Welsh Government

A40 Llanddewi Velfrey to Penblewin Improvements

Environmental Statement Chapter 7: Road Drainage and Water Environment

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7 Road Drainage and Water Environment

7.1 Introduction

7.1.1 The section describes and characterises the existing surface and groundwater resources in the vicinity of the Scheme. It sets out the methodology used for the assessment of potential impacts to water bodies, surface water drainage and flood risk as a result of the Scheme during the construction and operational phases. Potential impacts to groundwater resulting from the Scheme, including changes in groundwater level or resource and pollution as a result of road runoff, accidental spillage or construction activities are considered in this chapter. Potential impacts on groundwater due to the mobilisation of existing pollutants are considered within Chapter 6 Geology and Soils.

7.1.2 The assessment methodology follows the guidance set out in the Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 10: HD45/09 Road Drainage and the Water Environment (November 2009), subsequently referred to in the report as HD45/09.

7.2 Policy Context

European Legislation

7.2.1 **Water Framework Directive (WFD) 2000/60/EC**: the WFD provides a framework for the protection of inland surface waters (rivers and lakes), transitional waters (estuaries), coastal waters and groundwater. The Directive requires Member States to establish river basin districts and for each of these a river basin management plan (RBMP), which are prepared, implemented and reviewed every six years. The current period from 2015-21 is Cycle 2 of these RBMPs.

7.2.2 **Groundwater Daughter Directive 2006/118/EC**: a daughter directive of the WFD, the Groundwater Directive establishes a regime which sets groundwater quality standards and introduces measures to prevent or limit inputs of pollutants into groundwater. Amended by Directive 2014/80/EU to clarify groundwater information to be provided to the European Commission. Member States must provide information on groundwater bodies classified as being at risk and threshold values for the respective pollutants and indicators established.

7.2.3 **Floods Directive 2007/60/EC**: The Floods Directive requires Member States to assess if all water courses and coast lines are at risk from flooding, to map the flood extent and assets and humans at risk in these areas and to take adequate and coordinated measures to reduce this flood risk. The Directive requires that flood risk management plans be prepared, implemented and reviewed every six years for each river basin district, in coordination with RBMPs prepared under the WFD.

7.2.4 **Habitats Directive 92/43/EEC & Birds Directive 2009/147/EC**: The Habitats Directive and Birds Directive ensure the conservation of a range of rare or threatened species. They establish the EU-wide Natura 2000 ecological network of protected areas to safeguard against potentially damaging developments.

7.2.5 **Priority Substances Directive 2013/39/EU**: The Priority Substances Directive amends WFD 2000/60/EC and the Directive on Environmental Quality Standards (Directive 2008/105/EC) by updating the list of priority substances that would apply to WFD assessment.

7.2.6 **Urban Wastewater Treatment Directive 91/271/EEC (as amended) (UWWT Directive (consolidated)):** this Directive concerns the collection, treatment and discharge of urban waste water and the treatment and discharge of waste water from certain industrial sectors. The objective of the Directive is to protect the environment from the adverse effects of the above-mentioned wastewater discharges.

National Legislation

7.2.7 **Environmental Protection Act 1990**: The Act makes provision to control pollution arising from industrial and other processes for waste management.

7.2.8 **Water Industry Act 1991**: The Water Industry Act relates to water supply and the provision of wastewater services in England and Wales.

7.2.9 **Land Drainage Act 1991 (as amended**): The Land Drainage Act 1991 requires that a watercourse be maintained by its owner. The Act provides functions to internal drainage boards and local authorities to manage watercourses and provide consenting powers for proposed works to watercourses associated with development.

7.2.10 **Water Resources Act (England and Wales) 1991 (Amended 2009):** The Water Resources Act 1991 (WRA) (as amended) sets out the responsibilities of Natural Resources Wales (NRW) and the Environment Agency (EA) in relation to water pollution, resource management, flood defence, fisheries, and navigation.

7.2.11 **Environment Act 1995**: The Environment Act sets new standards for environmental management, such as requiring national strategies for air quality and waste. It also deals with the establishment of an Environment Agency (including Natural Resources Wales and the Scottish Environmental Protection Agency).

7.2.12 **Water Act 2003:** The Water Act 2003 amends the Water Resources Act 1991 and the Water Industry Act 1991 to make provision with respect to compensation under Section 61 of the Water Resources Act 1991.

7.2.13 **Water Resources (Abstraction and Impounding) Regulations SI 2006/641**: These Regulations contain provisions relating to the licensing of abstraction and impounding of water in England and Wales in the light of amendments made by the Water Act 2003 to the Water Resources Act 1991.

7.2.14 **Flood Risk Regulations 2009:** The Flood Risk Regulations 2009 transposes the EC Floods Directive (Directive 2008/60/EC) on the assessment and management of flood risk into domestic law in England and Wales and implements its provisions. The regulations designate a Local Lead Flood Authority (LLFA) and imposes duties on NRW and Lead Local Flood Authorities to prepare a number of documents including:

a) Preliminary Flood Risk Assessments;
b) Flood hazard and flood risk maps; and
c) Flood Risk Management Plans.

7.2.15 **Environmental Damage (Prevention and Remediation) (Wales) Regulations 2009:** these regulations are based on the 'polluter pays principle and impose obligations on operators of economic activities requiring them to prevent, limit or remediate environmental damage. They apply to damage to protected species, natural habitats, sites of special scientific interest (SSSIs), water and land and implement Directive 2004/35/EC, on environmental liability.

7.2.16 **The Groundwater (England and Wales) Regulations 2009:** These regulations implement parts of the WFD that apply to groundwater (such as the Groundwater Directive). They supplement the Environmental Permitting Regulations 2010 and existing water pollution legislation.

7.2.17 **Flood and Water Management Act 2010:** The Act makes provision for water, including provision about the management of risks in connection with flooding and coastal erosion.

7.2.18 **The Water Supply (Water Quality) Regulations 2010**: These regulations provide the framework for drinking water quality in England in respect of public supplies provided by water companies and licensed water suppliers. The Drinking Water Inspectorate, acting on behalf of the Secretary of State, enforces the legislation.

7.2.19 **The Water Framework Directive (Standards and Classification) Directions England and Wales 2015**: The Water Framework Directive (WFD) Directions presents the updated environmental standards to be used in the second cycle of the Water Framework Directive (2000/60/EC) river basin management planning process in England and Wales. Environmental standards help assess risks to ecological quality of the water environment.

7.2.20 **Well-being of Future Generations (Wales) Act 2015**: The Act strengthens existing governance arrangements for improving the social, economic, environmental and cultural well-being of Wales to ensure that present needs are met without compromising the ability of future generations to meet their own needs. The Act ensures that when making decisions public bodies take into account the impact they could have on people living in Wales in the future.

7.2.21 **The Groundwater (Water Framework Directive) (Wales) Direction 2016:** this sets out instructions to Natural Resources Wales (NRW) on obligations to protect groundwater, including requirements to monitor and set thresholds for pollutants, add new pollutants to the monitoring list and change the information reported to the European Commission.

7.2.22 **The Environmental Permitting Regulations 2016**: amend the Environmental Permitting (England and Wales) Regulations SI 2010/675 in order to extend the requirement for an environmental permit to flood risk activities in addition to polluting activities included

under the previous regulations. The new permitting requirements for flood risk activities replaces the current "flood defence consent Scheme", allowing the Environment Agency and NRW to concentrate on higher risk activities. NRW is identified out as the regulator for Wales.

7.2.23 **Environment (Wales) Act 2016:** The Act puts in place the legislation needed to plan and manage Wales' natural resources in a more proactive, sustainable and joined-up way. The Act clarifies the law relating to shellfisheries, marine licencing, flood risk management and land drainage in Wales.

7.2.24 **Water Environment (Water Framework Directive) (England and Wales) Regulations 2017**: The WFD was transposed into the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017. WFD is delivered in England and Wales through a framework of River Basin Management Plans (RBMPs).

7.2.25 **The Water Abstraction and Impounding (Exemptions) Regulations 2017:** specify enactments in the Water Resources Act 1991 so that nothing in those provisions can prevent the grant of an abstraction licence. They provide for some further exemptions from the licensing restrictions under the Water Resources Act 1991.

National Planning Policy

7.2.26 **The Wales Spatial Plan (WSP)** sets out the planning agenda for Wales. Its main principle is that development should be sustainable and protect water resources and manage flood risk.

7.2.27 **Planning Policy Wales Edition 10 (December 2018):** (PPW) sets out the land use planning policies of the Welsh Government. It specifically outlines design approaches and techniques that improve water efficiency and minimise adverse impacts on water resources, surface water quality, the ecology of rivers and groundwater. It also ensures that new development is not exposed unnecessarily to flooding.

7.2.28 **Technical Advice Note (TAN) 5: Nature Conservation and Planning (2009):** TAN 5 gives advice as to the consideration of impacts on designated sites in relation to the water environment.

7.2.29 **Technical Advice Note (TAN) 15: Development and Flood Risk (2004):** TAN 15 provides technical guidance which supplements the policy set out in PPW in relation to development and flooding. It advises on development and flood risk and provides a framework for the assessment of flooding.

7.2.30 **Welsh Government: Taking Wales Forward 2016-2021**: sets out the priorities of Welsh Government. It includes priorities relating to reductions in carbon emissions, delivering improvements to trunk roads and investment in flood defence / water management.

Regional Management Plans

7.2.31 **Western Wales River Basin Management Plan (RBMP) 2015:** River Basin Management Plans (RBMPs) are drawn up for the 11 river basin districts in England and Wales as a requirement of the WFD. The plan for the Western Wales River Basin District is managed by NRW and sets out the programme of measures needed to achieve the objective of the WFD over the next six-year period (2015-2021).

7.2.32 **Western Wales Flood Risk Management Plan (FRMP) 2015**: The Western Wales FRMP was first published in 2015 by NRW. The plan gives an overview of the flood risk in the Western Wales River Basin District and set out intended priorities to manage and reduce flood risk over the next six years and beyond.

Local Planning Policy

7.2.33 **Pembrokeshire Local Development Plan (LDP) 2013-2021**: the following policies are considered relevant as part of this assessment:

GN1 General Development Policy, Point 8;

GN2 Sustainable Design, Point 3;

GN3 Infrastructure and New Development;

GN23 Minerals Working, Point 4; and

GN24 Recycled Waste Materials and Secondary Aggregates, Point 5.

7.2.34 **Pembrokeshire Local Flood Risk Management Strategy 2012**: as the lead local flood authority (LLFA), Pembrokeshire County Council has responsibility for 'local flood risks', which includes the risk of flooding from ordinary watercourses, surface runoff and groundwater. The

Council have published a draft Flood Risk Management Strategy that details responsibilities, measures, objectives and assessments of flood risk.

Relevant Guidance

7.2.35 The Environment Agency's Pollution Prevention Guidelines (PPGs) have now been revoked and in Wales are being replaced by the Guidance for Pollution Prevention (GPPs). These provide guidance on similar areas of practice and where GPPs have yet to be issued, PPGs are still promoted as best practice in order to minimise pollution impacts during construction. The relevant PPGs include:

PPG 1 Understanding your environmental responsibilities – good environmental practices;

GPP 2 Above ground oil storage tanks;

PPG 3 Use and design of oil separators in surface water drainage systems;

PPG 4 Treatment and disposal of sewage where no foul sewer is available;

GPP 5 Works and maintenance in or near water;

PPG 6 Working at construction and demolition sites;

PPG 7 Safe storage – The safe operation of refuelling facilities;

GPP 8 Safe storage and disposal of used oils;

GPP13 Vehicle washing and cleaning;

PPG18 Managing fire water and major spillages;

GPP21 Pollution incident response planning;

PPG22 Incident response – dealing with spills; and

PPG26 Safe storage – drums and intermediate bulk containers (PPG 26).

7.2.36 CIRIA Guidance used for the assessment includes:

Control of Water Pollution from Construction Sites – Guide to Good Practice (SP156);

Control of Water Pollution from Construction Sites – Guidance for Consultants and Contractors (C532);

Control of Water Pollution from Linear Construction Projects – Technical Guidance (C648);

Environmental good practice on site (C692); and

Groundwater control: design and practice (second edition) (C750).

7.3 Consultations

7.3.1 During the EIA process, a scoping report was produced which included the approach to the assessment of road drainage and the water environment. A draft version of the report was circulated for review, feedback and comment from both statutory and non-statutory consultees, see Volume 3 Appendix 4.1. The recommendations from the scoping report were incorporated into the assessment.

7.3.2 The following stakeholders were consulted throughout the assessment, both to gather baseline data and to inform the assessment:

a) Pembrokeshire County Council (PCC);
b) Natural Resources Wales;
c) Welsh Government; and
d) Landowners.

7.3.3 Consultation was undertaken with NRW regarding the geomorphological impacts and requirements for WFD assessment during a meeting and walkover of the Scheme, with a geomorphology technical specialist, on 30 June 2017. NRW and PCC have also been consulted on the risk of flooding to and as a result of the Scheme and the approach taken was agreed with both parties.

7.4 Surveys

7.4.1 The following surveys were undertaken:

Ground investigation undertaken by WYG in 2016 on behalf of the Welsh Government. Results are presented in their factual report[1]. These investigations included drilling of boreholes and installation of groundwater monitoring instrumentation. As part of these investigations three rounds of groundwater monitoring were undertaken in 2016;

A Preliminary Sources Study Report, prepared by Mott MacDonald in March 2016 to document the findings of the geotechnical and hydrogeological desk based studies carried out;

A desktop survey of available mapping and Envirocheck data[2];

[1] Welsh Government, A40 Llandewi Velfrey to Penblewin, Ground Investigation Factual Report, WYG, June 2016.
[2] Envirocheck report provided during the tender stage, dated 23rd November 2015.

An Initial Traffic and Accident Data Report[3], prepared by Arup in 2017 using data obtained from Welsh Government and Dyfed-Powys Police to document traffic numbers and accident rates;

A site walkover on 29 and 30 June 2017 by a suitably qualified geomorphologist; and

Questionnaire survey of landowners to identify features including private water supplies, abstractions and springs.

7.5 Study Area

7.5.1 The study area for the assessment includes the geographical extent of the full scope of the works, along with surface and groundwater bodies within 500m. Where effects are deemed to have the potential to extend beyond 500m (i.e. due to hydrological connections to sensitive or protected waters) the study area is extended to the point of potential effect from the Scheme. The furthest extent of the study area is limited to the point on a receiving watercourse or groundwater body whereby the significance of the effect of any potential impact is deemed to be neutral.

7.5.2 The 500m buffer was selected based on professional judgement of the potential impacts posed by the Scheme. It is in line with study areas for assessments of the impact on the water environment undertaken for other highway construction projects. Water bodies outside the 500m buffer were considered based on professional judgement of their value and connectivity to the Scheme area.

7.5.3 Water features outside of the 500m buffer that were considered but screened out of the assessment include three unnamed tributaries of Longford Brook (north of the Scheme), the Afon Marlais and seven of its unnamed tributaries (south of the Scheme). The potential for possible impacts on these water features was considered negligible based on the source – pathway – receptor basis as they would not receive flows or otherwise be affected by the proposed Scheme and therefore no pathway is present for potential impacts.

7.6 Assessment Methodology

7.6.1 The assessment was undertaken in accordance with DMRB guidance HD45/09 Road Drainage and the Water Environment (2009), which provides the methodology and criteria for identifying likely impacts of a proposed road Scheme on the water environment and predicting their

[3] Arup, Initial Traffic and Accident Data Report (2017).

magnitude and the significance of the resulting effects. There are four topic areas assessed as part of the HD45/09 approach:

1. Determining the effect from routine highway runoff on the quality of surface watercourses;
2. Determining the effect from routine highway runoff on the quality of groundwater resources;
3. Predicting the likelihood of an accidental spillage causing pollution to receiving water bodies; and
4. Assessing flood risks.

7.6.2 In addition to the topic areas set out in HD45/09 further assessment was carried out where other impacts were identified, including:

a) Assessment of the potential effects on the water environment due to construction related impacts, using a source – pathway – receptor based assessment; and

b) Assessment of effects on the groundwater resource due to the proposed excavation of highway cuttings, the creation of embankment and any potential impacts on groundwater levels; and

c) Consideration and inclusion of the findings of a standalone WFD compliance assessment, which considers any potential impacts on WFD quality elements (e.g. hydromorphology) that may cause a deterioration in the status of a quality element or prevent it from reaching good status in the future.

7.6.3 HD45/09 provides a standard methodology for the assessment of each topic area, which has four key steps:

Step 1 Identification of water features within the study area and an assessment of the importance/value/sensitivity of each of these receptors, using the criteria in Table 7.2;

Step 2 Identification of potential impacts to the water features identified in Step 1, from construction and/or operation. Under the WFD, an impact is defined as causing a deterioration in the status of a water body or preventing a water body from reaching Good status in the future;

Step 3 Assessment of the potential magnitude (Table 7.3) of any construction or operation impacts on the receptor; and

Step 4 Assessment of the overall significance of any effects to receptors due to impacts, using the matrix in Table 7.4.

7.6.4 Specific methods required by HD45/09, which only have relevance to particular construction or operation impacts, are detailed in following sections.

Baseline Methodology

7.6.5 The drainage and water environment baseline data for the study area was obtained from a combination of desktop study, walkover survey, a groundwater levels survey and consultation with relevant bodies.

7.6.6 For the surface and groundwater baseline description, information was obtained from the following sources:

a) NRW 'Water Watch Wales' (last accessed 11/09/2018)[4];
b) NRW (2015) Western Wales River Basin Management Plan;
c) Preliminary Sources Study Report, by Mott MacDonald (2016);
d) Envirocheck Report[2];
e) Online historical maps[5];
f) Lle: Welsh Government Geo-Portal (last accessed 11/09/2018)[6];
g) A site walkover with a NRW geomorphologist on 29th & 30th June 2017;
h) Consultation with relevant bodies;
i) Groundwater monitoring and ground investigation reports[7];
j) Ordnance Survey (OS) topographical maps[8];
k) The Coal Authority interactive map viewer[9];
l) The Mineral Resources Map for Wales[10];
m) Geological mapping[11]; and
n) The British Geological Survey (BGS) borehole records database[12];

7.6.7 The flood risk baseline was informed by NRW's fluvial flood mapping[13] and PCC's surface water flooding assessment[14].

[4] http://waterwatchwales.naturalresourceswales.gov.uk/en/
[5] https://www.old-maps.co.uk
[6] http://lle.gov.wales/home
[7] Welsh Government, A40 Llanddewi Velfrey – Penblewin, Ground Investigation Factual Report (June 2017).
[8] http://lle.gov.wales/home
[9] http://mapapps2.bgs.ac.uk/coalauthority/home.html
[10] http://www.bgs.ac.uk/mineralsuk/planning/resource.html#MRW
[11] http://mapapps.bgs.ac.uk/geologyofbritain/home.html
[12] http://www.bgs.ac.uk/data/boreholescans/home.html
[13] https://naturalresources.wales/evidence-and-data/maps/long-term-flood-risk/?lang=en
[14] Pembrokeshire County Council. 2010. Assessment of Surface Water Flooding: Local Development Plan, Adoption - 2021

7.6.8 Data for the accidental spillage risk baseline was obtained from the Initial Traffic and Accident Data Report[3].

7.6.9 The baseline describes the existing condition of surface and groundwater bodies, flood risk and road drainage layout within the study area. The importance or sensitivity to change is considered for each water feature. Table 7.1 sets out the attributes for each water feature considered in defining the baseline. This was adapted from HD45/09 to also take account of WFD attributes.

Table 7.1 Surface water features, their attributes and indicators of quality (adapted from HD45/09)

Feature	Attribute/Service	Indicator of quality	Possible measure
Watercourse	Water Supply/quality	Amount used for water supply (potable); Amount used for water supply (industrial/agricultural); Chemical water quality.	Location and number of abstraction points; Volume abstracted daily; Physio-chemical quality elements of WFD ecological status; Supporting hydrological regime element of WFD ecological status.
	Dilution and removal of waste products	Presence of surface water discharges and effluent discharges.	Daily volume of discharge (treated/untreated)
	Recreation	Access to watercourse; Use of watercourse for recreation.	Length of watercourse used for recreation (fishing, water sports) and number of clubs
	Biodiversity	Biological water quality	WFD ecological status class; NRW routine fish and/or invertebrate monitoring data
		Fisheries quality	Fish Status; Supporting hydromorphological element of WFD ecological status, includes geomorphology
	Value to economy	Value of use of watercourse	Length of watercourse used for recreation commercially; Number of people employed;

Feature	Attribute/Service	Indicator of quality	Possible measure
			Length of river bank developed; Length of watercourse fished commercially.
	Conveyance of flow	Presence of watercourses	Number and size of watercourses
Floodplain	Conveyance of flood flows	Presence of floodplain; Flood flows.	Developed area within extent of floodplain affected; Existing flood risk/flood return period; Location/importance of flood flow routes.
Groundwater	Water Supply/quality	Amount used for water supply (potable); Amount used for water supply (industrial/agricultural).	Location and number of abstraction points; Volume abstracted daily; Location and grade of source protection zone; WFD groundwater quantitative chemical status.
	Soakaway	Presence of soakaways or other discharges to the ground.	Location and number of discharge points; and daily volume discharged.
	Vulnerability	Groundwater vulnerability.	Classification of aquifer vulnerability.
	Economic value	Extent of use for abstractions.	Number of people employed.
	Conveyance of flow	Presence of groundwater supported watercourses; Potential for groundwater flooding; Groundwater interception by road structures or drainage.	Changes to groundwater recharge, levels or flows; Number and size of watercourses.
	Biodiversity	Presence of groundwater supported wetlands.	Changes to groundwater recharge, levels or flows; Status or classification of wetland.

Methodology for Construction Impacts

7.6.10 The assessment of construction impacts follows the guidance set out in HD45/09, which recommends that construction impacts are considered using the source – pathway – receptor approach and defers specific guidance of bridge/highway construction impacts to CIRIA 648 Control of Water Pollution from Linear Construction Projects.

7.6.11 The potential impacts of construction on surface water are assessed based on the planned construction methods and sequencing and after discussion with the contractor. Potential impacts that are considered include:

Potential surface water impacts: impacts to surface water quality from sediment runoff, spillages or discharges, impacts to flood risk, and impacts on fish or eel passage/spawning due to noise, light, vibration or physical modification.

Potential groundwater impacts: changes to groundwater levels (these impacts are assessed together with impacts due to operation of the Scheme because the operational impacts on groundwater levels largely relate to the 'as-built' physical infrastructure) and impacts on groundwater quality due to spillages and discharges during construction.

7.6.12 Where construction methods are not available, standard construction practices were assumed. Cumulative impacts as a result of construction phasing is also assessed.

7.6.13 Where measures to reduce construction impacts are considered standard practice, they are included in the Pre-CEMP (see Volume 3 Appendix 2.2). Measures above those typically used are detailed in Sections 7.10 and 7.12.

Methodology for Operational Impacts

7.6.14 An assessment of the potential impacts during operation was undertaken for the five assessment components as set out below.

7.6.15 **Surface Water Quality:** An assessment of the potential impacts of routine runoff on surface waters was undertaken to determine whether there is an environmental risk and if pollution mitigation measures are needed. The Highways Agency Water Risk Assessment Tool (HAWRAT) was used to assess short term risks from intermittent

discharge (i.e. first flush) and the tool outputs are also compared against Environmental Quality Standards (EQSs) to assess the potential for annual cumulative impacts.

7.6.16 The methodology assesses the impact of road drainage water with any pollutants it contains, based on the predicted traffic volumes, the carriageway surface area and the local climate conditions. The impact assessment methodology dealing with water quality considers potential dilution within the receiving watercourse, the morphology and sensitivity of the watercourse and any protected sites downstream of the discharge point. Baseline surface water quality monitoring is not required for the HAWRAT method, and this has therefore not been carried out.

7.6.17 **Geomorphology:** a qualitative assessment of possible impacts on the river geomorphology was undertaken based on a fluvial geomorphologist's understanding of the potential for impacts to the watercourse flow dynamics and sediment transport processes and the subsequent effects that this might have on the ecological potential of the water body. These types of impacts were assessed based on experience of previous schemes and a theoretical understanding of flow.

7.6.18 Potential geomorphological responses to any anticipated changes in flow dynamics were evaluated. The assessment was supported by consultation and a site visit with NRW officers with appropriate experience of fluvial geomorphology.

7.6.19 **Groundwater Quality:** Annex I of HD45/09 provides a methodology (Method-C) to assess the potential impact on the quality of groundwater resources from routine runoff discharges to the ground. This risk assessment procedure is based on the source-pathway-receptor (S-P-R) protocol. The principles of this approach were applied to the discharge of road drainage where:

a) The source comprises the road drainage water with any pollutants (quantified using HAWRAT) it contained as it enters any unlined ditch or watercourse, attenuation basin or soakaway discharge system that in accordance with HD45/09 has potential to transmit water through the ground to groundwater;

b) The pathway represents the processes that may modify the pollutants during transmission through the discharge system and the ground until the actual 'point of entry' to groundwater; and

c) The receptor is the groundwater.

7.6.20 For there to be a risk of impact to groundwater, all elements of the S-P-R model have to be present to create a pollutant linkage. In accordance with HD45/09, a pathway to the groundwater receptor is only considered to be feasible if the receiving watercourse at the proposed outfall has little flow during dry periods or the drainage is to a soakaway. In accordance with HD45/09 this is assessed as a Q95 flow of less than 0.001m^3/s, see Section 7.8.4, which corresponds to all four outfall locations for the proposed road drainage of the Scheme.

7.6.21 **Hydrogeology and Groundwater Resources:** a specific methodology for the assessment of potential effects of the Scheme on hydrogeology and groundwater resources is not covered by HD45/09. The method of assessment includes the following:

a) Use of desk study information, the findings from site walkover studies and ground investigations to develop a ground model, including the likely groundwater levels across the Scheme.

b) Identification of any sensitive receptors that are reliant on the current groundwater levels, such as NRW designated groundwater Source Protection Zones (SPZ), groundwater dependent terrestrial ecosystems (GWDTEs), existing abstraction wells, or spring lines that feed surface water courses.

c) Identification of potential features or activities that are proposed for the Scheme that may result in an impact on groundwater levels, such as the long-term dewatering of highway cuttings. Dependant on the rate and duration of any dewatering an abstraction licence may be required.

d) Assessment of the potential impacts on the receptors. For the proposed highway cuttings, this would include hydrogeological calculations of the likely drawdown of the water table.

7.6.22 **Accidental Spillage:** the operational pollution effects from accidental spillage were calculated using Method-D from the HD45/09 guidance. When considering the risk of spillages, the calculated spillage risk return period must not be greater than 1 in 100 years, or 1 in 200 years where spillage could affect protected areas for conservation such as Sites of Special Scientific Interest (SSSIs), Special Protection Areas (SPAs) and Special Area of Conservation (SACs).

7.6.23 For assessment of the risk posed by accidental spillage, in line with HD45/09 guidance, if the annual probability that a spillage would cause a serious pollution incident to a water body is less than 1%, then the

risk posed is considered acceptable and no further assessment was carried out.

7.6.24 The risk is assessed initially without any mitigation measures. If mitigation measures are needed to reduce the probability, a reduction factor is applied, depending on the type of mitigation applied.

7.6.25 **Flood Risk:** the assessment of potential flood impacts was undertaken in accordance with NRW flood mapping and TAN15. The design of the highway drainage has followed the principles of DMRB. A technical note identifying the risks imposed by the Scheme in relation to flooding was prepared and was agreed with NRW and PCC (Volume 3 Appendix 7.2).

7.7 Significance Criteria

7.7.1 The significance of effects on the water environment is based on the methodology contained within the HD45/09 guidance, Annex IV. The importance or sensitivity of the affected receptor is combined with the magnitude of any effects to define the significance of the effects. Potential effects not covered by this guidance - chiefly related to geomorphology and WFD compliance - were assessed using the supplementary methods explained in the sections above.

7.7.2 For risks posed to the water environment, the significance of the effects was assessed based on the importance/sensitivity of the affected receptor in combination with the magnitude of any effects.

Environmental Value (or Sensitivity) of Resource / Feature

Table 7.2 Criteria for estimating the importance of environmental attributes (adapted from HD45/09, Annex 1, Table A4.3)

Importance	Criteria	Examples
Very High	Attribute has a high quality and rarity on regional or national scale	**Surface Water:** EC Designated Salmonid/ Cyprinid fishery. WFD Class 'High' Site protected/designated under EC or UK habitat legislation (SAC, SPA, SSSI, WPZ, Ramsar site, salmonid water)/ Species protected by EC legislation **Groundwater:** Principal aquifer providing a regionally important resource or supporting site protected under EC and UK habitat legislation SPZ1 **Flood Risk:** Floodplain or defence protecting more than 100 residential properties from flooding

Importance	Criteria	Examples
High	Attribute has a high quality and rarity on local scale	**Surface Water:** WFD Class 'Good' Major Cyprinid Fishery, Species protected under EC or UK habitat legislation **Groundwater:** Principal aquifer providing locally important resource or supporting river ecosystem SPZ2 **Flood Risk:** Floodplain or defence protecting between 1 and 100 residential properties or industrial premises from flooding
Medium	Attribute has a medium quality and rarity on local scale	**Surface water:** WFD class 'Moderate'; **Groundwater:** Aquifer providing water for agriculture use. **Flood risk:** Floodplain or defence protecting 10 or fewer industrial properties from flooding
Low	Attribute has a low quality and rarity on local scale	**Surface water:** WFD class 'Poor'; **Groundwater:** unproductive strata; **Flood risk:** Floodplain with limited constraints and low probability of flooding.

Magnitude of Impact

7.7.3 The magnitudes of potential effects were assessed using the criteria set out below.

Table 7.3 Estimating the magnitude of an impact on an attribute (adapted from HD45/09, Annex 1, Table A4.4 to include geomorphological examples)

Magnitude	Criteria	Typical Example
Major Adverse	Results in loss of attribute and/or quality and integrity of the attribute.	Surface Water: Failure of both soluble and sediment bound pollutants in HAWRAT and compliance failure with EQS values. Calculated risk of pollution from accidental spillage >2% annually. Loss or extensive change to a fishery. Loss or extensive change to a designated Nature Conservation Site. Major impedance or disruption of natural geomorphological processes. Loss of, or permanent impacts to, in-channel geomorphological features. Likelihood of scour and/or bank erosion that would require installation of hard revetment during the design life of the Scheme over a significant stretch of river.

Magnitude	Criteria	Typical Example
		Expected deterioration in WFD status or prevention of achievement of 'Good' status. Permanent loss of critical or sensitive habitat. Groundwater: Loss of, or extensive change to, an aquifer. Potential high risk of pollution to groundwater from routine runoff (>250). Calculated risk of pollution from accidental spillage >2% annually. Expected deterioration in WFD status or prevention of achievement of 'Good' status. Flood Risk: Increase in peak flood level (1% annual probability) >100mm
Moderate Adverse	Results in effect on integrity of attribute, or loss of part of attribute	Surface Waters: Failure of both soluble and sediment-bound pollutants in HAWRAT but compliance with EQS values. Risk of pollution from spillage >1% annually and <2% annually. Partial loss in productivity of a fishery. Effect on the integrity of the existing flora and fauna. Effects on the occurrence of natural geomorphological processes. Effects on the size and/or quality of geomorphological features. Risk of scour and/or bank erosion that would require installation of bioengineering during the design life of the Scheme at a localised level. Moderate impact on WFD quality element with no anticipated reduction in WFD status. Partial loss of critical or sensitive habitat. Groundwater: Partial loss or change to an aquifer. Potential medium risk of pollution to groundwater from routine runoff (score 150-250) Calculated risk of pollution from spillage >1% annually and <2% annually. Partial loss of the integrity of groundwater supported designated wetlands. Moderate impact on WFD quality element with no anticipated reduction in WFD status. Flood Risk: Increase in peak flood level (1% annual probability) >50mm.
Minor Adverse	Results in some measurable change in attributes	Surface Waters: Failure of either soluble or sediment-bound pollutants in HAWRAT. Risk of pollution from spillage >0.5%.

Magnitude	Criteria	Typical Example
	quality or vulnerability.	Low risk of scour and/or bank erosion. Minor impact on WFD quality element with no anticipated reduction in WFD status. Groundwater: Potential low risk of pollution to groundwater from routine runoff (risk score <150). Minor impact on WFD quality element with no anticipated reduction in WFD status. Flood Risk: Increase in peak flood level (1% annual productivity) >10mm.
Negligible	Results in effect on attribute but of insufficient magnitude to affect the use or integrity	Surface Water: No risk identified by HAWRAT (pass both soluble and sediment-bound pollutants). Risk of pollution from accidental spillages <0.5% annually. No change to geomorphological processes or forms and no new risks introduced. No change in WFD status, potential to achieve WFD objectives or habitat impacts. Groundwater: No predicted change in quality of any type of aquifer Risk of pollution from accidental spillages <0.5% annually. No change in WFD status or potential to achieve WFD objectives. Flood Risk: Negligible change in peak flood level (1% annual probability) <±10mm.
Minor Beneficial	Results in some beneficial effect on attribute or a reduced risk of negative effect occurring	Surface water: HAWRAT assessment of either soluble or sediment-bound pollutants becomes a Pass from an existing site where the baseline was a Fail condition. Calculated reduction in existing spillage risk by 50% or more (when existing spillage risk is <1% annually) (Method-D). Minor enhancements to geomorphological features or riparian habitat to support natural geomorphological processes. Delivery of WFD enhancements that provide ecosystems benefits but are unlikely to contribute directly to improving WFD status. Groundwater: - Calculated reduction in existing pollution risk from accidental spillages by 50% or more to an aquifer (when existing spillage risk is <1% annually) (Method-D). Delivery of WFD enhancements that provide some benefit but are unlikely to contribute directly to improving WFD status. Flood Risk: Reduction in peak flood level (1% annual probability) >10mm.

Magnitude	Criteria	Typical Example
Moderate Beneficial	Results in moderate improvement of attribute quality	Surface Water: HAWRAT assessment of both soluble and sediment bound pollutants Pass from an existing site where the baseline was a Fail condition. Calculated reduction in existing spillage by 50% or more (when existing spillage risk >1% annually) (Method-D). Significant enhancements to geomorphological features or riparian habitat to support natural geomorphological processes. Delivery of WFD enhancements that contribute to improving WFD status. Groundwater: - Calculated reduction in existing pollution risk from accidental spillages by 50% or more to an aquifer (when existing spillage risk >1%) (Method-D). Delivery of WFD enhancements that contribute to improving WFD status. Flood Risk: Reduction in peak flood level (1% annual probability) >50mm.
Major Beneficial	Results in major improvement of attribute quality	Surface Water: Removal of existing polluting discharge, or removing the likelihood of polluting discharge occurring to a watercourse. Restoration of natural geomorphological processes and forms where they are currently impeded or degraded. Improvement in WFD status. Groundwater: Removal of existing polluting discharges to an aquifer or removing the likelihood of polluting discharges occurring. Recharge of an aquifer. Improvement in WFD status. Flood Risk: Reduction in peak flood level (1% annual probability) >100mm.

Significance of Effect

7.7.4 The significance of potential effects was then determined using Table 7.4, by comparison of the identified importance/sensitivity of the receptors with the estimated magnitude of the effect. Effects were either beneficial or adverse, as defined in Table 7.5. It is considered that significance values of Moderate adverse and above are defined as significant potential effects, and mitigation measures are necessary.

Table 7.4 Estimating the significance of potential effects (extract from HD45/09, Annex 1, Table A4.5)

		Magnitude of Impact			
		Negligible	**Minor**	**Moderate**	**Major**
Importance of Attribute	**Very High**	Neutral	Moderate / Large	Large / Very Large	Very Large
	High	Neutral	Slight / Moderate	Moderate /Large	Large / Very Large
	Medium	Neutral	Slight	Moderate	Large
	Low	Neutral	Neutral	Slight	Slight / Moderate

7.7.5 The definitions of the significance values are further explained in Table 7.5.

Table 7.5 Definitions of significance values

Score	Comment
Very Large Adverse	Where the proposed Scheme would result in degradation of the water environment because it results in predicted very significant adverse impacts on at least one water attribute.
Large Adverse	Where the proposed Scheme would result in degradation of the water environment because it results in predicted highly significant adverse impacts on a water attribute.
Moderate Adverse	Where the proposed Scheme may result in the degradation of the water environment because it results in predicted moderate adverse impacts on at least one attribute.
Slight Adverse	Where the proposal may result in a degradation of the water environment because it results in a predicted slight impact on one or more attributes. More than one attribute may be affected.
Neutral	Where the net impact of the proposed Scheme is neutral, because it results in no appreciable effect, either positive or negative, on the identified attributes.
Slight Beneficial	All other situations where the proposed Scheme provides an opportunity to enhance the water environment or provide an improved level of protection to an attribute.
Moderate Beneficial	Where the proposed Scheme provides an opportunity to enhance the water environment because it results in a moderate improvement for an attribute.
Large Beneficial	It is unlikely that any proposed Scheme incorporating the construction of a new or improved trunk road would fit into this category. However, proposals could have a large positive impact if it is predicted that it would result in a 'very' or 'highly' significant improvement to a water attribute(s), with insignificant adverse impacts on other water attributes.

7.8 Limitations and Assumptions

7.8.1 Assessment of the drainage and the water environment aspects of the Scheme were carried out in accordance with HD45/09, and supplementary methods as explained in the above sections for potential impacts not covered by this guidance.

7.8.2 Limitations and assumptions associated with the recommended methods are discussed below.

Surface Water

7.8.3 The accuracy of the baseline condition described in the assessment is dependent upon the accuracy of information obtained from NRW and its 'Water Watch Wales' website.

7.8.4 For the HAWRAT model flow data is required. Due to the lack of flow data available for the watercourses in the study area, the Q95 flow was estimated using the method in the Institute of Hydrology (IOH) Report No. 108[15]. Where the Q95 estimated is < 0.001 m^3/s, in accordance with HD45/09 guidance, a Q95 of 0.001 m^3/s is used.

7.8.5 The water hardness parameter for HAWRAT was obtained from the Drinking Water Inspectorate (DWI) map which shows the rate of water hardness. This data is considered to be appropriate to use in the absence of chemical data for each watercourse. It is assumed that local potable water would have a similar hardness characteristic as the local surface water and the three water hardness levels used by the HAWRAT model are based on broad ranges.

7.8.6 The threshold limits for soluble zinc and copper and for sediments are based on the limits set by the HAWRAT model.

7.8.7 The Annual Average Daily Traffic (AADT) used for the HAWRAT model was based on data from the Initial Traffic and Accident Data Report[3].

7.8.8 The geomorphological assessment is a qualitative assessment of the risk, type and severity of potential geomorphological adjustment as a result of the development including construction activities.

7.8.9 In the absence of drawings, it was assumed based on evidence from the site walkover that the existing route of the A40 is drained via conventional kerbs and gullies that discharge to local water courses with no attenuation.

Groundwater

7.8.10 The Method-C assessment results in a significance of effect that is relevant to the specific locality of the point of discharge, which is not relevant to the wider groundwater body due to dilution effects.

[15] Institute of Hydrology Report No. 108: Low flow estimation in the United Kingdom. Available at: http://nora.nerc.ac.uk/6050/1/IH_108.pdf

Supplementary risk assessment is proposed to overcome this situation if it arises.

7.9 Baseline Conditions

Surface Water

7.9.1 Surface water features identified within the study area are shown on Volume 2 Figure 7.1 A&B and include:

a) Longford Brook and a number of its unnamed tributaries. Longford Brook and an unnamed tributary are crossed approximately midway along the proposed route at Ffynnon Farm and Pen-troydin-fach. Other tributaries, generally to the north and west of the Scheme, are within the 500m study area;

b) The Afon Daulan and a number of its unnamed tributaries. The Afon Daulan and an unnamed tributary are crossed by the proposed route to the north of Llanddewi Velfrey, near Pen-troydin-fawr. Another tributary to the northeast of the Scheme, is within the 500m study area;

c) The Afon Marlais and a number of its unnamed tributaries. The Afon Marlais itself is at its closest 80m from the Scheme's western edge. The catchment is parallel to the southern boundary of the existing route of the A40;

d) Two unnamed tributaries of the Afon Taf, which are not crossed by but are within 200m and 500m from the eastern boundary of the proposed route;

e) Seven ponds at grid references SN 14315 16763, SN 13051 16396, SN 12163 17049 (Caermaenau-Fawr), SN 13415 17249, SN13255 17346 (both Pen-ca'rmaenau), SN 15133 16968 and SN 120665 16574 (Pen-blewyn); and

f) Springs at multiple locations. As the proposed route spans the watershed between multiple catchments, the watercourses described above arise across the study area, with the majority indicated on OS mapping as being spring-fed.

7.9.2 Six ponds (labelled 1-6 on Volume 2 Figure 7.1 A&B) are excluded from the assessment as no pathways are known to exist that could result in a change to the quality or quantity of waters as a result of the Scheme. The pond immediately south of Penblewin roundabout (Pond 7 on Volume 2 Figure 7.1A) is retained in the assessment due to its proximity to the Scheme.

7.9.3 Flow data for the watercourses in the vicinity of the Scheme are not available from the National River Flow Archive[16] or the NRW river levels website[17].

7.9.4 Consented discharges to surface waters within the study area, as identified by the Envirocheck report, include:

a) Discharge from Llanddewi Velfrey Sewage Treatment Works into a tributary of Pont-Shan Brook, approximately 200m south of the Scheme; and

b) Discharge to the Afon Marlais from Pantygorphwys-Uchaf, 350m from the western end of the Scheme.

7.9.5 The proposed route of the Scheme broadly follows the watershed between the Longford Brook, Taf and Marlais catchments with areas south of the Scheme draining to the south and areas to the north draining northwards.

7.9.6 From site walkover, aerial imagery and mapping, the existing highway drainage is believed to discharge to local watercourses. No pollution control or attenuation measures are known to be present and none were encountered during the site walkover. The existing highway drainage is assumed to discharge to watercourses at the following locations:

a) The section from Penblewin roundabout to Henllan Lodge appears to drain to a low point approximately 350m to the east of the existing roundabout, with water discharged via an outfall to an existing watercourse to the south (NGR: SN123166), a tributary of the Afon Marlais.

b) The section between Henllan Lodge and the eastern edge of Llanddewi Velfrey (approximately 2km) appears to drain to a low point in Ffynnon Woods, prior to discharge into Longford Brook.

c) Following this, topography indicates the road drainage likely falls across an approximately 350m section of road towards a low point located near Glenfield, which looks likely to drain to the north to a tributary of the Afon Daulan.

d) The following section to the eastern tie in drains to a low point located mid-way between Bethel Cottage and Gwyndy Farm. From here, the highway drains into the adjacent watercourse to the south. Two existing headwalls were encountered at this location on site visits (NGR: SN161169).

[16] National River Flow Archive. Accessed at: www.nrfa.ceh.ac.uk on 28th July 2017.
[17] Natural Resources Wales: River Level Map. Accessed at: https://naturalresources.wales/riverlevels?lang=en on 28th July 2017.

Groundwater

7.9.7 Groundwater features identified in the study area are shown on Volume 2 Figure 7.2 A&B and described in Table 7.6.

Table 7.6 Groundwater features in the study area

Chainage	Feature	Location
0+200	Well at Caermaenau-Fawr	350m to the north of the western end of the Scheme
1+600	Well	10m north of the Scheme alignment
1+630	Well	25m south of Scheme alignment
1+780	Well	90m north of Scheme alignment
2+220	Well at Pentroydin Fawr, registered as a private water supply	70m north of Scheme alignment
3+150	Licensed abstraction (No. 356) at Blaen-Pentroydin from enclosed well	250m south of Scheme alignment
3+660	Four private water supplies; no further details available	150m north of Scheme alignment

7.9.8 The bedrock underlying the Scheme is classified as a Secondary B aquifer and with superficial deposits, present in the valley bottom of Longford Brook.

7.9.9 There are no mapped Source Protection Zones (SPZ) within the study area. Unmapped 50m SPZ1 exist around all potable water supplies.

7.9.10 Groundwater Dependant Terrestrial Ecosystems (GWDTE), defined as wetlands which critically depend on groundwater flows and/or chemistries[18], have not been identified within the study area.

7.9.11 The Scheme would require two significant areas of cutting to the north and east of Llanddewi Velfrey. Springs are marked in these areas, indicating the groundwater is likely to be present at a shallow depth. Groundwater monitoring data was obtained as part of the 2016

[18] Schutten, Verweij, Hall & Scheidleder, 2011. Common Implementation strategy for the Water Framework Directive (2000/60/EC). Technical report No. 6. Technical report on Groundwater Dependent Terrestrial Ecosystems. ISBN: 978-92-79-21692-3

investigation and is presented in the WYG factual report[19] and was assessed to confirm the hydrogeological model for the Scheme area.

7.9.12 Chapter 6 Geology and Soils contains a detailed discussion of the underlying geology and ground conditions of the Scheme.

Water Framework Directive

7.9.13 The study area includes three WFD river water bodies and two WFD groundwater bodies, shown on Volume 2 Figure 7.5 A&B. These are:

a) Taf – Felin Cwrt to Gronw river water body;
b) Longford Brook – Headwaters to confluence with Eastern Cleddau river water body;
c) Marlais – headwaters to confluence with Taf river water body;
d) Tywi, Taf and Gwendraeths groundwater body; and
e) Cleddau and Pembrokeshire groundwater body.

7.9.14 The current status, failing elements and reasons for failure of each of these WFD water bodies is summarised in Table 7.7.

7.9.15 A WFD Protected Area, the Cleddau Rivers SAC, is approximately 5km downstream of the proposed crossing of Longford Brook. The SAC is designated due to the presence of Bullhead, River Lamprey, Brook Lamprey, Otter and Sea Lamprey, along with rare habitats including rivers with floating vegetation often dominated by water-crowfoot, active raised bogs and alder woodlands on floodplains. This chapter considers the potential impacts to the waterbodies' WFD classification and the related quality criteria; potential impacts to the site and associated ecology are addressed in Chapter 8 Ecology and Nature Conservation and the Assessment of the Implications on European Sites (AIES).

7.9.16 A standalone WFD compliance assessment (Volume 3 Appendix 7.1) was completed for the Scheme.

[19] WYG, 2016 (as ref: 49 above)

Table 7.7 Summary of WFD water bodies in the study area. Information relevant for Cycle 2 of the WFD (2015-2021) and obtained from http://waterwatchwales.naturalresourceswales.gov.uk/en/ (Accessed on 11th September 2018).

WFD Waterbody	**Taf -Felin Cwrt to Gronw**	**Longford Brook - HW to confluence with E. Cleddau**	**Marlais - headwaters to confluence with Taf**	**Tywi, Taf and Gwendraeths**	**Cleddau and Pembrokeshire**
ID	GB110060036283	GB110061030680	GB110060029240	GB41002G200500	GB41002G200400
Type of Waterbody	River	River	River	Groundwater	Groundwater
Management Catchment	Carmarthen Bay and the Gower	Cleddau and Pembrokeshire Coastal Rivers	Carmarthen Bay and the Gower	WA South West	WA South West
Area (km^2)	41.42	14.54	26.63	1,947.43	1,115.63
HMWB/AWB?	No	No	No	No	No
Overall Status	Good	Moderate	Moderate	Poor	Poor
Objective	NA	Good by 2021	Good by 2021	Poor by 2015	Good by 2021
Chemical Status	Good	Good	Good	Poor	Poor
Ecological Status (river), Quantitative Status (groundwater)	Good	Moderate	Moderate	Good	Good
Driver of failure to achieve Good status	NA	Fish	Ammonia (Phys-Chem)	Chemical Dependent Surface Water Body Status	Chemical GWDTEs test
Reason for not achieving Good status	NA	Other (not on list)	Unknown	Point source pollution from abandoned mines.	Unknown
Other (including Mitigation Measures)	Dwr Cymru to investigate sources, transport and pathways of microbial pollution to Shellfish Waters as part of AMP 6 NEP programme. NRW to regulate.	Reduce diffuse source pollution at source by controlling or managing diffuse source inputs. Cleddau Rivers SAC at downstream end of catchment.			

Flood Risk

7.9.17 The route of the Scheme is not at risk of flooding from rivers and sea, based on NRW's flood map viewer[20].

7.9.18 Limited areas in the vicinity of watercourse crossings and along the proposed western section with the same alignment as the existing A40 are classified as having a low to medium surface water flood risk[21]. A low risk of surface water flooding equates to a chance of flooding of between 1 in 1000 and 1 in 100 years, whilst a medium risk equates to a chance of between 1 in 100 and 1 in 30 years. These areas are shown on Volume 2 Figure 7.4.

7.9.19 The Western Wales Flood Risk Management Plan and PCC's Flood Risk Management Strategy do not indicate any measures to reduce flood risk in the study area.

7.9.20 All areas of the Scheme route are designated as Zone A on Welsh Government's TAN15 mapping. Areas designated as Zone A are considered to be at little or no risk of fluvial or coastal/tidal flooding.

Accidental Spillage

7.9.21 Records of accidental spillage into the water environment from road accidents have not been identified.

7.9.22 As part of the Initial Traffic and Accident Data Report, an analysis of the Road Traffic Accidents in the area was undertaken to determine if there are any particular accident trends on the road network at or near the proposed Scheme location.

7.9.23 There were a total of 20 accidents recorded within the study area for the five-year period between 2011 and 2015 at various locations along the road. Accident rates along this section of the existing A40 are lower than the average default accident rate for this type of road[22].

[20] NRW Risk of Flooding from Rivers & Sea Map. Accessed at https://naturalresources.wales/our-evidence-and-reports/maps/flood-risk-map/?lang=en on 16th March 2017.
[21] NRW Surface Water Flood Risk Map. Accessed at https://naturalresources.wales/our-evidence-and-reports/maps/flood-risk-map/?lang=en on 16th March 2017.
[22] Arup, Initial Traffic and Accident Data Report, Table 4.9. Produced in September 2017.

Environmental Value of Water Features

7.9.24 Table 7.8 identifies the water features identified in the study and ascribes them a value for the assessment (see Table 7.2 for description of the values)

Table 7.8 Value of Water Features with the potential to be impacted. Features within the study area that have no potential to be impacted (e.g. those which are not hydrologically connected to the Scheme area) are excluded.

Feature Name	Chainage	Value	Justification
Surface Waters			
Pond at SN 12065 16574 (Penblewin Roundabout)	0+000	Low	No hydrological connections or known ecological importance. Included as <100m from Scheme area.
Unnamed tributary of Afon Marlais 2	0+290	Low	Drains to tributary of Afon Marlais (WFD status Moderate). Drain with limited ecological value.
Longford Brook	1+800	Medium	Drains to WFD waterbody of Moderate Status. Designated as SAC downstream and capable of supporting fish species.
Unnamed tributary of Longford Brook 1	2+050	Low	Drains to Longford Brook (Moderate WFD status). Drain with limited ecological value.
Unnamed tributary of Afon Daulan 1	2+640	Low	Drains to Afon Daulan (tributary of Taf - WFD status Good). Drain with limited ecological value.
Unnamed tributary of Afon Daulan 2	2+900	Low	Drains to Afon Daulan (tributary of Taf - WFD status Good). Drain with limited ecological value.
Afon Daulan	3+150	Medium	Drains to Taf (WFD status Good). Capable of supporting fish species.
Unnamed tributary of Afon Daulan 3	3+270	Low	Drains to Afon Daulan (tributary of Taf - WFD status Good). Drain with limited ecological value.
Unnamed tributary of Afon Daulan 4	3+400	Low	Drains to Afon Daulan (tributary of Taf - WFD status Good). Drain with limited ecological value.
Unnamed tributary of Afon Taf 1	3+800	Low	Drains to Afon Taf (WFD status Good). Minor stream with limited ecological value.
Unnamed tributary of Afon Taf 2	3+850	Low	Drains to Afon Taf (WFD status Good). Minor stream with limited ecological value.
Unnamed tributary of Afon Marlais 1	4+250	Low	Drains to tributary of Afon Marlais (WFD status Moderate). Drain with limited ecological value.
Groundwater			
Wells marked on OS mapping	0+200	Medium	Potential use for agricultural water supply.
	1+600		

Feature Name	Chainage	Value	Justification
	1+630 1+780		
Well at Pen-troydin-Fawr	2+220	High	Registered as private water supply.
Licensed abstraction at Blaen-Pen-troydin	3+150	Medium	Potential use for agricultural water supply.
Unnamed private water supplies	3+660	High	Registered as private water supply.
Tywi, Taf and Gwendraeths WFD water body	Eastern portion of route	Medium	Secondary B Aquifer
Cleddau and Pembrokeshire WFD water body	Western portion of route	Medium	Secondary B Aquifer
Flood Risk (water features receiving runoff or being physical modified by the Scheme only)			
Unnamed tributary of Afon Marlais 2	0+290	Low	There are no properties in the vicinity of the proposed culvert.
Longford Brook	1+800	Low	Nearby properties are not located in any flood zones.
Unnamed tributary of Afon Daulan 1	2+640	Low	There are no properties in the vicinity of the proposed culvert.
Unnamed tributary of Afon Daulan 2	2+900	Low	There are no properties in the vicinity of the proposed culvert.
Afon Daulan	3+150	Low	There are no properties in the vicinity of the proposed culvert.
Unnamed tributary of Afon Daulan 3	3+270	Low	There are no properties in the vicinity of the proposed culvert.
Unnamed tributary of Afon Marlais 1	4+250	Low	There are no properties in the vicinity of the proposed outfall.
Groundwater	N/a	Low	There is no history of groundwater flooding along the proposed alignment.

7.10 Mitigation Measures Forming Part of the Scheme Design

7.10.1 The design philosophy of the carriageway drainage includes a series of mitigations to ensure that flood risk in not increased in the vicinity of the Scheme and to ensure that soluble and suspended pollutants in carriageway runoff are reduced to acceptable levels prior to discharge to groundwater or local watercourses. These mitigations are described in the paragraphs below

and key features are shown on the General Arrangement drawings for the Scheme (Volume 3, Appendix 2.6).

7.10.2 Where possible, highway runoff would be infiltrated into the ground using attenuation/ infiltration basins. If infiltration is not possible, surface water runoff would be restricted to the 1-year return period Greenfield Runoff Rate and discharged into a local watercourse.

7.10.3 Attenuation would be provided in basins, sized to accommodate the 1 in 100-year event plus 30% to allow for climate change. This allowance was agreed with PCC.

7.10.4 Where a new drainage system is to be provided, or where an existing drainage network is to connect into the proposed network, the restricted flow would include the 1 in 1-year flow from the existing highway as well as the Greenfield Runoff Rate from the new highway.

7.10.5 Where the Scheme crosses watercourses flows would be maintained within their catchment through culverts where possible. These culverts would be designed to convey flow equivalent to the 100-year event plus 30% allowance for climate change beneath the proposed highway. Where the catchment area draining to the cross-drainage culvert is not readily defined, the minimum culvert diameter would be 1200mm in accordance with the DMRB.

7.10.6 The carriageway drainage would consist of a three-stage treatment train of filter drains, catch-pits and attenuation basins to remove and retain soluble and suspended pollutants to ensure discharges to groundwater or local watercourses are at acceptable levels.

7.10.7 A positive drainage system would be provided for the Scheme which would ensure that there is no surface water flooding for a 1 in 5-year return period event. This design standard is in accordance with DMRB which includes an allowance for climate change.

7.10.8 In cuttings, the surface runoff would be drained to combined surface water/ groundwater filter drains in the verge. Water drained in areas of cutting will be discharged via deep gravity systems.

7.10.9 Cut-off ditches at the top of cuttings and at the bottom of embankments would intercept natural runoff. If the natural topography falls away from the road alignment, cut-off ditches would not generally be provided other than to mitigate local flooding risk.

7.10.10 Any existing land drains encountered would be intercepted and diverted to cut-off ditches.

7.10.11 Attenuation/infiltration basins would be designed to ensure that groundwater would not impede their performance.

7.11 Assessment of Potential Effects

7.11.1 Linear construction projects, such as roads, have the potential to intersect a number of surface and groundwater features and create pollution sources or pathways that are not present under existing conditions.

7.11.2 Potential effects of roads on the water environment can be split into direct or indirect effects and occur as a result or construction, operation or a combination of construction and operation. Typically, these effects are grouped into temporary, short-term construction effects and permanent, long-term operational effects, although short and long-term effects can occur as a result of both construction and operation activities.

7.11.3 The mobilisation of existing contaminants is a potential effect during both construction and operation and is considered in Chapter 6 Geology and Soils.

7.11.4 The impact on designated sites with hydrological linkages are assessed in Chapter 8 Ecology and Nature Conservation.

Potential Effects during Construction

7.11.5 The assessment of the effects on the water environment considers possible changes to the water environment during the construction phase. In line with the DMRB methodology, the significance of the effects would depend on a combination of the potential for pollution and flooding and the sensitivity of the receptor.

Surface Water Quality

7.11.6 The most likely sources of water quality impacts to surface watercourses are:

a) Disturbance of silt/soil generating surface runoff with high sediment concentrations (mobilised suspended solids);

b) Accidental spillage of fuels, oils, chemicals and materials (e.g. concrete, plant fuels/oils, lubricants, hydraulic fluids and floating solids such as litter) resulting in pollution of watercourses and potential impacts on fish and downstream ecological designated features; and

c) Dewatering discharges containing high levels of suspended solids.

7.11.7 These risks of pollution impacts (silt/sediment and spills) are heightened during particular activities located in or near to watercourses or ponds, including but not limited to the construction of various culverts along the proposed route and the embankment in the vicinity of the Afon Daulan crossing.

7.11.8 These areas are most at risk when exposed soil is present, such as shortly before, during and after construction of culverts and embanked areas. Without control measures, the risk of runoff from exposed soil would remain until vegetation is established, which would take generally one growing season.

7.11.9 The risk of surface water flooding causing an uncontrolled release of sediments and/or waters from the surface water management system would be present over the construction sequence. Over much of the construction cycle, the potential for pollutants in these waters are limited to sediments from runoff and hydrocarbons spilled from vehicles, but during higher risk activities (e.g. concrete pouring), these impacts have the potential to be greater.

7.11.10 A common constraint of linear construction projects such as this is the limited area to store and, if needed, treat surface water runoff across the site. A potential impact of insufficient storage capacity is that the surface water management system could be overwhelmed during a rainfall event, causing an uncontrolled release of sediments and/or pollutants to surface watercourses.

7.11.11 The magnitude of these impacts would be moderate adverse and short term in timeframe. For all unnamed surface water features that would receive runoff from the Scheme, the significance of effect would be *slight adverse*, whilst the significance of effect on the Afon Daulan and Longford Brook would be *moderate adverse.*

Geomorphology

7.11.12 Plant trafficking, excavation or construction activities within or near to watercourses have the potential to cause bank failure, erosion or scouring and modification of geomorphological features.

7.11.13 Mobilisation of silts, during excavation, work on the river banks or by surface water runoff from bare areas, could result in washing of sediment into watercourses and cause siltation within any riverbed gravels. Clogging of river gravels by silt would reduce in-stream habitat quality. The effects of siltation could be medium term, as high flows are required to remobilise the silt and flush it downstream.

7.11.14 The potential magnitude of temporary geomorphological impacts is anticipated to be minor adverse, due to the potential impact on the water body WFD quality elements. This is because the impacts on morphological status within the water body are localised and wider impacts would be temporary. The significance of effect would therefore be *neutral* for all unnamed watercourses and *slight/moderate adverse* for the Afon Daulan and Longford Brook.

Groundwater

7.11.15 Sources of potential pollutants to groundwater include spills (e.g. fuel from vehicles/plant) or from water contaminated during specific activities, such as concrete pouring/washing. Potential pathways for these pollutants include direct infiltration at source or in the case of spillages, infiltration from the surface water management system during periods of low flow.

7.11.16 The potential magnitude of the risk of contamination is considered to be minor adverse due to a likely localised and temporary nature of potential impact (subject to good practice being implemented) and when combined with the classification of medium importance, the significance of effect associated with temporary activities is considered to be *slight adverse*.

7.11.17 The potential impact on groundwater quality resulting from land contamination is considered in Chapter 6 Soils and Geology.

7.11.18 Dewatering activities related to the construction of cuttings also have the potential to impact on groundwater. An assessment of this potential is presented in the WFD Compliance Assessment: Appendix B5. This showed a potential impact on the base flow of Unnamed tributary of Afon Daulan 1

at chainage 2+640 (Feature ID 22 on Volume 2 Figure 7.2 A&B) as a result of dewatering works at cutting at chainage 2+720 to 2+950. The potential magnitude of impact is moderate as groundwater recharge into that stream would be reduced, without a significant impact on the wider catchment of the Afon Daulan. Based on the low sensitivity of that watercourse, the significance of effect associated with dewatering works is considered to be *slight adverse*. No potential impacts upon private water supplies were noted.

Flood Risk

7.11.19 During construction, no effects on flood risk are expected provided that where works take place in the vicinity of watercourses, material and plant is stored beyond the areas potentially susceptible to flooding. New or extended culverts will be sufficiently sized to accommodate flood flows, as per Section 7.10.5.

7.11.20 Temporary works to divert watercourses during culvert construction, either by gravity flumes or over pumping will include suitable provisions to pass high flows.

7.11.21 The magnitude of the risk of flooding is negligible and when combined with the low importance (in terms of flood risk) of existing water features, the significance of effect is considered to be *neutral*.

Potential Effects during Operation

7.11.22 This section considers effects on the water environment when the Scheme is in operation. Similar to the assessment for the construction phase, the significance of the effects would depend on a combination of the potential for pollution and flooding as well as the sensitivity of the receptor.

Surface Water Quality

7.11.23 The most likely sources of water quality impacts to surface watercourses from the operation of the scheme are:

a) Pollution associated with routine runoff; and
b) Accidental spillage as a result of a road traffic collision.

7.11.24 The drainage design of the Scheme directs runoff from the carriageway to four attenuation basins prior to discharge into surface waters via four new outfalls. Wherever possible, runoff will be allowed to infiltrate to groundwater ahead of discharge to surface waters. The locations of the

outfalls and receiving water bodies are illustrated in Volume 2 Figure 7.3 and listed in Table 7.9. Water features that will not receive runoff are scoped out of this assessment.

Table 7.9 Discharge locations used for HAWRAT Assessments

Outfall	Chainage	Receiving Watercourse
Basin A	0+400	Unnamed tributary of Afon Marlais 2
Basin B	1+900	Longford Brook
Basin C	2+900	Unnamed tributary of Afon Daulan 1
Basin D	4+250	Unnamed tributary of Afon Marlais 1

7.11.25 Method-A of HD45/09 ('Simple Assessment') was used to assess the operational effects of the road surface runoff from the four proposed outfalls (Volume 2 Figure 7.3). A cumulative assessment of impacts has not been undertaken as the outfalls either discharge to separate waterbodies or are greater than 1km apart. The methodology, inputs and detailed results used in this assessment is presented in the WFD Compliance Assessment: Appendix B1.

7.11.26 The predicted traffic data for the proposed Scheme is 11,241 AADT in 2017 and 13,050 AADT in 2051[3], which is within the lowest range used in the HAWRAT assessment of between 10,000 and 50,000 AADT. On this basis, the assessments carried out for the Scheme are likely to overstate the potential risk to surface water quality.

7.11.27 The surface water quality of the undiluted runoff for all sections on the road fail Step 1 of the assessment because levels of sediment and dissolved metals in the runoff are above the threshold levels set in the HAWRAT model.

7.11.28 At Step 2, the surface water quality passes the HAWRAT assessment at Basin B and for zinc at Basin D but fails on all other counts for both sediment and dissolved metals.

7.11.29 At Step 3, the three stage treatment train included in the proposed drainage design (Section 7.10.6) is added to the assessment as a mitigation. With this included, all discharge locations pass the assessment for soluble pollutants and discharges from Basins B, C and D also pass for sediment but the discharge from Basin A marginally fails.

7.11.30 Following HD45/09, a Method-A assessment is not strictly necessary for discharges from Basins A, C and D as the Q95 of receiving watercourses is

<0.001m^3/s but was undertaken to address a worst case scenario. A Method-C assessment, which considers the impact of infiltration of road runoff to groundwater, is more appropriate. Method-C assessments were carried out for all four discharge locations (Section 7.11.46; WFD Compliance Assessment: Appendix B2) and have all passed at the additional assessment stage.

7.11.31 A long-term impact assessment of surface water runoff from the highway was undertaken (WFD Compliance Assessment: Appendix B1) by comparing the annual average concentrations of copper and zinc predicted in the HAWRAT results with the EQSs stated in the WFD (Standards and Classifications) Directions 2015.

7.11.32 The predicted concentrations are below the EQS thresholds for both copper and zinc at all locations, other than Basin's A and C, where the threshold for copper is exceeded. These failures are discounted as discharges of road runoff at these locations would likely be infiltrating into groundwater rather than entering surface waters, due to the low flow of the watercourses (Q95 < 0.001 m^3/s).

7.11.33 It is therefore considered that the magnitude of impact of sediment and dissolved metals discharging into surface watercourses is negligible with a significance of effect of *neutral*.

7.11.34 Traffic modelling[23] suggests a 96% reduction in traffic along the existing A40 in the village of Llanddewi Velfrey in design year 2035, falling from an estimated 15,430 AADT to 570 AADT. Given that the current drainage network is believed to discharge directly to local watercourses, this reduction in traffic will have a beneficial impact upon the quality of runoff being discharged from the existing highway.

Surface Water Quantity

7.11.35 The operational road drainage in areas of cutting has the potential to cause a localised reduction in surface water catchment area as surface run-off and shallow groundwater is intercepted.

7.11.36 The assessment of potential impact on surface water catchments resulting from the presence of cuttings and associated drainage that may intercept surface water run-off and shallow groundwater flow is presented in the WFD

[23] Arup, A40 Llanddewi Velfrey to Penblewin Improvements, Traffic Forecasting Report, 20135 Forecast Annual Average Daily Traffic Flows High Growth Scenario, November 2017.

Compliance Assessment: Appendix B5. This showed a potential impact on the base flow of a number of features as presented in Table 7.10.

Table 7.10 Identified features potentially impacted by construction of cuttings

ID (Figure 7.2 A&B)	Feature type	Approximate distance to cutting causing potential impact
19 (Unnamed tributary of Longford Brook 2)	Land drain	Cutting at chainage 2+050 to 2+450 60m NE
20 (Unnamed tributary of Longford Brook 1)	Collects (head of a watercourse)	Cutting at chainage 2+050 to 2+450 60m N
26 (Unnamed tributary of Afon Daulan 2)	Collects	Cutting at chainage 2+720 to 2+950 60m NE
36-38 (Unnamed tributary of Afon Daulan 4)	Collects	Cutting at chainage 3+440 to 3+848 130 - 150m N
44 (Tributary of Afon Taf 1)	Spring	Cutting at chainage 3+440 to 3+848 95m N
45 (Tributary of Afon Taf 1)	Collects	Cutting at chainage 3+440 to 3+848 240m NE

7.11.37 The potential magnitude of impact is moderate as surface water run-off recharge into these watercourses would be reduced, without a significant impact on the wider catchments. Based on the low sensitivity of the watercourses, the significance of effect associated with dewatering works is considered to be *slight adverse*.

Geomorphology

7.11.38 Potential impacts to the geomorphology of watercourses result from the installation of new culverts or drainage outfalls.

7.11.39 Three new culverts and two culvert extensions are proposed within the Scheme to enable to the proposed highway to cross existing watercourses, none of which are designated as main rivers. An existing culvert of Longford Brook beneath the existing A40 would remain. The culvert locations are shown in Table 7.11.

Table 7.11 Proposed drainage crossings

Culvert ID (Figure 7.3)	Approximate Culvert Chainage	Watercourse	Solution
Culvert 1	0+290	Unnamed tributary of Afon Marlais 2	Existing culvert to be extended.
Culvert 2	1+800	Longford Brook	Two culverts beneath existing A40 to remain. Western culvert to be extended (length to be determined in final design).
Culvert 3	2+640	Unnamed tributary of Afon Daulan 1	Proposed culvert 1.8m dia.
Culvert 4	3+150	Afon Daulan	Proposed culvert 1.8m dia.
Culvert 5	3+270	Unnamed tributary of Afon Daulan 3	Proposed culvert 1.8m dia.

7.11.40 New/extended culverts are likely to remove natural channel bed, banks and floodplain connectivity and if designed inappropriately, can also cause local scour, prohibit fish passage and impair downstream transport of sediment.

7.11.41 Four new outfalls would be installed to discharge treated carriageway runoff from the drainage system to surface watercourses. The discharges would be limited to the Greenfield Runoff Rate and would be located adjacent to the proposed attenuation basins. The outfalls would be located in the receiving watercourses listed in Table 7.9.

7.11.42 New outfall structures within a watercourse can alter local channel cross section and induce local bank or bed erosion, as well as reduce the available natural bank habitat area.

7.11.43 The effects of these structures on WFD quality elements are discussed in greater detail in the WFD Compliance Assessment, which is appended to this chapter as Volume 3 Appendix 7.1.

7.11.44 The magnitude of impact on features with potential geomorphological impacts (e.g. culverts/outfalls) is considered to be *moderate adverse* where culverts are proposed and *minor adverse* where outfalls are proposed (given the limited extent of modification for an outfall).

7.11.45 For the Afon Daulan, a significant length of culvert is proposed and when combined with its medium importance the significance of potential effect is

moderate adverse. Longford Brook is impacted by a new outfall, which when combined with its medium importance, gives a significance of potential effect of *slight adverse*. For unnamed tributary of Afon Marlais 2 and unnamed tributaries of Afon Daulan 1 & 3, new culverts are proposed, giving a significance of potential effect of *slight adverse*. New outfalls are the only proposed physical modification to unnamed tributary of Afon Daulan 2 and unnamed tributary of Afon Marlais 1, giving a significance of potential effect of *neutral*.

Groundwater

7.11.46 The most likely sources of impacts to groundwater from the operation of the scheme are:

a) Infiltration of road drainage from attenuation basins or at drainage outfalls; and

b) Localised reduction in groundwater level associated with drainage at cutting locations.

7.11.47 The proposed Scheme design is for routine runoff to be discharged from attenuation basins with some infiltration prior to discharge to surface watercourses. The anticipated flow during summer months in the receiving watercourses is likely to have a Q95 <= 0.001 m^3/s and would therefore discharge to groundwater. As a result, the potential impact on groundwater was considered at all attenuation basins (Basins A, B, C and D).

7.11.48 The predicted traffic for the proposed Scheme in 2017 is 11,241 AADT, which is at the lower end of the low risk range (0-50,000 AADT) used in the standard Method-C approach for providing the initial assessment of potential pollution impacts from routine runoff to groundwater. On this basis, the assessments carried out for the Scheme are likely to overstate the potential risk to groundwater quality.

7.11.49 The full Method-C assessments for the potential impacts to the groundwater body and specific receptors are provided in Appendix 7.1 WFD Compliance Assessment: Appendix B2.

7.11.50 The overall risk score for the HD45/09 Method-C assessment for all basins was in a range between 170 and 193. This is within the 150 to 250 suggested action class range. This indicates that based on this initial and generic assessment there is a potential for a ‘medium’ risk of impact as a result of discharge to groundwater from routine runoff at these locations.

7.11.51 In accordance with the HD45/09 Method-C initial and generic assessment, the potential 'medium' risk scenario warrants a higher level of assessment based on site specific data.

7.11.52 The result of the Method C assessment indicates that the hydrogeological situations at Basins A, B, C and D have a potential to present a 'medium' long term risk of impact to the groundwater body.

7.11.53 The HAWRAT modelling undertaken for each of the basin locations derived concentrations of the marker contaminants, copper and zinc.

7.11.54 As detailed in the WFD Compliance Assessment: Appendix B1, only the modelled concentrations of copper for Basin A and Basin C exceed the published EQS. Therefore, the routine runoff discharges may pose a risk to the groundwater contained within the Secondary A aquifer in the bedrock in these locations of discharge.

7.11.55 This risk would not be presented to the entire groundwater body, but rather a localised area around the attenuation basins because of the dilution and degradation behaviour of contaminants in groundwater. Consequently, an additional risk assessment was carried out to understand the extent of the impact. The assessment was undertaken in accordance with the Environment Agency's (England and Wales) Remedial Targets Methodology: Hydrogeological Risk Assessment for Land Contamination (see WFD Compliance Assessment: Appendix B3).

7.11.56 The results of the additional risk assessment demonstrate that the contaminant concentrations resulting from a long-term discharge of surface runoff diminish to the acceptable levels for copper at a distance of approximately 10m from the attenuation basins and outfalls. This is due to the anticipated dilution within the aquifer. Therefore, although the initial assessment indicated a potential 'medium' risk scenario of impact on groundwater, the detailed assessment indicated that the routine run-off discharge may only result in the localised impact limited to the proximity of the attenuation basin or outfall. Therefore, a minor adverse to negligible magnitude of impact is applicable to the wider groundwater body.

7.11.57 The groundwater body beneath the proposed Scheme area is classified as a secondary aquifer, which according to Table A4.3 of HD45/09, has a medium sensitivity in terms of groundwater vulnerability. Consequently, the significance of effect of discharge of routine runoff on the groundwater body is *slight adverse to neutral*. Therefore, no mitigation measures are necessary.

7.11.58 The assessment of potential impact on groundwater resulting from the proposed road drainage intercepting groundwater (i.e. in cuttings), is presented in WFD Compliance Assessment: Appendix B5. This showed a potential impact on the base flow of an unnamed tributary of Afon Daulan at chainage 2+640 (Feature ID 22 on Volume 2 Figure 7.2 A&BA) as a result of drainage intercepting groundwater at chainage 2+720 to 2+950. The potential magnitude of impact is *moderate* as groundwater recharge into that watercourse would be reduced, without a significant impact on the wider catchment of the Afon Daulan. Based on the low sensitivity of that watercourse, the significance of effect associated with the lowering of the groundwater it is considered to be *slight adverse*.

7.11.59 No potential impacts upon private water supplies were identified.

Flood Risk

7.11.60 The operational road drainage and the installation of culverts to cross existing watercourses present potential impacts to the level of flood risk to the wider area and to users of the new highway.

7.11.61 The Scheme is not expected to cause any detriment to fluvial, surface or groundwater flood risk. Additional detail regarding flood risk is included in Volume 3 Appendix 7.2, Flood Risk Note. Appropriate climate change allowances were agreed with PCC and incorporated into the design of the road drainage and culverts. This greater standard of flood protection for the new road over the old road would be a benefit to road users travelling through the area.

7.11.62 The magnitude of effect is therefore considered negligible and the significance of potential effect is *neutral*.

Accidental Spillage

7.11.63 The risk of an accident resulting in a serious pollution incident to surface or groundwaters was assessed for each proposed drainage outfall using the Method-D assessment outlined in the HD45/09 Volume 11, Section 3, Part 10. This assessment was carried out using vehicle numbers from the 2051 AADT flows to account for future growth.

7.11.64 On all roads, there is a risk that an accidental spillage or vehicle fire may lead to an acute pollution incident. It is generally accepted that the pollution risk on any road is linked to the risk of a HGV road traffic accident. Where

a spillage does reach a surface watercourse the pollution effect can be *severe,* but is usually of short duration.

7.11.65 The acceptable risk of a pollution incident is stated in HD45/09. The acceptable risk of pollution reaching a sensitive watercourse or groundwater is: an annual probability of less than 1%; or a return period of 100 years.

7.11.66 Using the HD45/09 assessment method, the risk of spillages was calculated for both the current and proposed situations. The results for 2051 are summarised in Table 7.12. The full assessment is provided in the WFD Compliance Assessment: Appendix B4.

Table 7.12 Spillage probability for design year 2051

Basin	Road Reference	Receiving water body	Spillage probability
A	Penblewin Roundabout	Unnamed tributary of Afon Marlais 2	0.007%
	A40 trunk road	Unnamed tributary of Afon Marlais 2	0.007%
B	A40 trunk road	Longford Brook	0.023%
	A40 Junction to old A40	Longford Brook	0.000%
C	A40 trunk road	Unnamed tributary of Afon Daulan 1	0.008%
	Bethel Chapel Roundabout W	Unnamed tributary of Afon Daulan 1	0.006%
	A40 slip road to Bethel Chapel Roundabout	Unnamed tributary of Afon Daulan 1	0.000%
D	A40 trunk road	Unnamed tributary of Afon Marlais 1	0.003%

7.11.67 The risks of accidental spillages are very low and well within the acceptable limits (i.e. 1%). Based on the spillage assessment, the magnitude of potential impact on surface or groundwaters is considered to be negligible. The significance of effect is therefore *neutral*.

7.12 Additional Mitigation and Monitoring

7.12.1 The following mitigation measures are required to protect water quality and the water environment and are to be included above and alongside the mitigation included in the initial design (Section 7.10).

Construction Mitigation

7.12.2 This section details mitigations required to reduce the significance of effect associated with construction. Measures that are considered as standard good

practice were included in a CEMP that will be implemented by the construction contractor, see Volume 3 Appendix 2.2: Pre-CEMP. Measures that are non-standard or site specific are detailed below and these should be incorporated into the contractor's construction method statement.

7.12.3 The standard measures included in the CEMP are based on the Guidance for Pollution Prevention (GPPs) and the Pollution Prevention Guidelines (PPGs; where they have yet to be replaced by GPPs), which includes the following relevant guidance:

a) GPP 5: Working in or near water;
b) PPG 7: Safe storage – the safe operation of refuelling facilities;
c) GPP 8: Safe storage and disposal of used oils;
d) GPP 13: Vehicle washing and cleaning;
e) PPG 18: Managing fire water and major spillages;
f) GPP 21: Pollution incident response planning;
g) PPG 22: Incident response - dealing with spills; and
h) PPG 26 Safe storage - drums and intermediate bulk containers.

7.12.4 Examples of the standard practice mitigations included in the Pre-CEMP include the provision of spill kits, restricting site traffic to dedicated haul roads and ensuring hard-standing areas are regularly swept and maintained.

7.12.5 Effective delivery of the measures set out here and, in the CEMP, will be monitored during the construction phase, by the Environmental Clerk of Works.

Surface Water Quality

7.12.6 To reduce the significance of effect associated with construction (moderate adverse without mitigation) the following mitigation measures should be implemented.

7.12.7 A surface water management system, using measures such as temporary silt fencing, cut-off ditches, settlement basins and bunds will be set up as early in the construction period as possible to capture all runoff within or traversing the construction corridor. The road drainage will be installed early in the construction period and used for site drainage. It will be designed for no flooding in a 1 in 5-year plus climate change event, with no flooding of the attenuation basins for a 1 in 100 year plus climate change event, which is in accordance with the requirements of the DMRB.

7.12.8 Discharge consenting requirements should be discussed and agreed with NRW prior to any construction works, with the quality of any discharges from the surface water management system monitored on a regular basis. A water quality monitoring programme prior to and during construction works will be agreed with NRW.

7.12.9 Further local measures (e.g. silt fencing / straw bales) to prevent ingress of sediments/contaminants into existing watercourses should be implemented.

7.12.10 Water with a higher risk of contamination, including groundwater pumped out of excavations during concrete pouring, will be contained and treated using appropriate measures such as coagulation of sediments, dewatering and pH neutralisation prior to discharge. There are various proprietary package treatment plants available that can provide these measures. Contaminated water that cannot be treated on site will, if necessary, be pumped to a suitably licenced tanker before being exported off site for treatment at an appropriately permitted facility.

7.12.11 All water pumped from excavations will be pumped via a pipe and gravel sump in order to prevent silt being agitated from the base of the excavation and to provide rudimentary filtration to the water prior to abstraction. For low volume pumping, water will either be pumped into a vegetated area remote from surface water drainage or into a small attenuation lagoon prior to being directed into the drainage system. For high volume pumping ($0.052m^3/s$ or above) water will be passed through an attenuation tank with a capacity of not less than $8m^3$. The outlet from the tank could be placed directly into site drainage, provided the water is free from silt contamination.

7.12.12 Activities such as concrete pouring for foundations and abutments, as well as washout of vehicles/equipment would create water contaminated with concrete. This water should be collected and pumped to an appropriate treatment solution, of water before it is returned to the surface water management system. Treatment may need to include a carbon dioxide adjustment system to neutralise high pH cement laden water and settlement of sediments to remove fines from wash waters. Settlement units use gravity to remove fines and can be combined with coagulants or flocculants to treat higher volumes of water. Any residual material (i.e. solids) from this process should be, where possible, re-used onsite under a Materials Management Plan or otherwise transported to an appropriately licenced waste facility.

7.12.13 Areas of exposed sediment deemed at risk of erosion during heavy rainfall or flood inundation should be protected using either temporary measures

(e.g. sheeting) or semi-permanent measures (e.g. coir matting) until vegetation is able to establish on these surfaces. The use of temporary or semi-permanent measures would vary based on the planned construction in that area. For example, the flood bund, once constructed, should be protected with semi-permanent erosion control until vegetation is established, whilst areas excavated for the haul road/laydown areas may only be exposed for a short period during construction and would therefore only require temporary erosion control.

7.12.14 During works, the Site Manager will regularly check river levels and the three-day weather/flood risk forecasts. Works in or near watercourses should be suspended during out-of-bank river flows and plant moved to a position of safety. Following a flood event any temporary works in watercourses or their floodplains will be checked for integrity prior to commencing works.

7.12.15 The process and procedure for responding to and reporting environmental incidents will be agreed with NRW and included within the CEMP.

Geomorphology

7.12.16 The significance of potential construction effects of the proposed Scheme on geomorphology is considered to be slight/moderate adverse. Mitigation measures should therefore be incorporated and are described below.

7.12.17 The amount of in-channel working should be minimised by using precast structures and working offline wherever possible.

7.12.18 The extent of the ground-works for the embankment crossing the Afon Daulan should be kept to a minimum. Vegetation removal to enable the work should be minimised and existing tree roots left in place wherever possible with no modifications made to the natural bank profile beyond the limits of the embankment.

7.12.19 Bare areas exposed during any works to river banks or by excavation or soil stripping on any floodplains should be protected with temporary measures to ensure no erosion or scouring during flood events prior to the installation of bioengineering and/or establishment of vegetation.

7.12.20 Defined plant trafficking routes should be located away from watercourses to prevent any further modification to in-channel features or loading of the banks which could cause bank failure.

7.12.21 Construction activities affecting the river banks or any in-channel features should be carried out under the supervision of a qualified geomorphologist.

Groundwater

7.12.22 The significance of potential construction effects of the proposed Scheme on groundwater quality and resource is considered to be slight adverse. Provided standard construction practices are followed (as detailed in the Pre-CEMP; Volume 3 Appendix 2.2), no further mitigation measures are proposed.

Flood Risk

7.12.23 The significance of potential construction effects of the proposed Scheme on flood risk is considered to be neutral provided that, where works take place in the vicinity of watercourses, material and plant is stored beyond the areas potentially susceptible to flooding. No further mitigation measures are proposed.

Operational Mitigation

7.12.24 This section identifies mitigation measures where adverse effects due to operation of the proposed Scheme were identified. For this assessment these include impacts on flood risk.

Surface Water Quality

7.12.25 The significance of potential operational effects of the proposed Scheme on surface water quality is considered to be neutral. Therefore, additional mitigation measures are considered unnecessary.

Surface Water Quantity

7.12.26 The significance of potential operational effects of the proposed Scheme on surface water quantity is considered to be slight adverse due to the modification of catchment areas as a result of multiple cuttings along the proposed alignment. The drainage of the cuttings is unable to mimic the natural drainage pathways in local groundwater but given the low importance/sensitivity of the watercourses involved, mitigation measures are considered unnecessary.

Geomorphology

7.12.27 The mitigation measures listed below are considered best practice for the design of outfalls and culverts and should be included for all structures, regardless of the significance of effect and to ensure that WFD objectives can continue to be met.

7.12.28 The design of any new or extended culverts should ensure that:

a) The base of the culvert is set >150mm below the existing bed of the watercourse with structures attached to the base of the culvert (e.g. wooden batons) to retain sediment within the full length of the culvert. This will help to retain habitat connectivity either side of the culvert and promote continued sediment transport downstream;

b) Culvert gradients are such that flow velocities within the culvert are suitable for fish passage across a range of flows; and

c) Any scour protection at the inlet or outlet uses bioengineering methods wherever practicable to maximise habitat potential.

7.12.29 The design of any new outfalls should ensure that:

a) The headwall structure is set back from or flush with the channel profile and does not protrude into the channel;

b) The outfall is angled to direct flow at an angle no greater than 60 degrees from the existing flow direction in the watercourse; and

c) Any scour protection surrounding the outfall headwall uses bioengineering methods wherever practicable to maximise habitat potential.

7.12.30 The design and construction supervision of these mitigation measures will be led by a qualified geomorphologist.

Groundwater

7.12.31 The significance of potential operational effects of the proposed Scheme on groundwater quality and resource is considered to be slight adverse to neutral. No receptors were identified within a 10m radius of the proposed drainage outfalls; therefore, mitigation measures are considered unnecessary.

Accidental Spillage Risk

7.12.32 The significance of potential operational effects of the proposed Scheme from accidental spillage is considered to be neutral. Therefore, mitigation measures are considered unnecessary.

Flood Risk

7.12.33 The significance of potential operational effects of the proposed Scheme from flood risk is considered to be neutral. Therefore, mitigation measures are considered unnecessary.

7.13 Assessment of Residual Effects

Construction Effects

Surface Water Quality

7.13.1 Following the implementation of mitigation measures and the CEMP during construction, the magnitude of any pollution incident is likely to be negligible. Therefore, the significance of effect would be reduced to *neutral*.

Geomorphology

7.13.2 Following the implementation of mitigation measures and the CEMP during construction, the magnitude of any geomorphological impacts is likely to be negligible. Therefore, the significance of effect would be reduced to *neutral*.

Groundwater

7.13.3 Following the implementation of standard practices included in the CEMP, the magnitude of impact to groundwater quality is reduced to negligible, leading to a significance of effect of *neutral*.

7.13.4 The significance of effects to groundwater quantity (levels and flows) remains *slight adverse* as no further mitigation measures were deemed necessary.

Flood Risk

7.13.5 The significance of effects remains *neutral* as no additional mitigation measures were deemed necessary.

Operational Effects

Surface Water Quality

7.13.6 The significance of effects remains *neutral* as additional mitigation measures were deemed unnecessary.

7.13.7 It is considered that the proposed Scheme would not cause a degradation in the status of any WFD surface water bodies in the vicinity of the Scheme and would not prevent them from attaining Good status in the future.

Surface Water Quantity

7.13.8 The significance of effect remains *slight adverse* as additional mitigation measures were deemed unnecessary.

Geomorphology

7.13.9 Following the implementation of mitigation measures to ensure the design of physical modifications retains natural processes and habitat area where possible, the significance of effect at locations where physical modifications are proposed is reduced to:

a) Afon Daulan (culvert) - *slight adverse*;
b) Longford Brook (outfall) - *neutral*;
c) Unnamed tributary of Afon Marlais 2 and unnamed tributaries of Afon Daulan 1 & 3 (culverts) - *neutral*; and
d) Unnamed tributary of Afon Daulan 2 and unnamed tributary of Afon Marlais 1 (outfalls) - *neutral*.

Groundwater

7.13.10 The assessment of effects on groundwater quality without mitigation measures in place concluded that any impacts would be limited to a 10m radius of the point source at each outfall. No receptors were identified within a 10m radius of the proposed outfalls; therefore, no additional mitigation was proposed, and the significance of effects remains *slight adverse to neutral*.

7.13.11 The significance of effects to groundwater quantity (levels and flows) remains *slight adverse* as additional mitigation measures were deemed unnecessary.

7.13.12 It is considered that the proposed Scheme would not cause a degradation in the WFD status of the Cleddau and Pembrokeshire or Twyi, Taf and Gwendraeths groundwater bodies and would not prevent either from attaining Good status in the future.

Flood Risk

7.13.13 The significance of effects remains *neutral* as no additional mitigation measures were deemed necessary.

Accidental Spillage Risk

7.13.14 The significance of effects remains *neutral* as no additional mitigation measures were deemed necessary.

Monitoring

7.12.34 No significant impacts were identified and therefore there is no requirement for future monitoring of the water environment as a result of the Scheme.

7.14 Conclusion

7.14.1 It was concluded that neither the temporary nor the operational impacts of the Scheme would have significant adverse impacts upon the water environment provided the mitigation measures as described above are implemented. Ongoing monitoring is not proposed because no likely significant impacts were identified, and the proposed mitigation measures are plainly established and uncontroversial.

7.14.2 The Scheme would not adversely affect the current status of the various WFD elements of the water bodies in question or prevent these or any other water bodies from reaching Good status (or potential) provided the outlined mitigation measures are implemented.

7.15 Summary

Table 7.13 Summary of construction phase impacts to the water environment (water features only included if potentially impacted by the Scheme)

Feature	Chainage	Sensitivity of receptor	Description of impact	Magnitude of impact without mitigation	Proposed Mitigation	Magnitude of impact with mitigation	Significance of impact following mitigation
Surface Waters							
Pond 7 (SN 12065 16574)	0+000	Low	Degradation of water quality (inc spillage)	Moderate adverse	CEMP, GPP & additional requirements	Negligible	Neutral
Unnamed tributary of Afon Marlais 2	0+290	Low	Degradation of water quality (inc spillage)	Moderate adverse	CEMP, GPP & additional requirements	Negligible	Neutral
			Physical modification	Minor adverse	CEMP and additional requirements	Negligible	Neutral
			Increase in flood risk to surrounding properties	Negligible	None required	Negligible	Neutral
Longford Brook	1+800	High	Degradation of water quality (inc spillage)	Moderate adverse	CEMP, GPP & additional requirements	Negligible	Neutral
			Physical modification	Minor adverse	CEMP and additional requirements	Negligible	Neutral
		Low	Increase in flood risk to surrounding properties	Negligible	None required	Negligible	Neutral
Unnamed tributary of Afon Daulan 1	2+640	Low	Degradation of water quality (inc spillage)	Moderate adverse	CEMP, GPP & additional requirements	Negligible	Neutral
			Physical modification	Minor adverse	CEMP and additional requirements	Negligible	Neutral

Feature	Chainage	Sensitivity of receptor	Description of impact	Magnitude of impact without mitigation	Proposed Mitigation	Magnitude of impact with mitigation	Significance of impact following mitigation
			Increase in flood risk to surrounding properties	Negligible	None required	Negligible	Neutral
			Reduction in baseflow as a result of dewatering during construction of cutting from chainage 2+720 to 2+950	Moderate adverse	None required	Moderate adverse	Slight adverse
Unnamed tributary of Afon Daulan 2	2+900	Low	Degradation of water quality (inc spillage)	Moderate adverse	CEMP, GPP & additional requirements	Negligible	Neutral
			Physical modification	Minor adverse	CEMP and additional requirements	Negligible	Neutral
			Increase in flood risk to surrounding properties	Negligible	None required	Negligible	Neutral
Afon Daulan	3+150	Medium	Degradation of water quality (inc spillage)	Moderate adverse	CEMP, GPP & additional requirements	Negligible	Neutral
			Physical modification	Minor adverse	CEMP and additional requirements	Negligible	Neutral
		Low	Increase in flood risk to surrounding properties	Negligible	None required	Negligible	Neutral
Unnamed tributary of Afon Daulan 3	3+270	Low	Degradation of water quality (inc spillage)	Moderate adverse	CEMP, GPP & additional requirements	Negligible	Neutral
			Physical modification	Minor adverse	CEMP and additional requirements	Negligible	Neutral

Feature	Chainage	Sensitivity of receptor	Description of impact	Magnitude of impact without mitigation	Proposed Mitigation	Magnitude of impact with mitigation	Significance of impact following mitigation
			Increase in flood risk to surrounding properties	Negligible	None required	Negligible	Neutral
Unnamed tributary of Afon Marlais 1	4+250	Low	Degradation of water quality (inc spillage)	Moderate adverse	CEMP, GPP & additional requirements	Negligible	Neutral
			Physical modification	Minor adverse	CEMP and additional requirements	Negligible	Neutral
			Increase in flood risk to surrounding properties	Negligible	None required	Negligible	Neutral
Groundwater							
Wells marked on OS mapping	0+200	Medium	Contamination of groundwater (inc spillage)	Minor adverse	CEMP standard practices	Negligible	Neutral
	1+600		Change in groundwater resource due to temporary dewatering	Negligible	None required	Negligible	Neutral
	1+630						
	1+780						
Well at Pen-troydin-Fawr	2+220	High	Contamination of groundwater (inc spillage)	Minor adverse	CEMP standard practices	Negligible	Neutral
			Change in groundwater resource due to temporary dewatering	Negligible	None required	Negligible	Neutral
Licensed abstraction at	3+150	Medium	Contamination of groundwater (inc spillage)	Minor adverse	CEMP standard practices	Negligible	Neutral

Feature	Chainage	Sensitivity of receptor	Description of impact	Magnitude of impact without mitigation	Proposed Mitigation	Magnitude of impact with mitigation	Significance of impact following mitigation
Blaen-Pen-troydin			Change in groundwater resource due to temporary dewatering	Negligible	None required	Negligible	Neutral
Unnamed private water supplies	3+660	High	Contamination of groundwater (inc spillage)	Minor adverse	CEMP standard practices	Negligible	Neutral
			Change in groundwater resource due to temporary dewatering	Negligible	None required	Negligible	Neutral
Groundwater (including WFD groundwater bodies)	Beneath Scheme	Medium	Contamination of groundwater (inc spillage)	Minor adverse	CEMP standard practices	Negligible	Neutral
		Medium	Change in groundwater resource due to temporary dewatering	Negligible	None required	Negligible	Neutral
		Low	Increase in flood risk to surrounding properties	Negligible	None required	Negligible	Neutral

Table 7.14: Summary of operational phase impacts to the water environment (water features only included if potentially impacted by the Scheme)

Feature	Chainage	Sensitivity of receptor	Description of impact	Magnitude of impact without mitigation	Proposed Mitigation	Magnitude of impact with mitigation	Significance of impact following mitigation	Notes/ Comments
Surface Waters								
Pond 7 (SN 1206516574)	0+000	Low	Degradation of water quality from routine road runoff	Negligible	None required	Negligible	Neutral	
			Accidental spillage	Negligible	None required	Negligible	Neutral	
Unnamed tributary of Afon Marlais 2	0+290	Low	Degradation of water quality from routine road runoff	Negligible	None required	Negligible	Neutral	
			Accidental spillage	Negligible	None required	Negligible	Neutral	
			Physical modification	Moderate adverse	Design considerations	Minor adverse	Neutral	New outfall & culvert
			Increase in flood risk to surrounding properties	Negligible	None required	Negligible	Neutral	
Longford Brook	1+800	High	Degradation of water quality from routine road runoff	Negligible	None required	Negligible	Neutral	
			Accidental spillage	Negligible	None required	Negligible	Neutral	
			Physical modification	Minor adverse	Design considerations	Negligible	Neutral	New outfall
		Low	Increase in flood risk to surrounding properties	Negligible	None required	Negligible	Neutral	

Feature	Chainage	Sensitivity of receptor	Description of impact	Magnitude of impact without mitigation	Proposed Mitigation	Magnitude of impact with mitigation	Significance of impact following mitigation	Notes/ Comments
Unnamed tributary of Longford Brook 1	2+050	Low	Reduction in baseflow	Moderate adverse	None proposed	Moderate adverse	Slight adverse	Result of cutting at chainage 2+050 to 2+450
Unnamed tributary of Afon Daulan 1	2+640	Low	Degradation of water quality from routine road runoff	Negligible	None required	Negligible	Neutral	
			Accidental spillage	Negligible	None required	Negligible	Neutral	
			Physical modification (culvert)	Moderate adverse	Design considerations	Minor adverse	Neutral	New culvert
			Increase in flood risk to surrounding properties	Negligible	None required	Negligible	Neutral	
Unnamed tributary of Afon Daulan 2	2+900	Low	Degradation of water quality from routine road runoff	Negligible	None required	Negligible	Neutral	
			Accidental spillage	Negligible	None required	Negligible	Neutral	
			Physical modification	Minor adverse	Design considerations	Negligible	Neutral	New outfall
			Increase in flood risk to surrounding properties	Negligible	None required	Negligible	Neutral	
			Reduction in baseflow	Moderate adverse	None proposed	Moderate adverse	Slight adverse	A result of drainage

Feature	Chainage	Sensitivity of receptor	Description of impact	Magnitude of impact without mitigation	Proposed Mitigation	Magnitude of impact with mitigation	Significance of impact following mitigation	Notes/ Comments
								from cutting at chainage 2+720 to 2+950
Afon Daulan	3+150	Medium	Degradation of water quality from routine road runoff	Negligible	None required	Negligible	Neutral	
			Accidental spillage	Negligible	None required	Negligible	Neutral	
			Physical modification	Moderate adverse	Design considerations	Minor adverse	Slight adverse	New culvert
		Low	Increase in flood risk to surrounding properties	Negligible	None required	Negligible	Neutral	
Unnamed tributary of Afon Daulan 3	3+270	Low	Degradation of water quality from routine road runoff	Negligible	None required	Negligible	Neutral	
			Accidental spillage	Negligible	None required	Negligible	Neutral	
			Physical modification	Moderate adverse	Design considerations	Minor adverse	Neutral	New culvert
			Increase in flood risk to surrounding properties	Negligible	None required	Negligible	Neutral	
Unnamed tributary of	3+400	Low	Reduction in baseflow	Moderate adverse	None proposed	Moderate adverse	Slight adverse	A result of drainage from cutting at chainage

Feature	Chainage	Sensitivity of receptor	Description of impact	Magnitude of impact without mitigation	Proposed Mitigation	Magnitude of impact with mitigation	Significance of impact following mitigation	Notes/ Comments
Afon Daulan 4								3+440 to 3+848
Unnamed tributary of Afon Marlais 1	4+250	Low	Degradation of water quality from routine road runoff	Negligible	None required	Negligible	Neutral	
			Accidental spillage	Negligible	None required	Negligible	Neutral	
			Physical modification	Minor adverse	Design considerations	Negligible	Neutral	New outfall
			Increase in flood risk to surrounding properties	Negligible	None required	Negligible	Neutral	
Tributary of Afon Taf 1	3+800	Low	Reduction in baseflow	Moderate adverse	None proposed	Moderate adverse	Slight adverse	A result of drainage from cutting at chainage 3+440 to 3+848
Groundwater								
Wells marked on OS mapping	0+200	Medium	Contamination of groundwater (inc spillage)	Negligible	None required	Negligible	Neutral	
	1+600		Change in groundwater resource due to road drainage	Negligible	None required	Negligible	Neutral	
	1+630							
	1+780							

Feature	Chainage	Sensitivity of receptor	Description of impact	Magnitude of impact without mitigation	Proposed Mitigation	Magnitude of impact with mitigation	Significance of impact following mitigation	Notes/ Comments
Well at Pen-troydin-Fawr	2+220	High	Contamination of groundwater (inc spillage)	Negligible	None required	Negligible	Neutral	
			Change in groundwater resource due to road drainage	Negligible	None required	Negligible	Neutral	
Licensed abstraction at Blaen-Pen-troydin	3+150	Medium	Contamination of groundwater (inc spillage)	Negligible	None required	Negligible	Neutral	
			Change in groundwater resource due to road drainage	Negligible	None required	Negligible	Neutral	
Unnamed private water supplies	3+660	High	Contamination of groundwater (inc spillage)	Negligible	None required	Negligible	Neutral	
			Change in groundwater resource due to road drainage	Negligible	None required	Negligible	Neutral	
Groundwater	Beneath Scheme	Medium	Contamination of groundwater	Minor adverse to negligible	None required	Minor adverse to negligible	Slight adverse to neutral	Secondary aquifer
		Medium	Change in groundwater resource due to road drainage	Negligible	None required	Negligible	Neutral	
		Low	Increase in flood risk to surrounding properties	Negligible	None required	Negligible	Neutral	