CHKD	APPD

• TITLE

A487 CAERNARFON AND BONTNEWYDD BYPASS

Road Drainage & Water environment
Waterbodies and Flood Risk Area (a-c)
Sheet 1 of 3

THIS DRAWING WAS PRODUCED USING AUTOCAD AND SHOULD ON NO ACCOUNT BE AMENDED BY HAND

Llywodraeth Cymru
Welsh Government

Balfour Beatty JONES BROS CIVIL ENGINEERING UK

ARCADIS | RAMBOLL | WSP | PARSONS BRINCKERHOFF | TACP

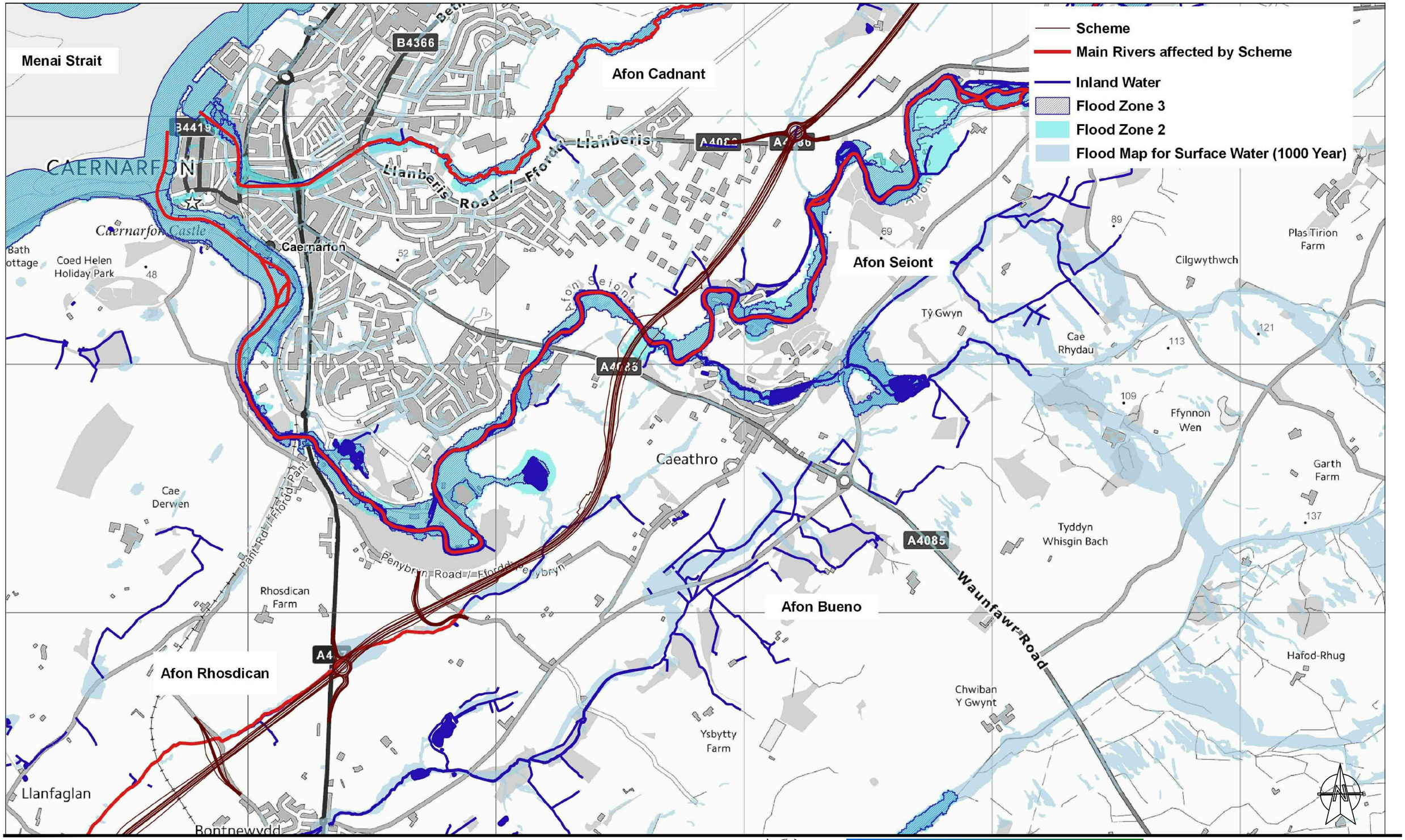
Ty Glyn, Canol Y Dre, Ruthin
Denbighshire Tel: 01824 703661

FINAL

• DATE 29/06/16
• SCALE Not To Scale

DRAWN BY RW
DESIGNED BS
CHECKED LJ
APPROVED PM

• FIGURE NUMBER
14.1a



REV	DATE	DESCRIPTION	BY	CHKD	APPD

• TITLE

A487 CAERNARFON AND BONTNEWYDD BYPASS

Road Drainage & Water environment
Waterbodies and Flood Risk Area (a-c)
Sheet 2 of 3

THIS DRAWING WAS PRODUCED USING AUTOCAD AND SHOULD ON NO ACCOUNT BE AMENDED BY HAND

Llywodraeth Cymru
Welsh Government

Balfour Beatty | Jones Bros Civil Engineering UK

ARCADIS | RAMBOLL | WSP | Parsons Brinckerhoff | TACP

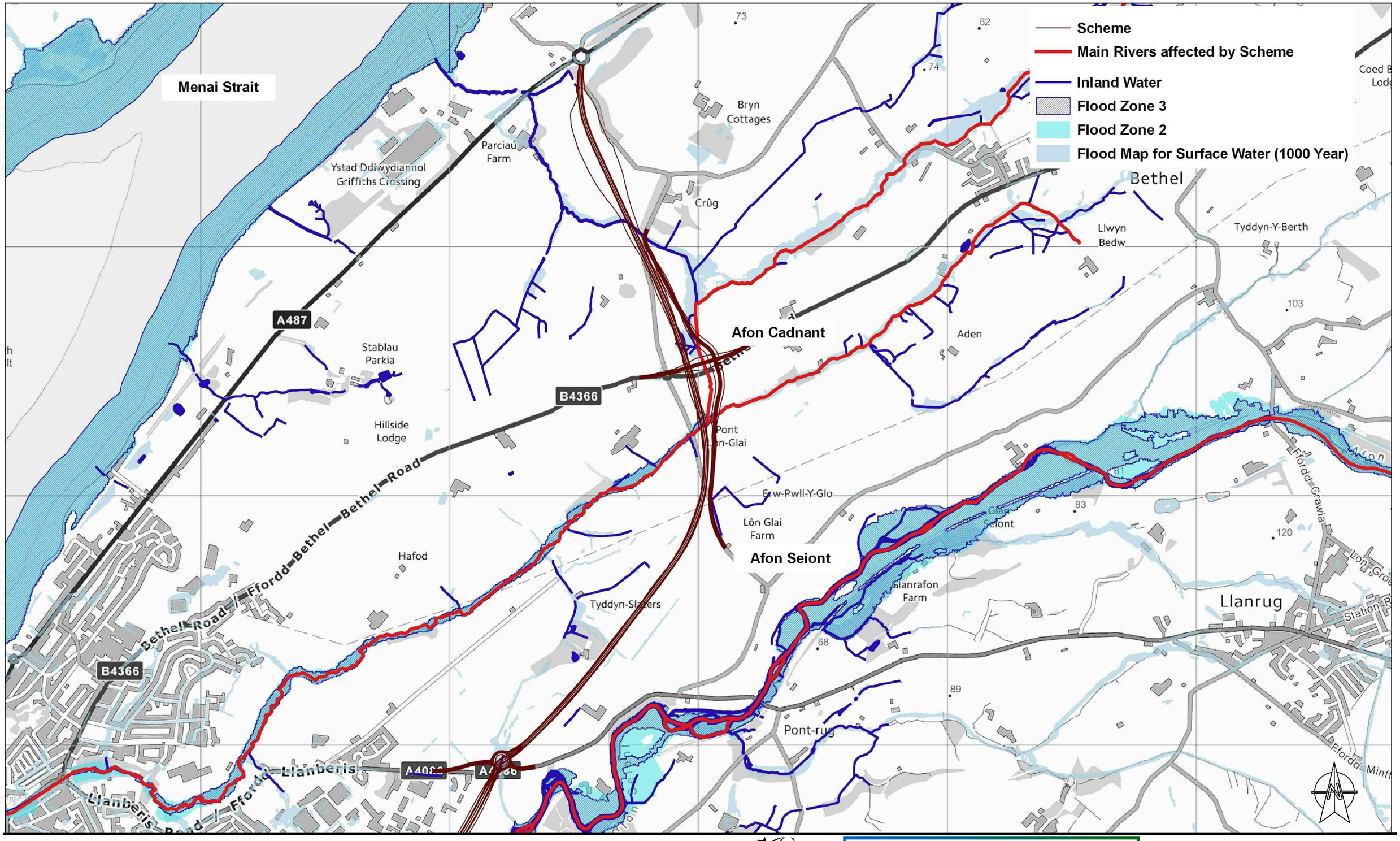
Ty Glyn, Canol Y Dre, Ruthin
Denbighshire Tel: 01824 703661

FINAL

• DATE 29/06/16
• SCALE Not To Scale

DRAWN BY RW
DESIGNED BS
CHECKED LJ
APPROVED PM

• FIGURE NUMBER
14.1b



REV	DATE	DESCRIPTION	BY	CHKD	APPD

• TITLE

A487 CAERNARFON AND BONTNEWYDD BYPASS

Road Drainage & Water environment
Waterbodies and Flood Risk Area (a-c)
Sheet 3 of 3

THIS DRAWING WAS PRODUCED USING AUTOCAD AND SHOULD ON NO ACCOUNT BE AMENDED BY HAND

Llywodraeth Cymru
Welsh Government

Balfour Beatty | Jones Bros Civil Engineering UK

ARCADIS | RAMBOLL | WSP | Parsons Brinckerhoff | TACP

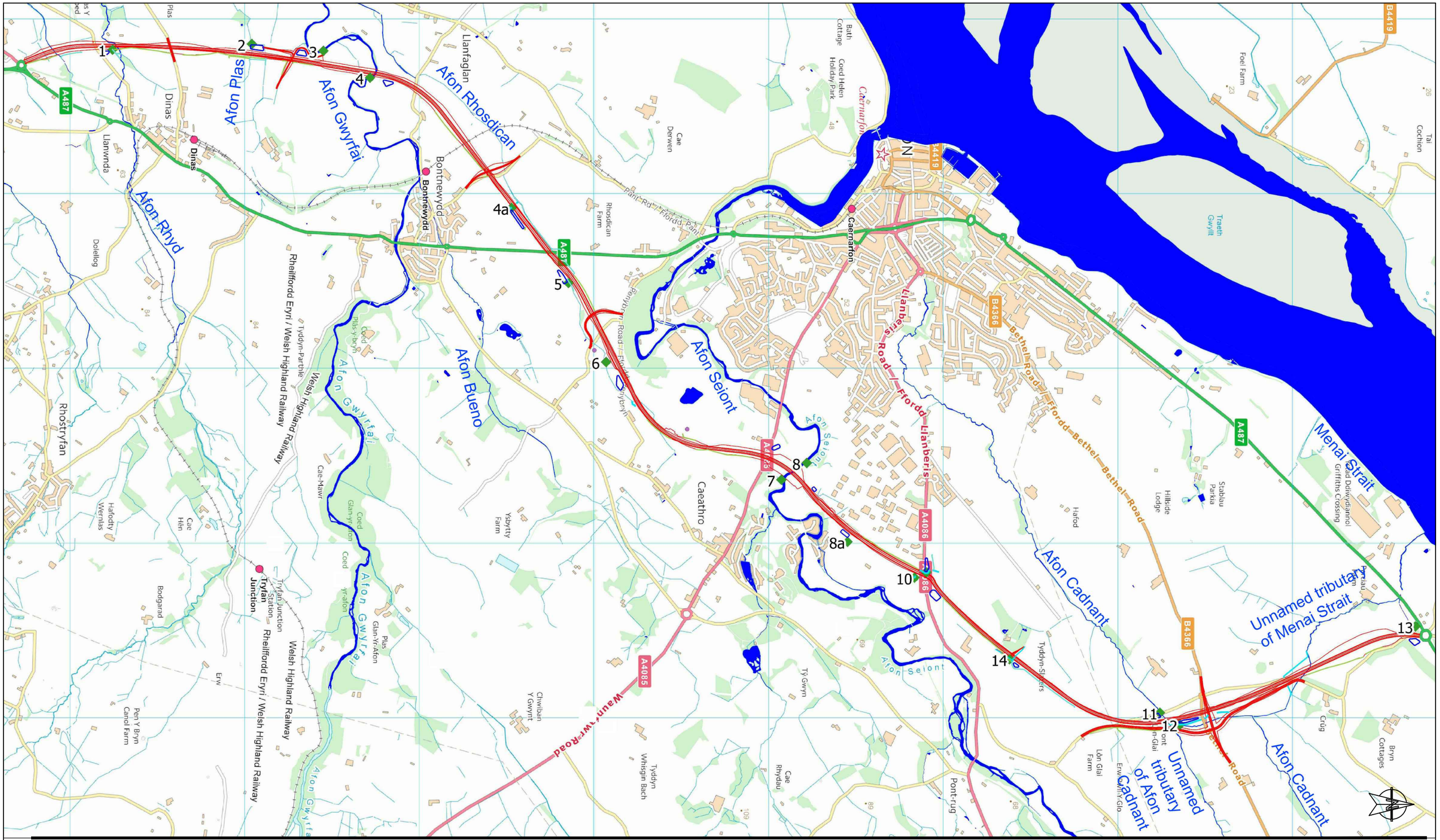
Ty Glyn, Canol Y Dre, Ruthin
Denbighshire Tel: 01824 703661

FINAL

• DATE 29/06/16
• SCALE Not To Scale

DRAWN BY RW
DESIGNED BS
CHECKED LJ
APPROVED PM

• FIGURE NUMBER
14.1c



REV	DATE	DESCRIPTION	BY	CHKD	APPD

• TITLE

A487 CAERNARFON AND BONTNEWYDD BYPASS

Road Drainage & Water Environment Net Outfalls and Pond Locations

THIS DRAWING WAS PRODUCED USING AUTOCAD AND SHOULD ON NO ACCOUNT BE AMENDED BY HAND

Llywodraeth Cymru
Welsh Government

Balfour Beatty JONES BROS CIVIL ENGINEERING UK

ARCADIS | RAMBOLL | WSP | PARSONS BRINCKERHOFF | TACP

Ty Glyn, Canol Y Dre, Ruthin
Denbighshire Tel: 01824 703661

FINAL

• DATE 29/06/16
• SCALE Not To Scale

DRAWN BY RW
DESIGNED BS
CHECKED LJ
APPROVED PM

• FIGURE NUMBER
14.2