11 Road Drainage and the Water Environment

This chapter assesses the impacts of the proposed scheme on the surface water environment, specifically considering the attributes of hydrology and flood risk, fluvial geomorphology and water quality.

The proposed scheme is located within the River Tay catchment between the elevations of 110m and 285m AOD (Above Ordnance Datum). Within the 500m study area, 89 surface water features were identified, 73 of which may be affected by the proposed scheme. The majority of these are upland, fast flowing and low stream order watercourses, which feature bedrock and/or cobble and gravel substrates, and which currently feature culverted crossings associated with the existing A9. The largest watercourse within the study area is the River Garry (catchment area: 798km^2), which is a dynamic upland to transitional watercourse with a predominantly cobble and gravel substrate. There are two major bridge crossings of the River Garry associated with the existing A9 at Pitaldonich and Essangal; referred to as the River Garry Underbridge and the Essangal Underbridge respectively.

The impact assessment was informed by consultation, desk-based assessments, site walkovers and surveys. Hydraulic modelling of the three largest watercourses within the study area (River Garry, Allt Bhaic and River Bruar) was undertaken to assess potential impacts on flood risk.

Significant potential impacts from the proposed scheme in the absence of mitigation include increases in fluvial flood risk, alterations to flows and sediment processes within watercourses, and deterioration in water quality in receiving watercourses from construction and operational runoff.

Mitigation during construction would be delivered through a Construction Environmental Management Plan (CEMP), which would include measures for flood risk, fluvial geomorphology and water quality. A sediment management plan, storage of machinery and material outside the floodplain, adherence to guidance such as the Pollution Prevention Guidelines, and specific management plans to manage drainage and minimise the generation of suspended sediment, are also included as measures to mitigate construction impacts.

With the implementation of mitigation measures during construction, residual impacts on the majority of receptors would not be significant. Significant residual impacts would remain during construction on both the River Garry and Allt Bhaic for hydrology and flood risk only, due to the requirement for works within the functional floodplain and the associated inherent risk to construction activities and adjacent land.

During the operational phase, mitigation measures include the use of Sustainable Drainage Systems (SuDS), scour protection and plans to manage flood flows.

With the implementation of mitigation measures during operation, residual impacts on the majority of receptors would not be significant. Significant adverse residual impacts from flood risk are reported for the River Garry, Allt Bhaic and a small watercourse near Calvine (WF136). These adverse residual impacts from flood risk relate to localised increases in flood depths on agricultural land and a minor road (B847 at Calvine), which are locations already subject to flooding.

Beneficial residual impacts associated with flood risk are also reported for watercourses WF92, WF134 and WF136, where the risk of flooding is removed from one property near Killiecrankie (WF92) and 6 residential properties in Calvine (WF134 and WF136). In summary, due to the beneficial impacts towards residential properties, the net effect of the proposed scheme for flood risk is considered to be beneficial.

11.1 Introduction

11.1.1 This chapter presents the DMRB Stage 3 assessment of the proposed scheme (see Chapter 5: The Proposed Scheme) in terms of the following aspects of the surface water environment: hydrology and flood risk, fluvial geomorphology and water quality. The chapter is supported by the following appendices, which are cross-referenced where relevant:

- Appendix A11.1 (Baseline Conditions);
- Appendix A11.2 (Surface Water Hydrology);
- Appendix A11.3 (Flood Risk Assessment);
- Appendix A11.4 (Hydraulic Modelling Report);
- Appendix A11.5 (Fluvial Geomorphology);
- Appendix A11.6 (Water Quality);

- Appendix A11.7 (Impact Assessment); and
- Appendix A11.8 (Watercourse Crossings Report).

11.1.2 The location of the proposed scheme and associated surface water features is shown on Figure 11.1 and the baseline flood risk is shown on Figure 11.2. Appendix A11.8 (Watercourse Crossing Report) provides example cross sections of the proposed watercourse crossings.

11.2 Approach and Methods

Structure of Assessment

11.2.1 The assessment of potential impacts on attributes of the surface water environment in this chapter includes:

- Hydrology and Flood Risk: potential impacts on the flow of water above ground and the risk of flooding from surface water;
- Fluvial Geomorphology: the sensitivity of, and potential impacts on, fluvial landforms associated with river systems and the flow and sediment transport processes which create and sustain them; and
- Water Quality: the quality of the water in terms of potential impacts on biodiversity, dilution and removal of waste products and water supply.

11.2.2 The surface water environment is intrinsically linked to groundwater and ecological receptors, considered in Chapter 10 (Geology, Soils, Contaminated Land and Groundwater) and Chapter 12 (Ecology and Nature Conservation) respectively. Commercial and recreational use of the surface water environment is considered in Chapter 8 (People and Communities: Community and Private Assets). The specialist teams undertaking each of these assessments worked closely together to cover interactions between these topics, and cross-referencing is provided throughout these chapters where relevant.

11.2.3 The approach and methods were informed by the recommendations made in the A9 Dualling Programme Strategic Environmental Assessment (SEA) (Transport Scotland, 2013). More detailed information on the SEA recommendations is presented in Appendix A6.1 (SEA Monitoring Framework).

Legislative and Policy Context

11.2.4 The assessment has taken into account relevant guidance, legislation and regulations, including those listed in Table 11.1.

11.2.5 The DMRB HD45/09 (The Highways Agency et al., 2009a, hereafter referred to as 'DMRB HD45/09') does not provide guidance on the assessment of fluvial geomorphology, therefore best practice guidance was applied as detailed in Table 11.1.

Table 11.1: Legislation, regulations and guidance

Topic	Name
Key Legislation	Water Environment Water Services (WEWS) Act 2003 (Scottish Government, 2003); Flood Risk Management (Scotland) Act 2009 (Scottish Government, 2009a); EU Floods Directive (2007/60/EC); and The Water Environment (Controlled activities) (Scotland) Regulations 2011 (as amended) (CAR) (Scottish Government, 2013).
Other Legislation	The Climate Change (Scotland) Act 2009 (Scottish Government, 2009b); Water Framework Directive (WFD) policy guidance 'The Future for Scotland's Waters, Guiding Principles on the Technical Requirements of the Water Framework Directive' (SEPA, 2002); European Union (EU) Drinking Water Directive (98/83/EC); The Environment Act 1995; Surface Waters (Fishlife) (Classification) (Scotland) (Amendment) Regulations, 2003; Control of Pollution Act 1974 (CoPA); Environmental Protection Act 1990; Environmental Liability (Scotland) Regulations 2009; The Water Supply (Water Quality) (Scotland) Regulations, 2001;

Topic	Name
	The Public Water Supplies (Scotland) Regulations 2014; The Private Water Supplies (Scotland) Regulations 2006; The Water Environment (Oil Storage) (Scotland) Regulations 2006; and Pollution Prevention and Control (Scotland) Regulations 2012 (PPC 2012).
General Guidance	British Standards BS 6031:2009 Code of Practice for Earthworks (British Standards, 2009); DMRB Volume 11, Section 3, Part 10 (HD 45/09): Road Drainage and the Water Environment (The Highways Agency et al., 2009a), hereby referred to as DMRB HD45/09; DMRB Volume 4, Section 2, Part 7 (HA 107/04): Design of Outfall and Culvert Details (The Highways Agency et al., 2004), hereby referred to as DMRB HA107/04; Interim Advice Note (IAN) 125/09: Supplementary Guidance for Users of DMRB Volume 11 Environmental Assessment (The Highways Agency et al., 2009b); CIRIA C689: Culvert Design and Operation Guide (CIRIA, 2010); WAT-SG-29: Good Practice Guide – Construction Methods (2009); CIRIA C741: Environmental Good Practice on Site (fourth edition) (CIRIA, 2015a); SEPA (WAT-SG-23) Engineering in the Water Environment: Good Practice Guidance: Bank Protection Rivers and Lochs (SEPA, 2008a); SEPA (WAT-SG-28) Engineering in the Water Environment: Good Practice Guidance: Intakes and Outfalls (SEPA, 2008b); SEPA (WAT-SG-29) Engineering in the Water Environment: Good Practice Guidance: Temporary Construction Methods (SEPA, 2009); SEPA (WAT-SG-25) Engineering in the Water Environment: Good Practice Guidance: River crossings (SEPA, 2010); SEPA (WAT-PS-06) Position Statement to Support the Implementation of the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (SEPA, 2015a); SEPA The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended) A Practical Guide (SEPA, 2017a); and SEPA Regulatory Method (WAT-RM-08), Sustainable Urban Drainage Systems (SEPA, 2017b).
Flood Risk Guidance	Technical Flood Risk Guidance for Stakeholders (SS-NFR-P-002) (SEPA, 2015b); The Flood Risk Management (Scotland) Act 2009; Scottish Government's Online Planning Advice on Flood Risk (22 June 2015); and Scottish Planning Policy (SPP), (Flooding and Drainage Chapter) Scottish Executive (2014).
Fluvial Geomorphology Guidance	Waterway Bank Protection: a guide to erosion assessment and management (Environment Agency, 1999); The Fluvial Design Guide (Environment Agency, 2010); Guidebook of Applied Fluvial Geomorphology (Sear et al., 2010); SEPA (WAT-SG-21) Environmental Standards for River Morphology (SEPA, 2012a); and SEPA (WAT-PS-07-02) Engineering in the Water Environment Good Practice Guide: Bank Protection – Rivers and Lochs (SEPA, 2008a).
Water Quality Guidance	CIRIA C532: Control of water pollution from construction sites (CIRIA, 2001); CIRIA C609: Sustainable drainage systems: Hydraulic, structural and water quality advice (CIRIA, 2004); CIRIA C648: Control of water pollution from linear construction projects: Technical Guidance (CIRIA, 2006a); CIRIA C649: Control of water pollution from linear construction projects: Site Guide (CIRIA, 2006b); CIRIA C698: Site handbook for the construction of SUDS (CIRIA, 2007); CIRIA C753: The SuDS Manual (CIRIA, 2015b); CIRIA R142: Control of pollution from highway drainage discharge (CIRIA, 1994); SEPA Code of Practice for installers, owners and operators of underground storage tanks and pipelines (SEPA, 2006); and SEPA Guidance for Pollution Prevention (GPPs) or Pollution Prevention Guidelines (PPGs) (SEPA, 2006-2017).

11.2.6 The following paragraphs discuss the key legislation of relevance to this chapter.

Water Environment and Water Services (Scotland) Act 2003 (WEWS Act)

11.2.7 The Water Framework Directive (WFD) (2000/60/EC) was transposed into Scottish law under the Water Environment and Water Services (Scotland) Act 2003 (WEWS Act). Under the WFD, new activities should not cause deterioration (of the ecological and chemical status of surface and ground water bodies), or prevent the achievement of overall Good Ecological Status (GES) or Potential (GEP, for artificial or heavily modified water bodies). However, such activities may be permitted, where:

- the benefits to human health, human safety or sustainable development outweigh their costs to the environment and to society;
- there are no significantly better alternative means of providing the benefits; and
- all practicable mitigation measures are taken to minimise their adverse effects on the water environment.

11.2.8 The aims of the WEWS Act are to:

- provide a sufficient supply of good quality surface water and groundwater as needed for sustainable, balanced and equitable water use;
- significantly reduce groundwater pollution;
- protect territorial and other marine waters; and
- achieve the objectives of international agreements.

11.2.9 This chapter is primarily concerned with surface water and has considered the requirements of the WEWS Act during the baseline characterisation of water features, the assessment of impacts and selection of mitigation measures. The assessment of groundwater is covered in Chapter 10 (Geology, Soils Contaminated Land and Groundwater) and was referred to where relevant.

The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended)

11.2.10 The WEWS Act (Scottish Government, 2003) gives Scottish Ministers power to regulate activities in the water environment (both surface waters and groundwater). This is achieved under The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended) (CAR) (Scottish Government, 2013); herein referred to as 'CAR'. This legislation controls engineering works within inland surface waters, as well as point source discharges, abstractions and impoundments.

11.2.11 There are three different levels of authorisation under CAR: General Binding Rules (GBR), Registration, and Licence (either Simple or Complex). The level of authorisation required for an activity relates to the risk associated with the activity, and is determined from the criteria set out within the CAR: A Practical Guide (SEPA, 2017a). The level of authorisation under CAR for the proposed scheme is likely to range from GBRs covering discharges from short road drainage catchments, to Simple Licences for culvert replacements and Complex Licenses for channel realignments. Discharges during construction are also likely to require a Simple Licence as a result of proposed amendments to CAR (SEPA, 2016a).

11.2.12 The development of a specimen design, preparation of a CAR scoping report and drafting of CAR license applications will be undertaken in consultation with SEPA following the completion of the DMRB Stage 3 Assessment.

Flood Risk Management Act (FRM Act)

11.2.13 The EU Floods Directive (2007/60/EC) is transposed into Scottish law through the Flood Risk Management (Scotland) Act 2009. The FRM Act sets in place a statutory framework for delivering a sustainable and risk-based approach to the management of flooding, including the preparation of assessments of the likelihood and impacts of flooding and associated catchment focussed plans.

11.2.14 The FRM Act places a duty on responsible authorities (Scottish Ministers, SEPA, Scottish Water and local authorities) to manage and reduce flood risk and promote sustainable flood risk management. The main elements of the FRM Act, which are relevant to the planning system, are the assessment of flood risks and undertaking structural and non-structural flood management measures.

Scottish Planning Policy (SPP)

11.2.15 Through the FRM Act, SPP (Scottish Government, 2014) requires planning authorities to consider all sources of flooding (coastal, fluvial, pluvial, groundwater, sewers and blocked culverts) and their associated risks when preparing development plans and reviewing planning applications.

11.2.16 The aims of SPP in relation to flooding are:

- to prevent developments which would be at significant risk of being affected by flooding;
- to prevent developments which would increase the probability of flooding elsewhere; and
- to provide a risk framework from which to identify a site's flood risk category and the related appropriate planning response.

11.2.17 This approach places planning in the wider context of Scottish Government aims and policies. SPP does not reinstate policy and guidance used elsewhere but should take into account the wider policy framework including the National Planning Framework in decision making.

Study Area

11.2.18 The baseline study area for this assessment extends 500m from the footprint of the proposed mainline, as shown on Figure 11.1 and includes identified water features ('WFs': including natural and artificial rivers, streams, drainage ditches, lochs and ponds), existing watercourse crossing points and flood inundation extents. For ecological designations, refer to Figure 5.2 and Figure 12.1.

11.2.19 As described in Chapter 1 (Introduction), the southern section of the A9 dualling programme comprises of five projects (from the Pass of Birnam to Glen Garry). The majority of the identified water features within this southern section were referenced sequentially from south to north (with occasional late additions appearing out of sequence). The proposed scheme is the northernmost dualling project of the southern section and as such the assessed water feature referencing starts at WF82.

11.2.20 For fluvial geomorphology, the study area was extended to 1km upstream and downstream of the proposed scheme to consider potential impacts on WFD status for designated water bodies, assess erosion risk, ascertain baseline sensitivity and inform the design of the proposed scheme and appropriate mitigation.

Baseline Conditions

11.2.21 Baseline conditions were identified through a combination of consultation with relevant stakeholders, desk-based assessment and site walkovers.

Desk-based Assessment

11.2.22 The desk-based assessment took into account relevant guidance (including DMRB HD45/09), legislation and regulations, as provided in Table 11.1. In addition, the data sources detailed in Table 11.2 have informed the assessments.

Table 11.2: Data sources

Topic	Sources of Information
Mapping and spatial data	• Aerial photography (BLOM, 2013); • Ordnance Survey (OS) 1: 25,000 mapping and 1: 1,250 to 1: 10,000 MasterMap data; • LiDAR topographical survey data; • Historical maps (National Library of Scotland, 2015); and • British Geological Survey Digital Mapping (BGS, 2016).
Hydrological data	• Flood Estimation Handbook (FEH) CD-ROM v3, Centre for Ecology and Hydrology (CEH, 2009); • SEPA Flood Maps (2015a); • Low Flows Enterprise (LFE) flow duration curve percentiles supplied by Wallingford Hydro Solutions; • SEPA Flood Frequency Curves and Time Series Data (SEPA, 2016b); • National River Flow Archive (CEH, 2015); • SEPA river gauging data records from 1990 to 2015 for station 15034 (River Garry at Killiecrankie) and associated hydrometric data (SEPA, 2016c); • SEPA RBMP data and classification results available on the SEPA Water Environment Hub (SEPA, 2016d); and • The River Basin Management Plan for the Scotland River Basin District: 2015 – 2027 (Scottish Government, 2015).

Topic	Sources of Information
Previous assessments	• A9 Dualling Programme Strategic Environmental Assessment (SEA) – Environmental Report (Transport Scotland, 2013); • A9 Dualling Programme Strategic Environmental Assessment (SEA) – Environmental Report Addendum (Transport Scotland, 2014a); • A9 Dualling Programme Strategic Environmental Assessment (SEA) – Post Adoption SEA Statement (Transport Scotland, 2014b); • DMRB Stage 1 Assessment A9 Dualling: Preliminary Engineering Support (PES) Services (Jacobs, 2014); • A9 Dualling Killiecrankie to Pitagowan: DMRB Stage 2 Scheme Assessment Report, Volume 1: Main Report and Appendices, Part 3: Environmental Assessment (Jacobs, 2016a); and • A9 Dualling Programme: Pitagowan to Glen Garry DMRB Stage 2 Assessment Report, Volume 1: Main Report and Appendices, Part 3: Environmental Assessment (Jacobs, 2016b).

Site Walkover and Surveys

11.2.23 The site walkovers and surveys undertaken to support the assessments are detailed in Table 11.3.

Table 11.3: Site walkover and surveys

Stage	Date	Discipline	Surveys
DMRB Stage 2	February, March, April and June (2015)	All	• Visual inspection of surface water features and the adjacent area to provide an understanding of the local topography, the hydrological regime and to enable catchment boundaries to be defined where they could not be identified with certainty from the desk-based assessment.
DMRB Stage 3	July, August, November and December (2016)	Flood Risk	• Surveys of water feature geometry e.g. channel cross-sections and hydraulic structures, using conventional topographical survey techniques. • Inspections of minor culvert crossings on the existing A9. • Strategic walkover surveys were at selected locations with a focus on developing Flood Risk Assessment (FRA) methodologies related to minor water features and how they should be analysed.
	May (2016)	Fluvial Geomorphology	• Geomorphological processes and features around several existing structures at a number of water features including: WF84, WF88, WF89, WF 98, WF 100 (River Garry), WF115, WF142, WF158 and WF164 (all water features are displayed on Figure 11.1). • Areas of erosion along the River Garry were visited in May 2016 to inform the baseline erosion risk assessment (see Appendix A11.5: Fluvial Geomorphology) which was used, in combination with Ground Investigation data (reported in Chapter 10: Geology, Soils and Groundwater), to inform the design process of the proposed scheme. • Field reconnaissance surveys to assess the reach scale geomorphological processes and functioning of the water features with existing structures (as listed above).
	September and October (2016)	Water Quality	• Visible inspection of proposed locations of SuDS outfalls, proposed locations of watercourse crossings associated with side roads and areas where additional specific mitigation may be required. • Properties with private water supplies (PWS) within the study area, where the location or source of the supply required confirmation.

Consultation

11.2.24 Details of the full consultation process for the proposed scheme are provided in Chapter 7 (Consultation and Scoping). Consultation relating to this assessment was undertaken with regulatory bodies and key stakeholders including SEPA, SNH, Perth & Kinross Council (PKC), Scottish Water and the Tay District Salmon Fisheries Board (TDSFB). Specific consultation undertaken during the DMRB Stage 3 assessment are summarised in Table 11.4.

Table 11.4: Consultations undertaken for DMRB Stage 3 assessment

Consultee	Date(s)	Aspect	Comment
Scottish Water	18 October 2016	Water supply abstractions	Details of abstraction points within water features in hydraulic connection with the proposed scheme.
SEPA	13 April 2015 and 21 May 2015	Hydrometric data	Historical flood flows and river flow data.
	26 April 2016	CAR licence locations	Provided a GIS file of CAR licence locations.
	August 2016	Water quality chemistry data	Provided monthly water quality monitoring data for locations throughout Scotland.
	Meetings 14 December and 28 September 2016	Drainage design	Sought feedback on drainage design throughout the design process.
	Meetings 28 July 2015 and 28 November 2016.	Flood Risk assessment (FRA) methodology and results	Ongoing dialogue was undertaken with SEPA since the meeting which has included multiple telephone conversations to clarify specific issues related to SEPA's written responses, and wider flood risk issues for discussion. Advice and guiding principles from SEPA were taken into consideration during the design and assessment stages.
	Meeting 28 November 2016	FRA, baseline and results.	Discussions on progress made to date on the assessment of flood risk, with particular focus on baseline and with-scheme hydraulic modelling results of the River Garry at high flood impact locations, including the Essangal Underbridge, Allt Bhaic Underbridge and the Pitaldonich Underbridge. Where the with-scheme modelling shows potential impacts, compensatory flood storage is to be assessed and modelled. Other options will be considered, including the Do-Nothing scenario.
	Meeting 19 October 2017	Watercourse crossings, flood risk mitigation	Discussions on watercourse crossings, proposed flood risk mitigation for WF92 and the approach for CAR license applications. It was discussed that the CAR license application process would be initiated following publication of the draft orders and ES.
Spey Fishery Board (SFB)	Meeting 05 November 2014	Salt application on roads	SFB raised concerns over salt discharge into designated waters through SuDS and highlighted that existing drainage may 'percolate' through 'habitats'. See comment below and refer to Appendix A11.6 (Water Quality) for the approach undertaken in relation to salt.
SNH	Meeting 07 July 2015	Salt application on roads	SNH highlighted the issue of salt and importance in gaining an understanding of current discharge. SEPA does not hold any evidence to suggest salt from the A9 is a current threat, but note that the A9 has few discharge points. Transport Scotland should consider salt issues in relation to A9 dualling programme. Refer to Appendix A11.6 (Water Quality) for the approach undertaken in relation to salt.

11.2.25 Flooding issues were raised at local drop-in sessions and public exhibitions by landowners and members of the public and these opportunities were used to capture local evidence and concerns. Discussions with attendees focussed on the nature of the observed flood extents, structure condition and maintenance and potential cumulative effects of other development proposals in addition to the proposed scheme. Meetings have also been held with some individual landowners where the flood history suggests there may be detailed flooding issues to consider. Information obtained from the consultation was used to inform the baseline assessment, where considered appropriate.

Impact Assessment Methodology

Introduction

11.2.26 The impact assessment reported in this chapter was undertaken in accordance with the guidance provided in DMRB HD45/09 (The Highways Agency et al., 2009a), whereby the level of significance of a potential impact on the existing baseline condition of the surface water environment is determined by the sensitivity of the surface water feature combined with the magnitude of impact. This assessment takes account of general and specific potential impacts from construction and/or operational activities,

both before and after the application of mitigation measures i.e. potential and residual impacts respectively.

11.2.27 The sensitivity and magnitude criteria presented in Tables 11.5 and 11.6 represent a development of those provided within DMRB HD45/09 Annex IV, to reflect the local sensitivities and other regulatory guidance.

Hydrology and Flood Risk

11.2.28 Assessment of potential impacts on hydrology and flood risk considered changes to the flow of water above the ground surface and within associated water features. In particular, the likelihood of flooding was assessed against the design 0.5% Annual Exceedance Probability (AEP) (1 in 200-year) plus a 20% allowance for climate change (cc) flood event in line with SEPA's Technical Flood Risk Guidance for Stakeholders (SEPA, 2015b); hereafter referred to as the 0.5% AEP (200-year) plus CC event.

11.2.29 AEP refers to the chance that a flood of a particular size is experienced or exceeded during any year. This chapter refers to a probability value expressed as a percentage to quantify this. For example, a 50% AEP equates to a 1 in 2 chance of the flood being experienced or exceeded in any given year, and a 0.5% AEP equates to a 1 in 200 probability of the flood being experienced or exceeded in any given year. The potential effects of climate change were allowed for in flood flow estimations by adding 20% to the 0.5% AEP (200-year) flood flows; in accordance with guidance (SEPA, 2015b). For simplicity, the terms 0.5% AEP (200-year) plus CC event *and* the 'design flood event' are used interchangeably to describe the flood event used in the assessment of flood risk.

Fluvial Geomorphology

11.2.30 Assessment of potential impacts on fluvial geomorphology considered both upstream and downstream changes in the bed substrate, and fluvial and geomorphological processes (including erosion, transport and deposition of sediment) both within the channel and adjacent floodplain zones.

11.2.31 The assessment of fluvial geomorphology impacts was undertaken using standard good practice and guidance notes from SEPA (Table 11.1), due to the absence of specific methodologies for the assessment of fluvial geomorphology with respect to road developments. The assessment was supported and further developed using professional judgement.

Water Quality

11.2.32 The assessment of potential impacts on water quality includes the sub-attributes of water supply/quality, dilution and removal of waste products and biodiversity, as specified within DMRB HD45/09.

Sensitivity

11.2.33 The sensitivity of water features, assigned within Appendix A11.1 (Baseline Conditions) was categorised on a scale of 'low' to 'very high' using various sources of information described below, as well as professional judgement, in accordance with the criteria provided in Table 11.5. In some cases, water features were categorised as a higher or lower sensitivity if there is sufficient justification. Where applicable, supporting information is provided within the relevant technical appendix.

11.2.34 For hydrology and flood risk, the sensitivity was based on the number and type of potential flood receptors including the existing A9 (assessed as critical social infrastructure in line with Scottish Government, 2014). Very high, high, medium and low sensitivities were assigned to watercourses taking into account the risk of flooding to identified receptors during the 0.5% AEP (200-year) plus CC event (SEPA, 2015b).

11.2.35 The sensitivity assessment of water quality was informed by the WFD water body condition status published by SEPA (to meet WEWS Act requirements) on its Water Environment Hub website (SEPA, 2016d). Where no data exist for smaller/minor water features, assumptions were made based on the status of the nearest classified water feature of a similar character (Mustow et al., 2005). In addition, any field observations which would likely affect the status of the water feature, if it were to be classified, were also taken into consideration.

Table 11.5: Sensitivity criteria – water features

Sensitivity	Criteria
Very High	**Attribute has a high quality and/or rarity on international scale**
	Hydrology and Flood Risk
	Water feature with direct flood risk to the adjacent populated areas, with greater than 100 residential properties and/or critical social infrastructure units such as the existing A9, hospitals, schools, safe shelters or other land use of great value at risk during the 0.5% AEP (200-year) plus CC event. Water feature with hydrological importance to: (i) sensitive and protected ecosystems of international status; and/or (ii) critical economic and social uses (e.g. water supply, navigation, recreation, and amenity).
	Fluvial Geomorphology
	Sediment Regime Water feature sediment regime provides a diverse mosaic of habitat types suitable for species sensitive to changes in sediment concentration and turbidity, such as migratory salmon and/or freshwater pearl mussel (FWPM). Water feature appears in complete equilibrium with natural erosion and deposition occurring. The water feature has sediment processes reflecting the nature of the catchment and fluvial system. **Channel Morphology** Water feature includes varied morphological features (e.g. pools, riffles, bars, natural bank profiles) with no sign of channel modification. **Natural Fluvial Processes** Water feature displays natural fluvial processes and natural flow regime, which would be highly vulnerable to change as a result of modification.
	Water Quality
	Water Supply/Quality '*High*' overall water quality status, and/or Water feature constitutes a valuable water supply resource due to extensive exploitation for public, private domestic and/or agricultural and/or industrial use, feeding ten or more properties; and/or Considered to exhibit 'High' water quality based on site observations and professional judgement, which may include no or very limited anthropogenic pressures on water quality from surrounding land-use with no impact on Environmental Quality Standards (EQS). **Dilution and Removal of Waste Products** A high number of licensed discharges/high daily volume of discharges to or within 50m of water feature (with potential hydraulic connectivity to the water feature) under CAR relative to flow. **Biodiversity** '*High*' overall ecology status or potential; or for non-classified water features, high ecosystem quality, based on site observations and professional judgement, and/or Protected/designated under EC legislation (Special Area of Conservation (SAC), Special Protection Area (SPA), Ramsar site), and/or No existing pressures to biodiversity.
High	**Attribute has a high quality and/or rarity on national scale**
	Hydrology and Flood Risk
	Water feature with direct flood risk to adjacent populated areas, with between 1 and 100 residential properties and/or more than 10 industrial premises at risk from flooding during the 0.5% AEP (200-year) plus CC event. Minor watercourses with an indirect and localised flood risk to critical infrastructure (including existing A9) during 0.5 % AEP plus CC event, due to existing undersized culverts. Water feature with hydrological importance to: (i) national designation sensitive and protected ecosystems; and/or (ii) locally important economic and social uses (e.g. water supply, navigation, recreation, and amenity).
	Fluvial Geomorphology
	Sediment Regime Water feature sediment regime provides habitats suitable for species sensitive to changes in sediment concentration and turbidity, such as migratory salmon and/or FWPM. Water feature appears largely in natural equilibrium with some localised accelerated erosion and/or deposition caused by land use and/or modifications. Primarily the sediment regime reflects the nature of the natural catchment and fluvial system. **Channel Morphology** Water feature exhibiting a natural range of morphological features (e.g. pools, riffles, bars, varied natural river bank profiles), with limited signs of artificial modifications or morphological pressures. **Natural Fluvial Processes** Predominantly natural water feature with a diverse range of fluvial processes that is highly vulnerable to change as a result of modification.
	Water Quality
	Water Supply/Quality '*Good'* overall water quality status and/or

Sensitivity	Criteria
	Water feature constitutes a valuable water supply resource due to exploitation for public, private domestic and/or agricultural and/or industrial use, feeding fewer than 10 properties and/or Considered to exhibit 'Good' water quality based on site observations and professional judgement. May have a small number of anthropogenic pressures and/or pollutant inputs from surrounding land-use that are not considered likely to affect compliance with EQS. This includes potentially contaminated land sites (as identified in Chapter 10: Geology, Soils and Groundwater) present 25-50m from water feature with potential hydraulic connection to the water feature and/or pollutant inputs that do not significantly affect WFD aims. **Dilution and Removal of Waste Products** Some existing licensed discharges/moderate daily volume of discharges to or within 50m of water feature under CAR relative to flow. **Biodiversity** '*Good*' overall ecology status or potential; or for non-classified water features, good ecosystem quality, based on site observations and professional judgement and/or Few existing pressures to biodiversity.
Medium	**Attribute has a medium quality and/or rarity on regional/local scale**
	Hydrology and Flood Risk
	A water feature with a possibility of direct flood risk to less populated areas (no residential properties or critical infrastructure units at risk) with <10 industrial premises and/or utilisable agricultural fields. A water feature with some but limited hydrological importance to: sensitive or protected ecosystems; and/or economic and social uses.
	Fluvial Geomorphology
	Sediment Regime Water feature sediment regime provides some habitat suitable for species sensitive to change in suspended sediment concentrations or turbidity. A water feature with natural processes occurring but modified, which causes notable alteration to the natural sediment transport pathways, sediment sources and areas of deposition. **Channel Morphology** Water feature exhibiting some morphological features (e.g. pools, riffles and depositional bars). The channel cross-section is partially modified in places, with obvious signs of modification to the channel morphology. Natural recovery of channel form may be present (e.g. eroding cliffs, depositional bars). **Natural Fluvial Processes** Water feature with some natural fluvial processes, including varied flow types. Modifications and anthropogenic influences having an obvious impact on natural flow regime, flow pathways and fluvial processes.
	Water Quality
	Water Supply/Quality '*Moderate*' overall water quality status, and/or Considered to exhibit 'Moderate' water quality based on site observations and professional judgement. May have a number of anthropogenic pressures and/or pollutant inputs from surrounding land-use that are considered likely to be affecting compliance with EQS for one or more parameters. This includes potentially contaminated land sites (as identified in Chapter 10: Geology, Soils and Groundwater) present 10-25m from water feature with potential hydraulic connection to the water feature. **Dilution and removal of waste products** Few existing licensed discharges/low daily volume of discharges to or within 50m of water feature under CAR relative to flow. **Biodiversity** '*Moderate*' overall ecology status or potential; or for non-classified water features, moderate ecosystem quality, based on site observations and professional judgement, and/or Existing pressures which are likely to be adversely affecting biodiversity.
Low	**Attribute has a low quality and/or rarity on local scale**
	Hydrology and Flood Risk
	A water feature passing through uncultivated agricultural land. A water feature which is assessed as not being a flood risk to the existing A9 for the 0.5% AEP (200-year) plus CC event. A water feature with minimal hydrological importance to: (i) sensitive or protected ecosystems; and/or (ii) economic and social uses.
	Fluvial Geomorphology
	Sediment Regime Water feature sediment regime which provides very limited physical habitat for species sensitive to changes in suspended solids concentration or turbidity. Highly modified sediment regime with limited/no capacity for natural recovery. **Channel Morphology** Water feature that has been extensively modified (e.g. by culverting, addition of bank protection or impoundments) and exhibits limited-to-no morphological diversity. The water feature is likely to have uniform flow, uniform banks and absence of bars. Insufficient energy for morphological change.

Sensitivity	Criteria
	Natural Fluvial Processes Water feature which shows no or limited evidence of active fluvial processes with unnatural flow regime or/and uniform flow types and minimal secondary currents.
	Water Quality
	Water Supply/Quality '*Poor*' or 'Bad' overall water quality status or potential, and/or Considered to exhibit 'Poor' or 'Bad' water quality based on site observations and professional judgement. May have a large number of anthropogenic pressures and/or pollutant inputs from surrounding land-use that are considered likely to be affecting the compliance of EQS for the majority of parameters. This includes potentially contaminated land sites (as identified in Chapter 10: Geology, Soils and Groundwater) present within 10m of water feature with potential hydraulic connection to the water feature. **Dilution and removal of waste products** No existing licensed discharges to or within 50m of the water feature under CAR. **Biodiversity** '*Poor*' or '*Bad*' overall ecology status or for non-classified water features, poor or bad ecosystem quality, based on site observations and professional judgement, and/or Many existing pressures which are considered to be adversely affecting biodiversity.

Impact Magnitude

11.2.36 The magnitude of potential impacts was assessed on a scale of 'major' to 'negligible' for both adverse and beneficial impacts based on the likely effect of proposed activities, guided by the criteria and examples provided in Table 11.6 and using professional judgement where necessary. The assessment of magnitude was influenced by the timing, scale, size and duration of changes to the baseline conditions, in addition to the likelihood or probability of occurrence.

11.2.37 The highest magnitude of impact is applied when any one of the criteria are met from the adverse categories presented in Table 11.6.

11.2.38 The classification of magnitude of impact on hydrology and flood risk in Table 11.6 below follow the guidance in DMRB HD45/09. However, it should be noted that DMRB HD45/09 classifies the magnitude of potential impacts on flood level using the 1% AEP (100-year) design flood event. In Scotland, the design standard (from Scottish Government, 2014 and SEPA, 2015b) is the 0.5% AEP (200-year) event; the assessment uses this design flood event and also includes a further allowance for climate change impacts to align with best practice principles of long-term sustainability as detailed in SPP (Scottish Government, 2014).

11.2.39 To meet the requirements of the WEWS Act, the magnitude of impact assessment on fluvial geomorphology takes into account the potential impacts on the condition status of the WFD water bodies and/or the supporting hydromorphological quality elements, as published on the SEPA Water Environment Hub website (SEPA, 2016d).

Table 11.6: Magnitude criteria – water features

Magnitude	Criteria
Major adverse	**Results in loss of water feature and/or quality and integrity of the water feature**
	Hydrology and Flood Risk
	Increase in peak flood level for the 0.5% AEP (200-year) plus CC event > 100mm.
	Fluvial Geomorphology
	Sediment Regime Extensive impacts on the water feature bed, banks and vegetated riparian corridor resulting in changes to sediment characteristics, transport processes, sediment load and turbidity. This includes extensive input of sediment from the wider catchment due to modifications. Impacts would be at the water body scale. **Channel Morphology** Extensive alteration to channel planform and/or cross section, including modification to bank profiles or the replacement of a natural bed. This could include significant channel realignment (negative); extensive loss of lateral connectivity due to new/extended embankments; and/or, significant modifications to channel morphology due to installation of culverts or outfalls. Impacts would be at the water body scale. **Natural Fluvial Processes** Significant change from baseline conditions with potential to alter processes at the catchment scale.

Magnitude	Criteria
	Condition Status Adverse impacts causing loss or damage to habitats. Impacts have the potential to cause deterioration in hydromorphology quality elements (quality and quantity of flow; river depth and width variation; structure and substrate of the bed dynamics; river continuity; structure of the riparian zone) preventing the achievement of water body objectives for Good Ecological Status (GES) or Good Ecological Potential (GEP).
	Water Quality
	Major shift away from baseline conditions. Likely to result in a downgrade in overall water quality status for all attributes (water supply/quality; dilution and removal of waste products; biodiversity) from either: • a measureable deterioration in EQS for greater than one month (construction); and/or • failure of both soluble and sediment-bound pollutants in the Highways Agency Water Risk Assessment Tool (HAWRAT) assessment, and compliance failure against EQS values (operation). Total removal of the water feature's capacity to dilute existing licenced discharges under CAR. Long-term loss or change to designated site or water supply. Calculated risk of pollution from a spillage >2% annually during operation.
Moderate adverse	**Results in effect on integrity of attribute, or loss of part of the water feature**
	Hydrology and Flood Risk
	Increase in peak flood level for the 0.5% AEP (200-year) plus CC event > 50mm.
	Fluvial Geomorphology
	Sediment Regime Some changes and impacts on the water feature bed, banks and vegetated riparian corridor resulting in some changes to sediment characteristics, transport processes, sediment load and turbidity. Impacts would be at the multiple reach scale. **Channel Morphology** Some alteration to channel planform and/or cross section, including modification to bank profiles or the replacement of a natural bed. Activities could include: channel realignment, new/extended embankments, modified bed and/bank profiles, replacement of bed and/or banks with artificial material and/or installation of culverts. Impacts would be at the multiple reach scale. **Natural Fluvial Processes** A shift away from baseline conditions with potential to alter processes at the reach or multiple reach scale. **Condition Status** Moderate adverse impacts at the reach or multiple reach scale, which causes some loss or damage to habitats. Impacts have the potential to cause failure or deterioration in one or more of the hydromorphological quality elements (quality and quantity of flow; river depth and width variation; structure and substrate of the bed dynamics; river continuity; structure of the riparian zone). May prevent the achievement of water body objectives for GES or GEP.
	Water Quality
	A moderate shift away from baseline conditions that may be long-term or temporary. Likely to result in a decline in water quality but not a downgrade in overall water quality status from either: • a measureable deterioration in EQS for less than one month (construction); and/or • failure of both soluble and sediment-bound pollutants in HAWRAT but compliance with EQS values (operation) Reduction in the water feature's capacity to dilute existing discharges under CAR. May result in temporary impacts on designated species/habitats or water supply. Calculated risk of pollution from a spillage >1% and <2% annually during operation.
Minor adverse	**Results in some measurable change in quality or vulnerability of attribute of the water feature**
	Hydrology and Flood Risk
	Increase in peak flood level for the 0.5% AEP (200-year) plus CC event of > 10mm.
	Fluvial Geomorphology
	Sediment Regime Limited impacts on the water feature bed, banks and vegetated riparian corridor resulting in limited (but notable) changes to sediment characteristics, transport processes, sediment load and turbidity at the reach scale. **Channel Morphology** A small change or modification in the channel planform and/or cross section. Includes upgrade to and/or extension of existing water feature crossing and/or structure with associated minor channel realignment with localised impacts. **Natural Fluvial Processes** Minimal shift away from baseline conditions with typically localised impacts up to the reach scale. **Condition Status** Minor adverse impacts at the reach scale, which may cause partial loss or damage to habitats. Impacts have the potential to cause failure or deterioration in one of the hydromorphological quality elements (quality and

Magnitude	Criteria
	quantity of flow; river depth and width variation; structure and substrate of the bed dynamics; river continuity; structure of the riparian zone).
	Water Quality
	Minor shift away from baseline conditions. Likely to result in a slight decline in water quality with no associated impacts on designated species/habitats or water supply, which is characterised by: • a temporary decline in water quality during construction; and/or • failure of either soluble or sediment-bound pollutants in HAWRAT during operation. Slight reduction in the water feature's capacity to dilute existing discharges under CAR. Calculated risk of pollution from a spillage >0.5% and <1% annually during operation.
Negligible	**Results in effect on attribute of the water feature, but of insufficient magnitude to affect the use or integrity**
	Hydrology and Flood Risk
	Negligible change in peak flood level for the 0.5% AEP (200-year) plus CC event of up to <+/- 10mm.
	Fluvial Geomorphology
	Minimal or no measurable change from baseline conditions in terms of sediment transport, channel morphology and natural fluvial processes. Any impacts are likely to be highly localised and not have an effect at the reach scale.
	Water Quality
	No perceptible changes to baseline conditions. No measureable change in water quality at any time during construction. No change in the water feature's capacity to dilute existing discharges under CAR. No risk identified by HAWRAT (Pass for both soluble and sediment-bound pollutants) during operation. Risk of pollution from a spillage <0.5% during operation.
Minor beneficial	**Results in some beneficial effect on attribute of the water feature or a reduced risk of negative effect occurring to the water feature**
	Hydrology and Flood Risk
	Reduction in peak flood level for the 0.5% AEP (200-year) plus CC event > 10mm
	Fluvial Geomorphology
	Sediment Regime Partial improvement to sediment processes at the reach scale, including reduction in siltation and localised recovery of sediment transport processes. **Channel Morphology** Partial improvements include enhancements to in-channel habitat, riparian zone and morphological diversity of the bed and/or banks. **Natural Fluvial Processes** Slight improvement on baseline conditions with potential to improve flow processes at the reach scale. **Condition Status** Slight beneficial impacts at the reach scale, which may cause partial habitat enhancement. Impacts have the potential to improve one of the hydromorphological quality elements (quality and quantity of flow; river depth and width variation; structure and substrate of the bed dynamics; river continuity; structure of the riparian zone).
	Water Quality
	Minor improvement over baseline conditions. HAWRAT assessment of either soluble or sediment-bound pollutants becomes '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).
Moderate beneficial	**Results in moderate improvement of the quality of the attribute of the water feature**
	Hydrology and Flood Risk
	Reduction in peak flood level for the 0.5% AEP (200-year) plus CC event > 50mm
	Fluvial Geomorphology
	Sediment Regime Reduction in siltation and recovery of sediment transport processes at the reach or multiple reach scale. **Channel Morphology** Partial creation of both in-channel and vegetated riparian habitat. Improvement in morphological diversity of the bed and/or banks at the reach or multiple reach scale. Includes partial or complete removal of structures and/or artificial materials. **Natural Fluvial Processes** Notable improvements on baseline conditions and recovery of fluvial processes at the reach or multiple reach scale.

Magnitude	Criteria
	Condition Status Notable beneficial impacts at the reach to multiple reach scale. Impacts have the potential to improve one or more of the hydromorphological quality elements (quality and quantity of flow; river depth and width variation; structure and substrate of the bed dynamics; river continuity; structure of the riparian zone) and/or assist in achieving the water body objectives for GES or GEP.
	Water Quality
	A moderate improvement over baseline conditions. HAWRAT assessment of both soluble and sediment-bound pollutants becomes '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).
Major beneficial	**Results in major improvement of attribute quality**
	Hydrology and Flood Risk
	Reduction in peak flood level for the 0.5% AEP (200-year) plus CC event > 100mm
	Fluvial Geomorphology
	Sediment Regime Improvement to sediment processes at the catchment scale, including recovery of sediment supply and transport processes. **Channel Morphology** Extensive creation of both in-channel habitat and riparian zone. Morphological diversity of the bed and/or banks is restored, such as natural planform, varied natural cross-sectional profiles, recovery of fluvial features (e.g. cascades, pools, riffles, and bars) expected for river type. Removal of modifications, structures, and artificial materials. **Natural Fluvial Processes** Substantial improvement on baseline conditions at catchment scale. Recovery of flow and sediment regime. **Condition Status** Substantial beneficial impacts at the catchment scale, which result in recovery/restoration of natural habitats suitable for supporting sensitive species. Potential improvement of overall status condition, which could lead to achievement of water body objectives for GES or GEP.
	Water Quality
	Major improvement over baseline conditions. The removal or likelihood of removal of existing pressures, resulting in a water body achieving its objectives for GES or GEP.

Impact Significance

11.2.40 The significance of potential impacts (either with or without mitigation measures) was determined as a function of the sensitivity of the water feature and the magnitude of a predicted impact. The matrix for the determination of significance, provided in the DMRB HD 45/09 guidance, is shown in Table 11.7.

11.2.41 Where the matrix indicates two alternative options (e.g. Slight/Moderate), the significance rating is selected using professional judgement, considering the sensitivity of receptor and duration or extent of works, in accordance with the DMRB HD 45/09 guidance.

11.2.42 In line with the precautionary principle, the higher significance is generally selected unless there is justification for the lower significance. Examples where a lower significance may be selected include where no in-channel works are proposed, where flood risk impacts occur on agricultural land as opposed to residential properties, or where the impact on one attribute is intrinsically linked to another attribute (e.g. water quality and biodiversity) that has a higher sensitivity.

Table 11.7: Matrix for determination of significance

Magnitude / Sensitivity	Negligible	Minor	Moderate	Major
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**

11.2.43 For the purposes of this assessment impact significance of '**Moderate'** or higher is considered significant in the context of the EIA Regulations and, therefore, is the focus for mitigation where practicable. However, it should be noted that for flood risk in particular (guided by discussions with SEPA and to ensure consistency with Scottish Planning Policy (Scottish Government, 2014) on flood risk), the aim has been to avoid any increased flood risk where feasible as part of DMRB Stage 3 design development. This avoidance of any increased flood risk is therefore considered irrespective of the significance classification, as set out in this chapter.

11.2.44 This chapter presents only those water features considered to potentially be significantly impacted (i.e. impacts of **Moderate** or greater significance) within Section 11.4 (Potential Impacts). Appendix A11.7 (Impact Assessment) provides the full assessment of water features within the study area (excluding those which are scoped out of the impact assessment, see Table 11.11).

Specific Methodologies

11.2.45 Throughout the DMRB Stage 3 assessment, there was regular discussion with members of the Environmental Steering Group (ESG) regarding the proposed scheme design and the environmental assessment methods, with reference to the SEA (Transport Scotland, 2013) for the wider A9 dualling programme.

Hydrology and Flood Risk

11.2.46 A flood risk assessment was undertaken following SEPA's Technical Flood Risk Guidance for Stakeholders (SEPA, 2015b), and giving consideration to the guidance within DMRB HD 45/09. 1D-2D numerical hydraulic modelling was undertaken for three principle watercourses; the River Garry, Allt Bhaic and the River Bruar. Hydraulic modelling using 1D and 1D-2D linked techniques was also undertaken for 8 minor watercourses (WF87, WF92, WF117, WF132, WF134, WF136, WF145 and WF156) to characterise flood mechanisms. Hydraulic spreadsheet based calculations were undertaken to assess flood risk from the remaining watercourses.

11.2.47 Full detailed methodologies are provided in Appendix A11.2 (Surface Water Hydrology), Appendix A11.3 (Flood Risk Assessment) and Appendix A11.4 (Hydraulic Modelling Report).

Fluvial Geomorphology

11.2.48 As part of the assessment for the proposed scheme, an assessment of potential impacts on the fluvial geomorphology of the water features affected by the proposed scheme was carried out in line with the Supporting Guidance (WAT-SG-21): Environmental Standards for River Morphology (SEPA, 2012a).

11.2.49 A baseline assessment of existing areas at risk of erosion along the River Garry was also undertaken to inform sensitivity ratings. These included locations where the existing A9 infrastructure is currently at risk, or the proposed scheme could be at risk from fluvial erosion in the future. Results of the erosion risk assessment are included in Appendix A11.1 (Baseline Conditions) with further details provided in Appendix A11.5 (Fluvial Geomorphology).

11.2.50 An additional geomorphological assessment was undertaken for the Habitat Regulations Assessment (HRA), focussing on potential impacts on the existing condition of SAC habitats and species. Further details on the methodology and results of the assessment are provided in Appendix A11.5 (Fluvial Geomorphology).

Water Quality

11.2.51 Specific water quality assessments were carried out to assess the impacts on the water environment from the operation of the proposed scheme.

Highways Agency Water Risk Assessment Tool (HAWRAT)

11.2.52 The assessment of operational impacts relating to routine runoff and spillage risk was carried out in line with the methods contained in DMRB HD 45/09 (Method A and Method D, respectively). The assessment of the magnitude and significance of operational impacts has taken into account the nature

of the water features proposed to receive road drainage and the dilution or dispersal potential of the water features.

11.2.53 A summary of DMRB HD45/09 Methods A and D of is provided in Appendix A11.6 (Water Quality).

Salt

11.2.54 The DMRB does not provide a method for assessing the potential impacts of salt on the surface water environment. However, SNH and the Spey Fisheries Board (refer to Table 11.3) recommended consideration as part of this assessment.

11.2.55 In the absence of an existing method for assessing salt concentrations in runoff and at the point of dilution, a simple and conservative risk-based model was developed that generally follows the approach taken by the HAWRAT method.

11.2.56 Full details of the salt assessment methodology, results and limitations are provided in Appendix A11.6 (Water Quality). It is not considered appropriate to incorporate the salt assessment into the assessment of impact magnitude and significance due to the limitations associated with the method; therefore, it is not discussed further within this chapter.

Access Tracks (Tier 3 Accesses)

11.2.57 Tier 3 accesses are private and/or agricultural accesses which are included as part of the proposed scheme. These access tracks would experience low traffic volumes with an Annual Average Daily Traffic (AADT) volume of <100 vehicles per day (vpd) and in some instances <10vpd.

11.2.58 The 'Simple Index Approach' (SIA) presented in 'The SuDS Manual' (Construction Industry Research and Information Association (CIRIA), 2015) was used to assess the impacts of runoff from these access tracks.

11.2.59 Tier 3 accesses are likely to be treated via 'over the edge' drainage that will be dispersed over vegetation with subsequent infiltration into groundwater, which the SIA considers to be one level of treatment. Where drainage is required parallel to the Tier 3 accesses, runoff will be permitted to infiltrate within open ditches or and residual flow will be spread diffusely over vegetated areas to allow for natural infiltration into groundwater.

11.2.60 Full details of the Tier 3 Accesses assessments are provided in Appendix A11.6 (Water Quality). The SIA assessments do not form part of the DMRB Stage 3 methodology and therefore are not discussed further within this chapter.

Limitations to Stage 3 Assessment

11.2.61 Baseline conditions described in Appendix A11.1 were informed by site walkover observations with surveys of water features made at specific times and water levels. However, it is recognised that seasonal variables (such as flow levels, vegetation growth and land use) can affect the visibility of in-channel features; as well as the overall morphology and fluvial processes observed at the time of survey, representing a limitation in recorded data sets, common to all aquatic field studies.

Hydrology and Flood Risk

11.2.62 Limitations relating to the flow estimation methods, hydraulic modelling and flood risk assessment are also provided in Appendix A11.2 (Surface Water Hydrology), Appendix A11.3 (Flood Risk Assessment) and Appendix A11.4 (Hydraulic Modelling Report) respectively.

Fluvial Geomorphology

11.2.63 Many watercourses were observed in the field at one point in time, therefore the predominant sediment regime and processes operating within the channel were inferred using best available site data and desk-based information. Measurements taken during initial geomorphological surveys were visual

estimates only. Where geomorphological issues were identified, further investigations to inform the design process made use of detailed topographic survey data.

11.2.64 Further limitations relating to the surveys and assessments undertaken for fluvial geomorphology are detailed in Appendix A11.5 (Fluvial Geomorphology).

Water Quality

11.2.65 The identification of private water supplies (PWS) was based on the information obtained through desk studies, consultation with local authorities and SEPA, as well as site visits (refer to Chapter 10: Geology, Soils and Groundwater). Reasonable skill, care and diligence were exercised in identifying PWS; however, notwithstanding this, there may be PWS which have not been identified, or PWS which may not be correctly characterised due to erroneous or out of date information provided during consultation.

11.2.66 Limitations relating to the water quality assessments undertaken are also provided in Appendix A11.6 (Water Quality).

11.3 Baseline Conditions

Water Features

11.3.1 A detailed description of all water features affected by the proposed scheme is provided within Appendix A11.1 (Baseline Conditions). This includes the baseline conditions and sensitivity for all water environment attributes covered within this chapter, namely: Hydrology and Flood Risk, Fluvial Geomorphology and Water Quality (Water Supply, Dilution and Removal of Waste Products and Biodiversity). As part of the baseline assessment for all water features, a sensitivity rating was determined for each water environment attribute and is included within the appendix. Where more information is required, for example in relation to increased sensitivity levels, this is located within the relevant technical appendix and a cross-reference provided.

11.3.2 Within the 500m study area, 89 water features were identified, including artificial drainage channels, lochs, minor watercourses and larger river systems.

11.3.3 As described in Chapter 1 (Introduction), the southern section of the A9 dualling programme comprises four projects currently progressing through the DMRB design and assessment process (from the Pass of Birnam to Glen Garry). The majority of identified water features within this southern section were referenced sequentially from south to north. The water features within the Killiecrankie to Glen Garry (Project 05) section are therefore numbered from WF82 to WF178.

11.3.4 The River Garry (WF100) flows through the entire study area and is contiguous with all the other water features. As such, it is the first water feature to be considered within the text and is assessed in two parts: the WF100 (upper) and WF100 (lower), as they align with two separate WFD water bodies with different baseline sensitivities.

11.3.5 The locations of all water features, with corresponding identification references, proposed scheme crossing locations and flood inundation extents are shown on Figures 11.1 and 11.2. For ecological designations, refer to Figure 12.1.

11.3.6 During the assessment process, 16 of the 89 initially identified water features within the 500m study area were screened out of the assessment for some or all attributes, as they were assessed as being unlikely to be affected by the construction or operation of the proposed scheme due to a lack of hydraulic connectivity. The baseline conditions of all water features are described in the following paragraphs, and those screened out of impact assessment are confirmed at the end of this section (refer to Table 11.11).

11.3.7 The baseline assessment includes consideration of river typology in line with the Environmental Standards for River Morphology (SEPA, 2012a). The different types and definitions of water features, identified within the study area, are described below in Table 11.8.

Table 11.8: Types and definitions of water features within the study area

Water Feature Type	Definition	Example within the Study Area	
Very large watercourse	Natural river channel Width >10m	**Photograph 11.1** River Garry (WF100) - View upstream of bridge at Killiecrankie	
Large watercourse	Natural river Width 5-10m	**Photograph 11.2** Allt Anndeir (WF158) - View downstream from National Cycle Route (NCR) 7 crossing	
Medium watercourse	Natural river Width 2-5m	**Photograph 11.3** Allt Bhaic (WF115) - View downstream towards existing A9 bridge crossing	
Small watercourse	Natural or modified stream Width 1-2m	**Photograph 11.4** WF159 - View downstream towards existing A9 embankment	

Water Feature Type	Definition	Example within the Study Area	
Drainage channel	Artificial field, forest or road drainage channel May be ephemeral or have intermittent flow Width <2m	**Photograph 11.5** WF116 - Facing downstream towards the existing A9	
Artificial pond	Man-made body of inland surface water	**Photograph 11.6** Pond WF94	

SEPA Monitored Surface Water Features

11.3.8 The majority of water features within the study area are not monitored by SEPA. Only eight of the larger water features are currently monitored, comprising:

- River Garry (WF100) – this includes two reaches separated by the weir at Old Struan, immediately upstream of the confluence with Errochty Water:
  - River Garry WF100 (upper): Garry Intake to Errochty Water confluence – this reach begins beyond the northern end of the proposed scheme and terminates at the Old Struan weir; and
  - River Garry WF100 (lower): Errochty Water confluence to Loch Faskally – this reach begins at the Old Struan weir and confluence with Errochty Water; and terminates at Loch Faskally, beyond the southern end of the proposed scheme.
- Lower Allt Girnaig (WF89);
- River Tilt (WF173);
- Banvie Burn (WF171);
- Allt Bhaic (WF115);
- River Bruar (WF123);
- Allt a' Chrombaidh (WF142); and
- Allt Anndeir (WF158).

Licenced Abstractions and Discharges

11.3.9 As advised by SEPA (consultation response received 26 April 2016), there are a number of activities (discharges, abstractions and impoundments) licenced under CAR within 50m of water features within

the 500m study area, as outlined in Table 11.9. The locations of the licensed activities are further detailed in Appendix A11.1 (Baseline Conditions).

Table 11.9: Licenced activities (abstractions, discharges and impoundments)

Water Feature	Total Number of Licensed Activities	Number of Licenced Discharge
WF87 (Troopers Den Burn)	2	Private septic tank effluent (2)
WF92	1	Private septic tank effluent (1)
WF96	1	Private septic tank effluent (1)
WF97	1	Private septic tank effluent (1)
WF (Allt Chluain)	5	Private septic tank effluent (5)
WF100 (River Garry) (lower)	9	Private septic tank effluent (3)
		Sewage discharge overflows (3)
		Sewage treatment final effluent (2)
		Trade effluent from Shierglas Quarry (1)
WF100 (River Garry (upper)	2	Private septic tank effluent (2)
WF123 (River Bruar)	1	Sewage treatment final effluent (1)
WF126	4	Private septic tank effluent (4)
WF170	1	Private septic tank effluent (1)
WF173 (River Tilt)	1	Private septic tank effluent (1)

Water Supply

11.3.10 A number of private water supply (PWS) abstractions from surface waters were identified within the 500m study area, as detailed in Table 11.10, and as shown on Figure 11.1.

11.3.11 Chapter 10 (Geology, Soils, Contaminated Land and Groundwater) provides a full list of PWS, including those from springs and boreholes, and within 850m of the proposed scheme.

Table 11.10: PWS abstractions from surface waters within the study area

Water Feature	PWS Reference	Source of Information	Property	Status	Comments
WF87 (Troopers Den Burn)	KP-PWS1	Landowner consultation	Coille Essan	Active	Supplies one to two properties for domestic/agricultural use. Pipeline connecting the source with the property(s) crosses the existing A9. Collection tanks in poor state of repair. Landowner trying to obtain mains connection.
WF92	KP-PWS2 KP-PWS3 KP-PWS14	Landowner Consultation	Craigurrard Orchilmore Farm Buildings and Steading Units	Active	Part of a domestic and agricultural (cattle/irrigation) supply from stream and springs. Fed by gravity through underground pipes.
WF95	KP-PWS5	Landowner consultation	The Barn, Lettoch Farm	Active	Together with spring supply WF95 supplies one property for domestic use.
WF96	KP-PWS9	Landowner consultation	Fieldstone, Mains of Orchil	Active	Supplies approximately three properties for domestic use.
WF102	PGG-PWS9	Landowner consultation	Glackmore	Active	Type B supply. Surface water supply sourced is being described as located 700m from property by land owners. Gravity fed.
WF103	PGG-S2	Statutory consultation (Perth & Kinross Council) & Landowner consultation	Garrybank	Active	Type A Level 1 supply. Described by landowner as a surface water supply, captured in a tank and piped under A9 to property. Unclear if this is surface water or shallow groundwater.

Water Feature	PWS Reference	Source of Information	Property	Status	Comments
WF133	PGG-PWS3	Landowner consultation	Tomchitchen	Active	Tenant is new at this property and was unaware of the configuration of existing supply. There was no visible evidence of the location of the PWS source and associated network.
WF156	PGG-PWS8	Landowner consultation	Dalreoch	Active	Surface water abstraction is pumped to the property. Frequent water shortage.

11.3.12 The Allt Girnaig (WF89) is a designated Drinking Water Protected Area (DWPA) under The Water Environment (Drinking Water Protected Areas) (Scotland) Order 2007 and provides water to settlements in the local area via the Killiecrankie Water Treatment Works (WTW). However, the intake for abstraction from Allt Girnaig (WF89) DWPA is upstream of the existing A9, and the proposed scheme, at approximately NGR NN 92565 65072. There is also a Scottish Water abstraction from the River Tay (River Tay DWPA) at Perth, though this is at a considerable distance downstream of the proposed scheme (~50km). As such, these Scottish Water abstractions were scoped out of this assessment.

Existing Road Drainage Network

11.3.13 Road drainage treatment on the existing A9 between Killiecrankie and Glen Garry is generally limited, consisting predominantly of kerbs and gullies which discharge untreated road runoff into the nearest watercourse. There are some limited sections of filter drains within the roadside verges, which will provide an initial level of treatment for road runoff.

Struan Weir

11.3.14 Struan Weir (NGR NN 80953 65430) was installed on the River Garry 60 years ago as part of the Tummel Valley Hydro-electric power scheme to prevent fish (predominantly salmon) passage upstream of the confluence with Errochty Water. This was required to prevent fish from encountering low water levels and areas of dry river bed caused by the abstraction from the River Garry and its tributaries upstream of this location. The Struan Weir was partially removed in January 2017 by SSE as part of a strategy to restore connectivity and reintroduce more natural flow conditions to the River Garry.

11.3.15 As the weir structure does not include abstraction or diversion of flows, alteration of the weir results in no change to the peak flow estimates. The future strategy for the reach of the River Garry between the Garry Intake and the confluence with Errochty Water includes reducing abstraction and improving low flow conditions, but this is unlikely to affect peak flow estimates used in the hydraulic modelling.

11.3.16 Further detail on methods used in the estimation of design flows are provided in Appendix A11.2 (Surface Water Hydrology).

Existing Flood Risk

11.3.17 The characterisation of baseline flood risk is described in detail in Appendix A11.3 (Flood Risk Assessment). This includes an assessment of existing flood risk from rivers (fluvial), surface water (pluvial), groundwater, sewers and failure of water-retaining infrastructure.

11.3.18 Current fluvial flood risk is described for each watercourse in Appendix A11.1 (Baseline Conditions) and a summary of existing fluvial and pluvial flood risk from Appendix A11.3 (Flood Risk Assessment) is provided below.

Fluvial Flood Risk

11.3.19 Existing fluvial flood risk was separated into flood risk from principal watercourses (medium/large/very large watercourses) and flood risk from minor watercourses (small watercourses/drainage channels) and reported in the subsequent sections. Within the proposed scheme (from Killiecrankie to Glen Garry) there are 13 identified principal watercourses (including the upper and lower River Garry) and 64 minor watercourses identified as being potentially impacted by the proposed scheme, thereby a total of 77 watercourses were included in the scope of this assessment.

Principal Watercourses

11.3.20 The SEPA Flood Maps indicate that the majority of the study area is located outwith the 0.5% AEP (200-year) flood extent (the functional floodplain). There are a few notable locations where the existing A9 encroaches into SEPA's estimated functional floodplain of the River Garry. These locations include: where the existing A9 crosses the River Garry at Essangal (ch4300); where the existing A9 lies in close proximity to the functional floodplain between Blair Atholl and Pitagowan, including south of Bruar at the River Garry crossing at Pitaldonich (ch11250-11360); and in the vicinity of the confluence of the River Garry with Allt Bhaic (ch9200).

11.3.21 Significant historic flooding of the River Garry was recorded, particularly in the vicinity of Blair Atholl, as recently as December 2015. Other significant floods occurred in 1931, 1916 and 1888. Further details of historical flooding can be found in Appendix A11.3 (Flood Risk Assessment).

11.3.22 Two separate hydraulic models were developed in order to assess flood risk from the River Garry, Allt Bhaic and the River Bruar:

- Hydraulic Model V: the River Garry crossing at Essangal; and
- Hydraulic Model VI: the confluence between the River Garry and Allt Bhaic (including the lower sections of the River Bruar).

11.3.23 The baseline flood risk associated with these watercourses for the 0.5% AEP (200-year) plus CC event, as presented within Figure 11.2, is discussed in further detail below.

Hydraulic Model of the River Garry crossing at Essangal

11.3.24 Immediately downstream of the existing Essangal Underbridge, hydraulic modelling shows that the River Garry spills out of bank with an onset of flooding during the 3.33% AEP (30-year) event. Floodwater spreads onto the southern floodplain of the River Garry and flows west towards the raised A9 embankment and then onto the northern floodplain area towards the Highland Main Line railway embankment. Flood depths in the northern floodplain area can reach above 1.25m, with the Highland Main Line railway embankment overtopping during the 3.33% AEP (30-year) event.

11.3.25 Upstream of the existing Essangal Underbridge, modelling results show flooding of the Highland Main Line railway during the 3.33% AEP (30-year) event. During this event, Chestnut Cottages at Kings Island, located between the B8079 and Highland Main Line railway, and certain sections of the B8079, are at risk of flooding.

11.3.26 The modelling confirms that the existing A9 is at risk of fluvial flooding from the River Garry during the design flood event, when a 20m section of the A9 is shown to be flooded between ch4580 and ch4600. The existing Essangal Underbridge itself it not shown to significantly influence water levels upstream of the structure during the flood events modelled.

Hydraulic Model of the confluence between the River Garry and Allt Bhaic

11.3.27 The hydraulic modelling results show that there is a current flood risk to the existing A9 at ch9500 from the River Garry during the 3.33% AEP (30-year) event with an 80m length of road becoming inundated. During the 0.5% AEP (200-year) plus CC event the flood risk increases, with the River Garry overtopping a 470m length of the existing A9. Once overtopped, floodwater enters the western floodplain of the Allt Bhaic and contributes to flooding in this area. The Allt Bhaic, by itself, is not predicted to overtop the A9 during the design flood event.

11.3.28 Out of bank flooding occurs in the northern River Garry floodplain, on the opposite bank to the existing A9. The hydraulic model shows that this would result in flooding to the B8079 underpass of the Highland Main Line railway (adjacent to ch9300), with an onset of flooding during the 0.5% AEP (200-year) plus CC event. The model predicts that the underpass would flood up to depths of approximately 500mm during the design flood event, making it impassable to vehicles.

11.3.29 As the existing A9 begins to rise towards the existing Pitaldonich Underbridge, it crosses the River Garry floodplain, separating the floodplain into two distinct areas. Immediately upstream of the existing

Pitaldonich Underbridge, the hydraulic model results show the River Garry would spill out over the riverbank onto the eastern floodplain during the 3.33% AEP (30-year) event. At this location floodwater spreads in an easterly direction and ponds against the southern embankment of the existing A9. Floodwater would make the access track impassable to vehicles, while flooding the properties at Pitaldonich and Tomban during the design flood event. Flood depths would reach to around 800mm along the track in some locations.

Minor Watercourses

11.3.30 Between Killiecrankie and Glen Garry the existing A9 crosses 55 minor watercourses. These are typically smaller unnamed streams, confined to narrow, often deep channels with relatively small catchment areas (<0.5km^2). The majority of these minor watercourses have channels passing through agricultural land and flow under the existing A9 through circular culverts ranging in diameter between 400mm and 1.2m. During the design flood event, the peak flow estimates for these watercourses range from 0.08m^3/s to 4.42m^3/s.

11.3.31 The risk of flooding from these watercourses is generally low as they typically flow through rural areas with no flood sensitive receptors. The greatest risks are usually associated with the watercourse crossings, especially in those cases where the existing capacity of the culvert is insufficient to convey flood flows and where there is limited upstream flood storage, potentially placing sensitive receptors (including the existing A9) at greater risk of flooding.

11.3.32 An assessment of the hydraulic performance of existing culverts indicates that around 60% of the existing A9 mainline watercourse crossings have adequate capacity to pass the design flow, albeit with limited culvert freeboard. Around 30% of the crossings are under capacity and may also pose a potential risk of flooding to the existing A9. Approximately 10% of the crossings are under capacity but do not pose a risk of flooding to the existing A9. Further detail is provided within Appendix A11.3 (Flood Risk Assessment).

Surface Water (Pluvial) Flood Risk

11.3.33 The SEPA Flood Map which is presented on Map 1 of Annex B, Appendix A11.3, indicates that for the 0.5% AEP (200-year) rainfall event, there are a number of small areas of land in close proximity to the existing A9 and within the study area which may be susceptible to surface water (pluvial) flooding.

11.3.34 The majority of the existing A9 between Killiecrankie and Glen Garry is on a raised embankment, which reduces the risk of the road becoming flooded by surface water. In these cases, the SEPA Flood Map identifies surface water ponding against the embankment, or the embankment diverting overland flow routes to the nearest minor watercourse.

Erosion Risk

11.3.35 As part of the geomorphological baseline investigations, locations of erosion risk were identified along the River Garry (WF100). These locations were either close to the existing A9 or parts of the proposed scheme that may be at risk of fluvial erosion.

11.3.36 To inform design development for the proposed scheme, a detailed erosion risk assessment was undertaken to identify the potential level of risk at each location. This level of risk was identified based on the likelihood of erosion occurring (based on factors such as channel type, historical channel change and bed/bank material) combined with the likely magnitude of an impact. One area of river bank close to the existing A9 between ch9900-10150 is considered to have a high risk of erosion and is shown in Photograph 11.7. Here, the bank is undercutting with a bare bank face composed of cobbles and sandy substrate. The erosion appears to be migrating upstream, with approximately a 15m length of the bank at risk of erosion. The access track was completely removed at this location by fluvial erosion. Embedded mitigation is included as part of the design of the proposed scheme as explained within Chapter 4 (Iterative Design Development) including moving the road alignment south away from the river and, if required, installing a gravity wall with rock armour toe protection (adjacent to the road).

Photograph 11.7: Erosion at ch10000

Baseline Sensitivity Summary

11.3.37 Table 11.11 provides a summary of the baseline sensitivity classifications for hydrology and flood risk, fluvial geomorphology and water quality attributes for all water features within the study area. Table 11.11 also indicates where water features were scoped out for the impact assessment. Water features are generally scoped out on the basis that no pathway was identified by which the proposed scheme could impact them.

11.3.38 Water Quality is considered in terms of four sub-attributes: 'Quality', 'Supply', 'Dilution and Removal of Waste Products', and 'Biodiversity'. Water supply is only relevant for where a PWS or public water supply abstraction is present.

11.3.39 A full description of the baseline conditions for all water features is provided in Appendix A11.1 (Baseline Conditions).

Table 11.11: Summary of water feature sensitivity

Water Feature ID	Water Feature Type	Sensitivity						Initial Screening
		Hydrology and Flood Risk	Fluvial Geomorphology	Water Quality				
				Quality	Water Supply	Dilution and Removal of Waste Products	Biodiversity	
WF100 (lower) (River Garry)	Very large watercourse	very high	high	high	high	low	very high	-
WF100 (upper) (River Garry)	Very large watercourse	high	high	high	-	low	medium	-
WF82 & WF83	Drainage channel	high	low	low	-	low	low	Scoped out for all attributes as no hydraulic connectivity with the proposed scheme.
WF84 (Allt Eachainn)	Medium watercourse	high	medium	medium	-	low	medium	-
WF85 & WF86	Drainage channel	low	low	low	-	low	low	Scoped out for all attributes as no hydraulic connectivity with the proposed scheme.
WF87 (Troopers Den Burn)	Small watercourse	low	medium	medium	high	medium	medium	-
WF89 (Lower Allt Girnaig)	Medium watercourse	very high	high	very high	very high	low	very high	-
WF90	Drainage channel	low	low	low	-	low	low	Scoped out for all attributes as no hydraulic connectivity with the proposed scheme.
WF91	Drainage channel	low	low	low	-	low	low	Scoped out for all attributes as no hydraulic connectivity with the proposed scheme.
WF92	Small watercourse	high	low	medium	high	low	medium	-
WF94	Drainage channel and artificial ponds	low	low	low	-	low	low	Scoped out for hydrology/flood risk and fluvial geomorphology as no direct flood risk or geomorphological impact identified.
WF95	Small watercourse	low	low	medium	high	low	low	-
WF96	Small watercourse	high	low	medium	high	low	medium	-
WF97	Drainage channel	low	low	low	-	low	low	-
WF98 (Allt Chluain)	Medium watercourse	high	medium	medium	-	medium	medium	-
WF99	Small watercourse	low	low	low	-	low	low	-
WF101	Small watercourse	low	low	low	high	high	low	-
WF102	Small watercourse	low	medium	medium	high	low	medium	-

Water Feature ID	Water Feature Type	Sensitivity						Initial Screening
		Hydrology and Flood Risk	Fluvial Geomorphology	Water Quality				
				Quality	Water Supply	Dilution and Removal of Waste Products	Biodiversity	
WF103	Small watercourse	high	medium	medium	high	low	medium	-
WF104	Small watercourse	low	medium	medium	-	low	medium	
WF105	Drainage channel	low	low	low	-	low	low	-
WF106 & 107	Drainage channel	low	low	low	-	low	low	-
WF108	Small watercourse	high	low	medium	-	low	medium	-
WF109	Drainage channel	low	low	low	-	low	low	-
WF110	Drainage channel	low	low	low	-	low	low	-
WF111	Small watercourse	high	medium	medium	-	low	medium	-
WF112 & WF113	Drainage channel	high	low	low	-	low	low	-
WF114	Small watercourse	low	medium	medium	-	low	low	-
WF115 (Allt Bhaic)	Medium watercourse	very high	high	high	-	low	very high	-
WF116 & WF117	Drainage channel	high	low	low	-	low	low	-
WF118	Drainage channel	low	low	low	-	low	low	-
WF119 & WF120	Drainage channel	low	low	low	-	low	low	-
WF121	Small watercourse	low	medium	medium	-	low	medium	-
WF123 (River Bruar)	Large watercourse	very high	high	high	-	low	very high	-
WF125 / WF126	Drainage channel	high	low	low	-	high	low	-
WF127	Small watercourse	high	low	medium	-	low	medium	-
WF128	Drainage channel	high	low	low	-	low	low	-
WF129	Drainage channel	low	low	low	-	low	low	-
WF131	Drainage channel	low	low	low	-	low	low	-
WF132	Small watercourse	high	medium	low	-	low	low	-
WF133	Small watercourse	high	medium	medium	high	low	medium	-
WF134	Small watercourse	high	low	low	-	low	low	-
WF135	Drainage channel	medium	low	low	-	low	low	Scoped out for all attributes as no hydraulic connectivity with the proposed scheme.
WF136	Small watercourse	high	low	low	-	low	low	-

Water Feature ID	Water Feature Type	Sensitivity						Initial Screening
		Hydrology and Flood Risk	Fluvial Geomorphology	Water Quality				
				Quality	Water Supply	Dilution and Removal of Waste Products	Biodiversity	
WF137	Small watercourse	low	low	low	-	low	low	-
WF139	Drainage channel	low	low	low	-	low	low	-
WF140	Small watercourse	high	medium	medium	-	low	medium	-
WF141	Drainage channel	low	low	low	-	low	low	-
WF142 (Allt a' Chrombaidh)	Medium watercourse	low	very high	high	-	low	high	-
WF143	Small watercourse	medium	low	medium	-	low	low	-
WF144	Small watercourse	low	low	medium	-	low	low	-
WF145	Small watercourse	low	low	medium	-	low	medium	-
WF147	Small watercourse	low	low	medium	-	low	medium	-
WF148	Drainage channel	low	low	low	-	low	low	-
WF149 (Allt nan Cuinneag)	Medium watercourse	low	medium	medium	-	low	medium	-
WF150	Drainage channel	high	low	low	-	low	low	-
WF151	Small watercourse	low	medium	medium	-	low	low	-
WF152	Drainage channel	low	low	low	-	low	low	-
WF153	Small watercourse	low	low	medium	-	low	low	-
WF154	Small watercourse	low	medium	medium	-	low	medium	-
WF155	Drainage channel	low	low	low	-	low	low	-
WF156	Small watercourse	high	medium	medium	high	low	medium	-
WF157	Small watercourse	low	low	medium	-	low	medium	-
WF158 (Allt Anndeir)	Large watercourse	medium	high	high	-	low	medium	-
WF159	Small watercourse	high	medium	medium	-	low	medium	-
WF160	Drainage channel	low	low	low	-	low	low	-
WF161	Drainage channel	high	low	low	-	low	low	-
WF162	Small watercourse	low	low	medium	-	low	medium	-
WF163	Drainage channel	low	low	low	-	low	low	-
WF164 (Allt Geallaidh)	Medium watercourse	high	high	medium	-	low	medium	-
WF165 (Allt Carn na Saidhe)	Medium watercourse	low	medium	medium	-	low	medium	-

Water Feature ID	Water Feature Type	Sensitivity						Initial Screening
		Hydrology and Flood Risk	Fluvial Geomorphology	Water Quality				
				Quality	Water Supply	Dilution and Removal of Waste Products	Biodiversity	
WF88/WF167 (Allt Crom Bhruthaich)	Medium watercourse	medium	medium	low	-	low	low	-
WF168	Small watercourse	very high	low	medium	-	low	medium	Scoped out for all attributes as no hydraulic connectivity with the proposed scheme.
WF169	Small watercourse	very high	low	low	-	low	low	Scoped out for all attributes as no hydraulic connectivity with the proposed scheme.
WF170	Small watercourse	very high	low	high	-	medium	medium	Scoped out for all attributes as no hydraulic connectivity with proposed scheme.
WF171 (Banvie Burn)	Medium watercourse	very high	medium	medium	-	medium	very high	Scoped out for all attributes as no hydraulic connectivity with the proposed scheme.
WF172	Small watercourse	very high	medium	medium	-	medium	medium	Scoped out for all attributes as no hydraulic connectivity with the proposed scheme.
WF173 (River Tilt)	Large watercourse	very high	high	medium	-	low	very high	Scoped out for all attributes as no hydraulic connectivity with the proposed scheme.
WF174	Drainage channel and artificial ponds	low	low	low	-	low	low	Scoped out for all attributes as no hydraulic connectivity with the proposed scheme.
WF176	Small watercourse	very high	low	medium	-	medium	medium	Scoped out for all attributes as no hydraulic connectivity with the proposed scheme.
WF177	Drainage channel	low	low	low	-	low	low	Scoped out for all attributes as no hydraulic connectivity with proposed scheme.
WF178	Small watercourse	high	low	low	-	low	low	-

11.4 Potential Impacts

Introduction

11.4.1 This section describes the assessment of potential impacts of the proposed scheme (as described in Chapter 5: The Proposed Scheme) on the surface water environment, that could arise in the absence of mitigation measures (i.e. those not already embedded within the proposed scheme designs).

11.4.2 Associated potential impacts affecting groundwater and ecological receptors are addressed in Chapter 10 (Geology, Soils, Contaminated Land and Groundwater) and Chapter 12 (Ecology and Nature Conservation) respectively.

11.4.3 Potential impacts on the surface water environment arising from the construction and operational phases of the proposed scheme are assessed separately for each of the hydrology and flood risk, fluvial geomorphology and water quality attributes.

11.4.4 For all surface water environment attributes, a set of potential general and specific potential impacts associated with each of the construction and operational phases of activity is identified. All potential impacts reported are adverse, unless otherwise stated.

Construction

11.4.5 A summary of typical construction activities associated with the proposed scheme that are likely to occur in close proximity to, over or within surface water features, is provided in Table 11.12. Further detail on proposed construction activities is provided in Appendix A11.7 (Impact Assessment) and Appendix A11.8 (Watercourse Crossings).

Table 11.12: Summary of construction activities within, near or close to water features

Location of Activity	Construction Activities	No of Water Features Potentially Impacted
Within 50m of water feature	Mainline widening	75
	Proposed SuDS features	11
	New side road	34
	Other infrastructure (incl. retaining wall)	22
Over water feature	New bridge	3
	Bridge extension	2
	Bridge replacement	5
Within water feature	Culvert replacements	47
	New culverts (in locations not currently culverted)	17
	Culvert extensions	5
	Channel realignment/regrading	26
	Cascades	23
	New outfalls	10

Construction – General Impacts

11.4.6 This section presents an overview of the potential general impacts likely to occur during construction in the absence of mitigation.

11.4.7 Potential impacts arising from construction activities are typically considered to be short-term, although in some cases they can have longer term effects. For instance, short-term, acute impacts on water quality could have longer term chronic effects on aquatic ecology (see Chapter 12: Ecology and Nature Conservation).

11.4.8 Table 11.13 outlines potential general impacts on the surface water environment during the construction of the proposed scheme.

Table 11.13: Potential general construction impacts

Type of Impact	Potential General Impacts from Construction Activities
Hydrology and Flood Risk	
Changes to runoff rates and flow characteristics	• Increased runoff and/or reduced infiltration rates from soil compaction due to construction traffic and the presence of temporary haul routes in the area of the proposed scheme. • Changes to flow characteristics due to disturbance or unintentional changes to channel dimensions and/or sedimentation etc. associated with works which may impact on the hydraulic flow characteristics of a water feature. • Disruption or blockage of existing natural flow paths due to temporary channel diversions and other associated temporary works, coffer dams etc. to facilitate culvert or bridge construction. • Increases peak flow rates going into water feature(s) due to temporary construction works for SuDS features within catchments. • Local lowering of groundwater and/or barriers to groundwater flow due to dewatering of excavations or temporary works for excavations requiring groundwater cut-offs. • Flash flooding of works during rapid runoff (pluvial) events potentially leading to major hazards, in particular if there are haul routes upstream of steep slopes where the proposed scheme is in cutting.
Increase in flood risk	• Increased flood risk due to temporary channel diversions to facilitate culvert or bridge construction; in-channel works; any associated temporary works and/or re-direction of flow through constructed realignments or into pre-earthwork ditches with a lower conveyance. • Reduced flood storage capacity due to temporary loss of floodplain area or compartmentalisation of the floodplain. • Reduced natural floodplain conveyance due to construction materials and plant within the floodplain; haul route construction or other temporary works related to carriageway widening and other activities in the floodplain. • Reduced watercourse conveyance capacity due to under-sized culverts or sediment/blockage e.g.at temporary haul route crossings and under the existing A9. • Increased risk of flooding from exposed sewers and water mains that may also result in a pollution incident due to the increased potential for service strikes. • Increased risk of flooding of working areas, potentially damaging plant and materials and/or leading to pollution incidents.
Fluvial Geomorphology	
Changes to sediment regime	• Release of suspended solids from: exposed bare earth surfaces; due to in-channel working for culvert and outfall installation and channel realignment construction; construction of clear-span bridges; vegetation clearance (likely to be greater in winter months). • Increased sediment supply from accidental damage to river banks or bed resulting from vegetation clearance, plant movement or other construction activities. • Increased sediment delivery and transport due to temporary earthworks being washed away.
Changes in channel morphology	• A reduction in diversity of the channel bed due to increased fine sediment supply from bare earth surfaces, in-channel construction of structures and vegetation clearance. • Loss of active features such as exposed gravel deposits due to smothering by fine sediment. • Loss or disturbance of channel bed in the vicinity of culvert installation and outfall construction or where channels are realigned. • Reduced morphological diversity due to vegetation clearance, loss of tree roots and/or woody material. (Woody material within the channel may encourage the formation of different geomorphological features such as riffles, deposits and pools.) • In-channel adjustments, through erosion and deposition, due to alterations to cross-section and planform. • Increase in channel erosion as water is released down realigned channels, particularly if the channel is straightened and gradient increased. • Reduced bank stability during the construction of crossings, channel diversions/realignments or other works requiring vegetation clearance of the banks of the water features. This could result in increased bank erosion and associated sediment release.
Changes to natural fluvial processes	• Increased bare earth surfaces and changes to flow pathways could result in alterations to the quantity of flow entering the channel with potential to locally alter flow processes. This could lead to changes in erosion and deposition and sediment processes. • Alteration to fluvial processes and associated erosion and deposition regimes within a channel due to changes to the quantity of flow. • Channel instability may be triggered by straightening, particularly during high flows. • Changes in lateral (floodplain) connectivity as a result of works within the channel and the surrounding floodplain.

Type of Impact	Potential General Impacts from Construction Activities
Water Quality	
Decline in water quality or supply	• An increase in suspended sediment concentrations in downstream water features from construction of crossing structures in-channel or on watercourse banks, soil stripping and vegetation removal, soil storage, erosion of drainage ditches and all other earthworks which could result in the mobilisation of sediment. This would form silt-laden runoff which could migrate to downstream water features if insufficient treatment is provided. • Accidental release of oils, fuels and chemicals to the water environment from mobile or stationary plant in or near to water features, and from inappropriate refuelling and fuel storage practices. This could include an increase in alkalinity from poor management and spillages of concrete or cement. • Inputs of contaminants to the water environment could occur from disturbance of potentially contaminated land with potential drainage pathways to surface water features. Contaminated particles within suspended sediment may increase the bio-toxicity of in-channel sediment deposits. • Sewage inputs to the water environment from accidental/uncontrolled release from sewers through damage to pipelines during service diversion or unsatisfactory disposal of sewage from site staff facilities. • Pollution of a viable water resource through construction activities taking place upstream of a public or private water supply surface water abstraction. • Severance of a public or private water supply due to disruption of pipelines and other buried assets present along the existing A9 corridor.
Reduction in dilution capacity	• A reduction in the dilution capacity of a watercourse due to the decline in water quality (as described above) or diversion of sub-catchment flows.
Adverse impacts on biodiversity	• A decline in river ecosystem health and loss of protected aquatic species due to the decline in water quality (as described above). • Excess sediment settling out in sensitive stretches of a watercourse with the potential to smother gravels used for salmonid spawning and hatching. • Excess sediment affecting the health of aquatic fauna by interfering with respiration and increasing stress levels. • Releases of chemicals and concrete which can have severe or fatal consequences on freshwater ecology.

Construction - Specific Impacts

11.4.9 This section provides the results of an assessment of the significance of potential impacts likely to occur during construction, that are specific to individual water features within the study area in the absence of mitigation. The assessment is based on key construction works proposed either within or near to each water feature, full details are provided within Appendix A11.7 (Impact Assessment) and summarised in Table 11.12.

11.4.10 The results below include only potential impacts of **Moderate** significance or above for hydrology and flood risk, fluvial geomorphology and water quality.

Table 11.14: Potential impacts (pre-mitigation) on water features – Construction

Water Feature	Attribute	Description of Specific Construction Impacts on Water Feature	Sensitivity	Magnitude	Significance
WF100 (lower) River Garry: Errochty Water Confluence to Loch Faskally	Hydrology and Flood Risk	Temporary increase of impermeable areas within the catchment and the construction of six new road drainage outfalls (Combined outfall E(1) and E(2), F, I, J(1), J(2), K) within/in close proximity to the River Garry have the potential to increase peak flow rates into the river and increase the risk of flooding. Temporary construction structures for the new Essangal and River Garry Underbridges may result in increased hardstanding within close proximity to the watercourse/in-channel works including the construction of in-channel piers for the Essangal Underbridge (ch4300) may cause constrictions of flows/loss of floodplain storage due to works encroaching into the floodplain and therefore result in increased flood risk.	very high	major	**Very Large**
	Fluvial Geomorphology	General construction in tributaries of the River Garry and near sensitive locations, large erosional/depositional features or areas with SSSI and SAC designations could lead to impacts on the River Garry. Works within more specific locations are outlined below: • Construction of the Essangal Underbridge (ch4300) and the River Garry Underbridge (ch11200) would require works within the vicinity (1m) of the River Garry (WF100) potentially altering channel banks. Potential fine sediment inputs could ensue affecting the channel bed. • The design of the Essangal Underbridge (ch4300) includes piers within the channel cross-section, therefore in-channel works would be required during their construction. This would also lead to the removal of lengths of natural bed and banks to accommodate the structure. There is the potential for increased risk of fine sediment delivery downstream during in-channel works smothering bed substrate. Due to removal of natural features, potential for movement of coarse material downstream. Excavation of the river bed to install scour protection would further disturb the channel bed. Works in the channel are likely to require a dry working area leading to some form of dam being put in place within the channel, further disturbing the channel bed. At the River Garry Underbridge (ch11200) new abutments in the floodplain would also be required, altering lateral connectivity. Potential fine sediment inputs could ensue affecting the channel bed. • Construction of outfalls requiring works within the channel.	high	moderate	**Large**
	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	high	major	**Very Large**
	Biodiversity		very high	major	**Very Large**
	Water Supply	Severance of water supply KP-PWS15 through disruption of pipeline underlying the proposed scheme from excavations or compaction.	high	major	**Large**
WF100 (upper reach) River Garry: Garry Intake to Errochty Water confluence	Hydrology and Flood Risk	The increase of impermeable areas within the catchment and the construction of three outfalls/SuDS features (SuDS M, N and O) (which will discharge directly into the River Garry) have the potential to increase peak flows entering the watercourse and increase the risk of flooding.	high	moderate	**Moderate**
	Fluvial Geomorphology	Works within the vicinity and along the banks of the River Garry altering the channel cross-section with potential changes to bank profiles and riparian vegetation. Potential fine sediment input to river from proposed works within the channel and within tributaries, with associated changes to morphological features.	high	moderate	**Moderate**
	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	high	major	**Large**
	Biodiversity		medium	major	**Large**
WF87 (Troopers Den Burn)	Fluvial Geomorphology	Culvert extension and channel realignment resulting in the input of fine sediment to the water column. Modification of banks and bed. Construction has the potential to cause disturbance to existing morphological features within the channel, in particular bedrock features including a natural step-pool sequence.	medium	moderate	**Moderate**

Water Feature	Attribute	Description of Specific Construction Impacts on Water Feature	Sensitivity	Magnitude	Significance
	Water Quality	Decline in water quality and pollutant removal capacity, adverse impacts on biodiversity from the generation of sediment runoff and increased risk of chemical pollution.	medium	moderate	**Moderate**
	Dilution and Removal of Waste Products		medium	moderate	**Moderate**
	Biodiversity		medium	moderate	**Moderate**
	Water Supply	Severance of water supply KP-PWS1 through disruption of pipeline underlying the proposed scheme from excavations or compaction.	high	major	**Very Large**
WF89 (Lower Allt Girnaig)	Hydrology and Flood Risk	Bridge supports and surrounding earthworks are elevated above the bankfull width of the channel and are unlikely to cause restriction in flood flows. Increase of impermeable areas within the catchment and the construction of two outfalls (from SuDS features A and B) which discharge into the watercourse have the potential to increase peak flows rates into the watercourse and increasing the risk of flooding. However, this modification of the catchment is considered to be insignificant in comparison the overall catchment size.	very high	minor	**Moderate**
	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	very high	moderate	**Large**
	Biodiversity		very high	moderate	**Large**
WF92	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increases in runoff rates into the watercourse. Construction of replacement culvert/cascade/channel realignment may cause restriction in flood flows, temporary increase in flood risk locally and may be susceptible to flood damage. Change to runoff rates from site drainage and change in vegetation type.	high	moderate	**Moderate**
	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	medium	moderate	**Moderate**
	Biodiversity		medium	moderate	**Moderate**
WF95	Water Quality	Decline in water quality and adverse impacts on biodiversity as per WF100 (lower reach).	medium	moderate	**Moderate**
WF96	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increases in runoff rates into the watercourse. Construction of culvert extension/temporary construction structures may cause; loss of floodplain area, restriction in flood flows, temporary increase flood risk locally and may be susceptible to flood damage.	high	moderate	**Moderate**
	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	medium	moderate	**Moderate**
	Biodiversity		medium	moderate	**Moderate**
WF98 (Allt Chluain)	Hydrology and Flood Risk	Supports of the Allt Chluain Underbridge and surrounding earthworks are well above the channel zone and are unlikely to cause restriction of flood flows, temporarily increase flood risk locally or be susceptible to flood damage. Temporary construction works for SuDS within catchment may slightly increase peak flow rates into watercourse. Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increases in runoff rates into the watercourse.	high	moderate	**Moderate**
	Water Quality	Decline in water quality and pollutant removal capacity, adverse impacts on biodiversity as per WF87.	medium	major	**Large**
	Dilution and Removal of Waste Products		medium	moderate	**Moderate**
	Biodiversity		medium	major	**Large**

Water Feature	Attribute	Description of Specific Construction Impacts on Water Feature	Sensitivity	Magnitude	Significance
WF178 (located between WF98 and WF101)	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increases in runoff rates into the watercourse. Temporary construction works for SuDS feature D2 will discharge to this watercourse may slightly increase peak flow rates into watercourse. Culvert replacement/channel realignment may cause; restrictions in flood flows, temporary increase in flood risk locally and may be susceptible to flood damage.	high	moderate	**Moderate**
WF101	Dilution and removal of waste products	Decline in pollutant removal capacity resulting from increased risk of chemical pollution.	high	moderate	**Moderate**
WF102	Fluvial Geomorphology	Construction of culvert extension would require working within the channel at currently undisturbed locations. This would lead to the alteration of the natural channel bed, banks and riparian vegetation and the release of fine sediment downstream.	medium	moderate	**Moderate**
	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	medium	major	**Large**
	Biodiversity		medium	major	**Large**
WF103	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increases in runoff rates into the watercourse. Construction of culverts/temporary construction structures placed within the flood risk zones/ditch realignment may cause; loss of floodplain area, restriction in flood flows, temporary increase in flood risk locally and may be susceptible to flood damage.	high	moderate	**Moderate**
	Fluvial Geomorphology	Construction of three new culverts would require working within the channel at currently undisturbed locations. This would lead to the alteration of the natural channel bed, banks and riparian vegetation and the release of fine sediment downstream.	medium	moderate	**Moderate**
	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	medium	major	**Large**
	Biodiversity		medium	major	**Large**
	Water Supply	Disruption or severance of pipeline underneath the existing A9 which connects Garrybank (residential property) to PWS PGG-S2 source (domestic use) upslope of existing A9.	high	major	**Very Large**
WF104	Fluvial Geomorphology	Construction of new culverts would require working within the channel at currently undisturbed locations. This would lead to the alteration of the natural channel bed, banks and riparian vegetation and the release of fine sediment downstream.	medium	moderate	**Moderate**
	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	medium	major	**Large**
	Biodiversity		medium	major	**Large**
WF108	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increase in runoff rates into the watercourse. Construction of culvert/cascade/temporary construction structures placed within the flood risk zones may cause; loss of floodplain area, restrictions in flood flows, temporary increase in flood risk locally and may be susceptible to flood damage.	high	moderate	**Moderate**
	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	medium	moderate	**Moderate**
	Biodiversity		medium	moderate	**Moderate**
WF111	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increases in runoff rates into the watercourse. Construction of replacement culvert/new culvert/ cascade/temporary construction structures placed within the flood risk zones may cause; loss of floodplain storage, restrictions in flood flows, temporary increase in flood risk locally and may be susceptible to flood damage.	high	moderate	**Moderate**

Water Feature	Attribute	Description of Specific Construction Impacts on Water Feature	Sensitivity	Magnitude	Significance
	Fluvial Geomorphology	Construction of a new culvert and channel realignment would require machinery working within the water feature and removal of existing geomorphological features including a step-pool sequence and cobble/pebble substrate.	medium	moderate	**Moderate**
	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	medium	moderate	**Moderate**
	Biodiversity		medium	moderate	**Moderate**
WF112	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increases in runoff rates into the watercourse. Construction of replacement culvert/new culvert/ cascade/temporary construction structures placed within the flood risk zones may cause; loss of floodplain storage, restrictions in flood flows, temporary increase in flood risk locally and may be susceptible to flood damage.	high	moderate	**Moderate**
WF113	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increases in runoff rates into the watercourse. Construction of replacement culvert/new cascade/new culvert/temporary construction structures placed within the flood risk zones may cause; loss of floodplain storage, restrictions in flood flows, temporary increase flood risk locally and may be susceptible to flood damage.	high	moderate	**Moderate**
WF114	Fluvial Geomorphology	Construction of culvert extension would require working within the channel at currently undisturbed locations. This would lead to the alteration of the natural channel bed, banks and riparian vegetation and the release of fine sediment downstream.	medium	moderate	**Moderate**
	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	medium	moderate	**Moderate**
WF115 (Allt Bhaic)	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction and the construction of two outfalls may result in temporary increases in runoff rates into the watercourse. The proposed location of the SuDS features encroaches into the floodplain and therefore may also increase flood risk locally due to loss of floodplain area during construction works. Construction of the Allt Bhaic Underbridge/temporary construction structures placed within the flood risk zones would cause; loss of floodplain area, restriction in flood flows, temporary increase flood risk locally and may be susceptible to flood damage.	very high	moderate	**Large**
	Fluvial Geomorphology	Channel realignment would require works within the water feature and the removal of a large section of existing road drain. Demolition of the existing bridge and construction of the new bridge would require works on the banks and potential removal of riparian vegetation. The construction activity would also result in fine sediment transfer downstream.	high	moderate	**Moderate**
	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	high	major	**Very Large**
	Biodiversity		very high	major	**Very Large**
WF116	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increases in runoff rates into the watercourse. Construction of replacement culvert/channel regrading/temporary construction structures placed within the flood risk zones may cause; loss of floodplain storage, restrictions in flood flows, temporary increase flood risk locally and may be susceptible to flood damage.	high	moderate	**Moderate**
WF117	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increases in runoff rates into the watercourse. Construction of replacement culvert/new culvert/temporary construction structures placed within the flood risk zones may cause; loss of flood plain storage, restrictions in flood flows, temporary increase in flood risk locally and may be susceptible to flood damage.	high	moderate	**Moderate**
WF121	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	medium	major	**Large**
	Biodiversity		medium	major	**Large**

Water Feature	Attribute	Description of Specific Construction Impacts on Water Feature	Sensitivity	Magnitude	Significance
WF123 (River Bruar)	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increases in runoff rates into the watercourse. Potential for increased flood risk during construction due to construction works potentially encroaching into the floodplain of the River Bruar (WF123).	very high	minor	**Moderate**
	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	high	moderate	**Moderate**
	Biodiversity		very high	moderate	**Large**
WF125 and WF126	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increases in runoff rates into the watercourse. Construction of replacement culvert/realignment/temporary construction structures placed within the flood risk zones may cause; loss of floodplain storage, restrictions in flood flows, temporary increase in flood risk locally and may be susceptible to flood damage.	high	moderate	**Moderate**
	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	low	major	**Moderate**
	Biodiversity		low	major	**Moderate**
WF127	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increases in runoff rates into the watercourse. Construction of culvert extension/temporary construction structures placed within the flood risk zones may cause; restriction in flood flows, temporary increase in flood risk locally and may be susceptible to flood damage.	high	moderate	**Moderate**
	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	medium	moderate	**Moderate**
	Biodiversity		medium	moderate	**Moderate**
WF128	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increases in runoff rates into the watercourse. Construction of new side road culverts/culvert extension/channel realignment/temporary construction structures placed within the flood risk zones may cause; loss of floodplain area, restriction in flood flows, temporary increase in flood risk locally and may be susceptible to flood damage.	high	moderate	**Moderate**
WF132	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increases in runoff rates into the watercourse. Construction of replacement culvert/temporary construction structures placed within the flood risk zones may cause; loss of floodplain area, restriction in flood flows, temporary increase in flood risk locally and may be susceptible to flood damage.	high	moderate	**Large**
WF133	Water Supply	Severance of water supply PGG-PWS3 through disruption of pipeline underlying the proposed scheme from excavations or compaction.	high	major	**Very Large**
WF134	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increases in runoff rates into the watercourse. Construction of replacement culvert/side road/bridge/temporary construction structures placed within the flood risk zones may cause; loss of floodplain area, restriction in flood flows, temporary increase in flood risk locally and may be susceptible to flood damage.	high	moderate	**Large**
	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	low	major	**Moderate**
	Biodiversity		low	major	**Moderate**
WF136	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increases in runoff rates into the watercourse. Construction of replacement culvert /cascade/channel realignment/temporary construction structures placed within the flood risk zones may cause; loss of floodplain area, restriction in flood flows, temporary increase in flood risk locally and may be susceptible to flood damage. Temporary construction works for SuDS feature L may slightly increase peak flow rates into watercourse.	high	moderate	**Large**

Water Feature	Attribute	Description of Specific Construction Impacts on Water Feature	Sensitivity	Magnitude	Significance
WF140	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increases in runoff rates into the watercourse. Construction of replacement culvert/cascade/channel realignment/temporary construction structures placed within the flood risk zones may cause; loss of floodplain area, restriction in flood flows, temporary increase in flood risk locally and may be susceptible to flood damage.	high	moderate	**Moderate**
	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	medium	moderate	**Moderate**
	Biodiversity		medium	moderate	**Moderate**
WF142 (Allt a' Chrombaidh)	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	high	major	**Large**
	Biodiversity		high	major	**Large**
WF143	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increases in runoff rates into the watercourse. Construction of replacement culvert/regrading of channel/drainage ditch realignment/temporary construction structures placed within the flood risk zones may cause; loss of floodplain area, restriction in flood flows, temporary increase in flood risk locally and may be susceptible to flood damage.	medium	moderate	**Moderate**
	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	medium	moderate	**Moderate**
WF145	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	medium	moderate	**Moderate**
	Biodiversity		medium	moderate	**Moderate**
WF147	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	medium	major	**Large**
	Biodiversity		medium	major	**Large**
WF149 (Allt nan Cuinneag)	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	medium	major	**Large**
	Biodiversity		medium	major	**Large**
WF150	Hydrology and Flood Risk	Potential for temporary increase in hardstanding areas and soil compaction during construction to result in temporary increased runoff rates in the watercourse. Construction of channel realignment/temporary construction structures placed within the flood risk zones may cause; loss of floodplain area, restriction in flood flows, temporary increase in flood risk locally and may be susceptible to flood damage.	high	moderate	**Moderate**
WF153	Water Quality	Decline in water quality from the generation of fine sediment-laden runoff and chemical pollution.	medium	moderate	**Moderate**
WF154	Fluvial Geomorphology	Construction of a new culvert and channel realignment would require works within the water feature and the removal of a large section of existing earth road drain.	medium	moderate	**Moderate**
	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	medium	moderate	**Moderate**
	Biodiversity		medium	moderate	**Moderate**
WF156	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increases in runoff rates into the watercourse. Construction of new culverts/channel realignment/regrading/cascade/temporary construction structures placed within the flood risk zones may cause; loss of floodplain area, restriction in flood flows, temporary increase in flood risk locally and may be susceptible to flood damage. Change to runoff rates from site drainage and change in vegetation type.	high	moderate	**Moderate**
	Fluvial Geomorphology	Construction of two new culverts would require working within the channel at currently undisturbed locations. This would lead to the alteration of the natural channel bed, banks and riparian vegetation and for release of fine sediment downstream.	medium	moderate	**Moderate**

Water Feature	Attribute	Description of Specific Construction Impacts on Water Feature	Sensitivity	Magnitude	Significance
	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	medium	moderate	**Moderate**
	Biodiversity		medium	moderate	**Moderate**
	Water Supply	Pollution of PWS (PGG-PWS8) from construction activities taking place upstream of the PWS source and potential disruption to PWS infrastructure.	high	major	**Very Large**
WF157	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	medium	moderate	**Moderate**
	Biodiversity		medium	moderate	**Moderate**
WF158 (Allt Anndeir)	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increases in runoff rates into the watercourse. Construction of new bridges/side road/temporary construction structures placed within the flood risk zones may cause; loss of floodplain area, restriction in flood flows, temporary increase in flood risk locally and may be susceptible to flood damage. Temporary construction works for SuDS features/outfalls Q and R may slightly increase peak flow rates into watercourse.	medium	moderate	**Moderate**
	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	high	major	**Large**
	Biodiversity		medium	major	**Large**
WF159	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increases in runoff rates into the watercourse. Construction of new culverts/channel realignment/temporary construction structures placed within the flood risk zones may cause; loss of floodplain area, restriction in flood flows, temporary increase in flood risk locally and may be susceptible to flood damage.	high	moderate	**Moderate**
	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	medium	major	**Large**
	Biodiversity		medium	major	**Large**
WF161	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increases in runoff rates into the watercourse. Construction of new culvert/temporary construction structures placed within the flood risk zones may cause; loss of floodplain area, restriction in flood flows, temporary increase in flood risk locally and may be susceptible to flood damage.	high	moderate	**Moderate**
WF162	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	medium	moderate	**Moderate**
	Biodiversity		medium	moderate	**Moderate**
WF164 (Allt Geallaidh)	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increases in runoff rates into the watercourse. Construction of new bridge and demolition of existing bridge/realignment of tributary ditches/construction of SuDS feature/temporary construction structures placed within the flood risk zones may cause; loss of floodplain area, restriction in flood flows, temporarily increase in flood risk locally and may be susceptible to flood damage. Temporary construction works for SuDS feature S and its outfall may slightly increase peak flow rates into watercourse.	high	moderate	**Moderate**
	Fluvial Geomorphology	Demolishing existing bridge and construction of the Allt Geallaidh Underbridge would result in the input of fine sediment to the water column. Potential modification of banks and bed. The construction could also potentially cause disturbance to existing morphological features within the channel, in particular bedrock features including a large depositional feature.	high	moderate	**Moderate**
	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	medium	major	**Large**
	Biodiversity		medium	major	**Large**

Water Feature	Attribute	Description of Specific Construction Impacts on Water Feature	Sensitivity	Magnitude	Significance
WF88/WF167 (Allt Crom Bhruthaich)	Hydrology and Flood Risk	Potential for temporary increase in hardstanding area and/or soil compaction during construction to result in temporary increases in runoff rates into the watercourse. Bridge supports and surrounding earthworks may cause; loss of floodplain storage, restriction in flood flows, temporary increase in flood risk locally and may be susceptible to flood damage. Temporary construction works for SuDS feature P and its outfall may slightly increase peak flow rates into watercourse.	medium	moderate	**Moderate**
	Water Quality	Decline in water quality and adverse impacts on biodiversity from the generation of fine sediment-laden runoff and chemical pollution.	low	major	**Moderate**
	Biodiversity		low	major	**Moderate**

Operation

Operation – General Impacts

11.4.11 This section describes the general potential impacts on the surface water environment likely to occur during operation, in the absence of mitigation measures. These potential impacts are described in Table 11.15 in terms of hydrology and flood risk, fluvial geomorphology and water quality.

11.4.12 Operational impacts are generally longer-term or permanent effects that would influence water features after the proposed scheme is constructed.

Table 11.15: Potential general operational impacts

Type of Impact	Potential general operational impacts
Hydrology and Flood Risk	
Changes to runoff rates and flow characteristics	• Introduction of new impermeable areas within surface water catchments could potentially increase the volume and peak flow of surface runoff reaching water features and could therefore contribute to an increased flood risk. The proposed scheme may also act as a barrier to water movement within existing catchments, increasing flooding upstream. • Alteration of the physical flow and water level regimes from crossings including new culverts/bridges or the modifications to existing culverts/bridges. • Channel realignments could potentially change the discharge regime of water features. • Operation of integrated SuDS features could slow the movement of water and increase infiltration locally. • Potential changes to flow regimes as a result of flows from one catchment being discharged to another via the proposed scheme's drainage system, could potentially increase or decrease flood risk depending on the specific location.
Changes in flood risk Floodplain	• Changes in flow regimes could potentially increase or decrease flood risk depending on the specific location. • Operation of, culverts (or bridges) can affect flow carrying capacity of a water feature/channel. Imposing a constriction would potentially result in higher flood levels upstream. Conversely, increasing the size of a culvert could increase the flood risk downstream if, previously, the culvert restricted flow, effectively making it a flood retention structure. • Earthworks partially spanning a floodplain can cause a constraint in the movement of flood waters along the floodplain and result in an increased flood risk either upstream or downstream.
Fluvial Geomorphology	
Changes to sediment regime	• Potential for changed sediment processes due to increased runoff from impervious surfaces, areas of erosion, new structures (such as culverts, outfalls) and channel realignments. Increased flow velocities and decreased roughness from culverts would further alter the sediment processes. • Additional sediment supply from potentially eroding banks and bed, e.g. scour at culvert outlets caused by new structures (including culverts and outfalls). • Deposition within culverts during low flows. • Increased discharge into the channel has the potential to locally alter sediment regime (e.g. increased flow velocity could remove a layer of fine sediment from the channel substrate). • Realignment of a water feature would have potential to either reduce or increase the length of a channel, directly altering the gradient and changing sediment processes. Realignment could provide a beneficial impact with opportunity for improved transportation of sediment and encouragement of natural fluvial processes.
Changes in channel morphology	• Increased runoff from drainage could potentially cause increase in erosion downstream on water features. • A permanent crossing in the form of a culvert or an outfall structure would remove the natural channel bed and banks within the particular location, creating a uniform artificial channel. Locally altered flow patterns have the potential to create areas of erosion and/or deposition upstream and/or downstream of the structure. • Changes in flow regime and sediment processes caused by channel realignment could alter the morphology of the channel. In some cases, disruption to the channel morphology would be short-term and realignment may actually improve the channel morphology. Along historically modified (engineered) channels, realignment may offer an opportunity to restore/rehabilitate the water feature. • Bank protection requirements could result in the transfer of the site of erosion downstream resulting in bank retreat and/or channel incision. Hard or raised reinforcement could also impact on lateral connectivity and marginal habitat. • Alteration to channel morphology, flow and/or sediment processes could cause changes to the current channel characteristics and in-channel physical habitat features which provide

Type of Impact	Potential general operational impacts
	ecological resilience for water-dependent flora and fauna. These changes may also impact on the function and habitat value of designated sites, including SSSIs and SACs.
Changes to natural fluvial processes	• Potential for increase in runoff which could locally alter flow regime within the channel. • Lateral and longitudinal connectivity would be impacted within the immediate location of culverts. Alteration of flow patterns due to the uniform, artificial channel. • Realignment of a water feature would have potential to either reduce or increase the length of a channel, directly altering the gradient and changing flow processes. • Outfall structures and the associated discharge to the channel would have the potential to locally alter flow patterns. • Potential impact on riparian woodland which could inhibit lateral connectivity with the floodplain.
Water Quality	
Decline in water quality or supply	• Increased pollutant loading from the operation of the proposed scheme, comparative to the pollutant loading from the existing A9, could reach surface water features from accidental spillages via outfalls or other surface water pathways. This could include: suspended solids and contaminants bound to them (such as metals and phosphorus); biodegradable organic materials (such as debris and grass cuttings); diffuse sources with high levels of nutrients (nitrogen and phosphorus); de-icing salt (chloride); and oil and related compounds. • Changes to channel morphology (detailed above) could have an associated effect on water quality by mobilising suspended solids and releasing previously 'locked' contaminants into the water column. • New or extended culverts could cause oxygen sags due to the lack of light, restricting aquatic plant photosynthesis and rapid microbiological degradation of biodegradable matter. Typically, longer structures would have greater impacts on water quality. Any reduction in surface area through culverts would also likely reduce atmospheric oxygenation of the water. • Changes in turbulence could also affect atmospheric oxygenation of the water.
Reduction in dilution capacity	• A reduction in dilution capacity due to the decline in water quality
Adverse impacts on biodiversity	• A decline in ecosystem health due to the decline in water quality.

Operation – Specific Impacts

11.4.13 This section describes the specific potential impacts on the surface water environment likely to occur during operation, which is specific to individual surface water features within the study area. The assessment is based on structures that would be permanent during operation such as drainage outfalls, culverts and bridges and other elements of the proposed scheme such as new or widened mainline and access tracks. Further information on water features crossings is provided in Appendix A11.8 (Watercourse Crossings Report) and the location of all crossings is shown on Figure 11.1.

11.4.14 The specific operational impacts for hydrology and flood risk, fluvial geomorphology and water quality with significance of **Moderate** or above are presented in Table 11.16. A more detailed overview of the impact assessment process and results for each of the water features (including those not considered to have a significant impact) is provided in Appendix A11.7 (Impact Assessment).

Table 11.16: Potential impacts (pre-mitigation) on specific water features – Operation

Water Feature	Attribute	Description of Specific Operational Impacts	Sensitivity	Magnitude	Significance
Adverse Impacts					
WF100(lower reach) (River Garry)	Hydrology and Flood Risk	Structures within the flood risk zones/bridge piers and abutments/SuDS features/access tracks may cause restriction in flood flows at the Essangal and River Garry Underbridges. The proposed scheme was assessed as resulting in a net loss of floodplain storage of approximately 20,100m^3 upstream of the existing A9 embankments at the River Garry Underbridge for the 0.5% AEP plus CC event. Modelling indicates that upstream of the River Garry Underbridge on the eastern floodplain of the River Garry peak water levels will increase by >100mm for the 0.5% AEP (200-year) plus CC event. A local road is located within the flood extent outline for the design flood event. The model also indicates the loss of upstream floodplain storage and increases in peak water levels in the channel downstream by approximately 10mm for the design flood event resulting in additional water spilling out of the watercourse around ch10900. There is also loss of floodplain downstream of the River Garry Underbridge bridge due to a new NMU access track. The proposed scheme results in some areas of increased flood risk but these are limited to agricultural land and terrestrial habitats of the River Tay SAC which, in these locations, are not considered as sensitive receptors in terms of flood risk. The proposed scheme was assessed as resulting in the net loss of floodplain storage of approximately 7,610m^3 as a result of widening the A9 road embankments and the construction of SuDS features and access tracks in the floodplain at the Essangal Underbridge for the 0.5% AEP (200-year) plus CC event. Modelling indicates that upstream of the Essangal Underbridge flood water is simulated to impound against the north side of the proposed scheme with flood depths being simulated to increase by approximately 28mm over a small area. The proposed scheme is however not assessed as being at risk for the 0.5% AEP (200-year) plus CC event. There is also simulated to be a slight reduction in peak water levels of approximately 7mm in a localised area south of the A9 embankment. There is simulated to be a negligible change in flood levels at Chestnut Cottage, the Highland Main Line railway and the B8079 upstream of the bridge crossing (approximate 2mm increase in flood level estimated for these attributes). Overall the impact of the proposed scheme at the Essangal Bridge crossing was assessed as negligible by the FRA but with localised beneficial and adverse flood impacts being noted. The increase of impermeable areas within the catchment and the operation of six new road drainage outfalls into the River Garry catchment have the potential to increase peak flows into the river, and increase the risk of flooding without appropriate attenuation.	very high	major	**Very Large**
	Fluvial Geomorphology	The pier in the floodplain and in the channel is likely to lead to localised impacts around the Essangal Underbridge and some channel adjustment downstream. This would include: erosion of the upstream face of the existing deposit on the left bank; deflection of flows towards the right bank potentially causing incision against the existing bank reinforcement; scour of the upstream pool; partial loss of the existing riffle feature as a result of the pier; and, potential deposition downstream of eroded material. Further information is provided in Appendix A11.5 (Fluvial Geomorphology).	high	moderate	**Moderate**
WF92	Hydrology and Flood Risk	As part of the embedded design, the existing culvert capacity will be maintained in order to prevent downstream flood risk impacts from increased pass forward flows. This will pose a direct flood risk to the proposed scheme due to the existing culvert capacity only conveying between the 50% AEP (2-year) and 20% AEP (5-year) flood event. In addition, it has been assessed that there is insufficient floodplain storage upslope of the crossing to prevent direct impacts to the proposed scheme during the 0.5% AEP (200-year) plus CC event.	high	moderate	**Large**
WF99	Water Quality	Discharge of routine road runoff off (from proposed combined drainage outfall E(1) & E(2)) resulting in a HAWRAT 'Fail' for soluble pollutants and an exceedance of the Annual Average Environmental Quality Standard (AA-EQS) for dissolved copper.	low	major	**Moderate**
	Dilution and Removal of Waste Products		low	major	**Moderate**

Water Feature	Attribute	Description of Specific Operational Impacts	Sensitivity	Magnitude	Significance
	Biodiversity		low	major	**Moderate**
WF102, WF103, WF104	Fluvial Geomorphology	The addition of new culverts (WF103 and WF104) and a culvert extension (WF102) would remove natural river bed and banks. The structures would alter geomorphological features (including bed substrate and associated flow types), flow patterns, constrict flow, confine the channel and remove/alter of lateral and longitudinal connectivity.	medium	moderate	**Moderate**
WF111	Fluvial Geomorphology	The addition of new culverts would remove natural river bed and banks. The structures would alter geomorphological features (including bed substrate and associated flow types), flow patterns, constrict flow, confine the channel, and remove/alter of lateral and longitudinal connectivity. Channel realignment would also lead to removal of a natural length of cobble and pebble bed (and associated step-pool sequence) and banks.	medium	moderate	**Moderate**
WF114	Fluvial Geomorphology	The new culvert would lead to the removal of a length of natural bed and banks. A cascade feature would be required to drop the existing channel into the new culvert. This could alter the flow and sediment processes and potentially lead to scour around the banks and inlet of the culvert. Changes in the channel gradient within the vicinity of the new culvert leading to changes in flow and sediment processes. Loss of natural morphological features in new channel. There is also a requirement for a small tributary to the main channel (a drainage channel) to be realigned as well. This has the potential to alter flow pathways and subsequently flow processes in the main channel.	medium	moderate	**Moderate**
WF115 (Allt Bhaic)	Hydrology and Flood Risk	The increase of impermeable areas within the catchment and the operation of two new road drainage outfalls (from SuDS features G and H) into the watercourse have the potential to increase peak flows into the river, increasing the risk of flooding. However, attenuation of flows within SuDS features will ensure that discharge rates into the watercourse are limited to the greenfield runoff rate (50%AEP/2-year flow). Alterations to flood risk due to: bridge abutments and SuDS features encroaching into the 0.5% AEP (200-year) flood extent outline therefore reducing floodplain storage. It is estimated that the proposed scheme will result in a net loss of approximately 10,900m3 of floodplain storage on the eastern floodplain and the loss of 20,600m3 of net floodplain storage on the western floodplain of the Allt Bhaic for the 0.5% AEP (200-year) plus CC event. The FRA has identified varying impact magnitudes due to a range of modelled flood depths across the floodplain; the greatest increase in modelled flood depth results in major adverse impacts. There is also simulated to be a 30mm increase in peak water level on the B8079 underpass of the Highland Main Line railway for the 0.5% AEP plus CC event. This receptor is however simulated to flood to a depth of approximately 500mm in the baseline. The proposed scheme is not assessed as being at flood risk as it is proposed to raise the road at this location.	very high	major	**Very Large**
	Fluvial Geomorphology	The proposed Allt Bhaic Underbridge would completely remove an existing adjusting area of eroding bank and deposition. The existing bridge structure appears to have triggered channel adjustment upstream of the bridge; it is likely that similar adjustment would occur upstream of the new proposed bridge. There is potential for removal of morphological features as a result of the proposed bridge.	high	moderate	**Moderate**
	Water Quality	Discharge of routine road runoff (from proposed drainage outfalls G+H) resulting in a HAWRAT 'Fail' for sediment bound pollutants for the single outfall assessment at Tier 1 and for soluble pollutants for the combined outfall assessment at Tier 2.	high	minor	**Moderate**
	Biodiversity		very high	minor	**Large**
WF136	Hydrology and Flood Risk	Alterations to flood risk due to: operation of replacement culvert/cascade and channel realignment. Operation of replacement culvert is predicted to result in a reduction in upstream water levels with the culvert being simulated to have sufficient capacity to convey the design 0.5% AEP (200-year) + CC event. The proposed scheme is simulated to not be at flood risk. Detailed 1D-2D hydraulic modelling of WFs132/134/136 indicate that there will be a moderate to negligible beneficial impact on flood risk through Calvine for the design flood event. The B847 will, however, have a greater than 60mm (moderate adverse) very localised increase in flood depth for the design flood event due to the behaviour of the culvert. The FRA (Appendix A11.3) has assessed that the flood frequency and hazard would remain unchanged from the baseline. Attenuation of flows within SuDS features will help control runoff rates entering the watercourse.	high	moderate	**Moderate**

Water Feature	Attribute	Description of Specific Operational Impacts	Sensitivity	Magnitude	Significance
	Water Quality	Discharge of routine road runoff (from proposed drainage outfall L) resulting in a HAWRAT 'Fail' for soluble pollutants and an exceedance of the Annual Average Environmental Quality Standard (AA-EQS) for dissolved copper.	low	major	**Moderate**
	Dilution and Removal of Waste Products		low	major	**Moderate**
	Biodiversity		low	major	**Moderate**
WF151	Fluvial Geomorphology	The culvert extension would remove natural river bed and banks. The structure would alter geomorphological features (including bed substrate and associated flow types), flow patterns, constrict flow, confine the channel, and remove/alter of lateral and longitudinal connectivity. There is also the potential to increase the rate of erosion at a knickpoint downstream of the proposed re-grading, which could destabilise the water feature further.	medium	moderate	**Moderate**
WF154	Fluvial Geomorphology	The addition of new culvert would remove natural river bed and banks. The structure would alter geomorphological features (including bed substrate and associated flow types), flow patterns, constrict flow, confine the channel, and remove/alter of lateral and longitudinal connectivity. Potential for channel adjustment upstream and downstream as a direct consequence of the new culvert and realignments due to the steeper nature of the water feature.	medium	moderate	**Moderate**
WF156	Fluvial Geomorphology	The addition of two new culverts/culvert extensions would remove natural river bed and banks. The structure would alter geomorphological features (including bed substrate and associated flow types), flow patterns, constrict flow, confine the channel, and remove/alter of lateral and longitudinal connectivity. Potential for channel adjustment upstream and downstream as a direct consequence of new/extended structures within the water feature, particularly due to the steeper nature of the channel.	medium	moderate	**Moderate**
WF158 (Allt Anndeir)	Water Quality	Discharge of routine runoff resulting in a HAWRAT 'Fail' for sediment-bound pollutants.	high	minor	**Moderate**
Beneficial Impacts					
WF134	Hydrology and Flood Risk	Alterations to flood risk due to operation of: a replacement culvert under the proposed scheme and Calvine Underpass in close proximity to the watercourse. Operation of the replacement culvert is predicted to result in a reduction in upstream water levels with the culvert being simulated to have sufficient capacity to convey the design 0.5% AEP plus CC flood event. The proposed scheme is simulated to not be at flood risk during operation. Detailed 1D-2D hydraulic modelling of WFs132/134/136 indicate that here will be a moderate to negligible beneficial impact on flood risk through Calvine for the design flood event.	high	minor beneficial	**Moderate**
WF136	Hydrology and Flood Risk	Alterations to flood risk due to: operation of replacement culvert/cascade and channel realignment. Operation of the replacement culvert is predicted to result in a significant reduction in flood extent resulting in six properties being no longer at flood risk during the design flood event. The culvert was simulated to have sufficient capacity to convey the design 0.5% AEP plus CC flood event. The proposed scheme is simulated to not be at flood risk. Detailed 1D-2D hydraulic modelling of WFs132/134/136 indicate that there will be a moderate to negligible beneficial impact on flood risk through Calvine for the design flood event. As highlighted above, the B847 will, however, have a greater than 60mm (moderate adverse) increase in flood depth for the design flood event due to the behaviour of the culvert. The FRA (Appendix A11.3) has assessed that the flood frequency and hazard would remain unchanged from the baseline.	high	major beneficial	**Large**

11.5 Mitigation

Introduction

11.5.1 This chapter makes reference to overarching standard measures applicable across A9 dualling projects ('SMC' mitigation item references), and also to project-specific measures ('P05' mitigation item references). Those that specifically relate to road drainage and the water environment are assigned an 'W' reference.

11.5.2 The objective of this section is the identification of mitigation measures to avoid, prevent, reduce or offset potential significant impacts, described in Section 11.4 (Potential Impacts), taking into account best practice, legislation and guidance during both construction and operation.

11.5.3 As stated in Section 11.12 (Approach and Methods), consultation with SEPA and SNH was undertaken throughout the DMRB Stage 3 process to seek guidance on surface water drainage, pollution prevention measures and engineering activities on waterbodies. Further information on the consultation process is provided in Chapter 7 (Consultation and Scoping).

Embedded Mitigation

11.5.4 Substantial environmental input has contributed to the design process to help inform the most sustainable alignment options, watercourse crossing design and drainage solutions (referred to as primary or embedded mitigation). This iterative approach has included discussion of proposed engineering options and their associated potential environmental impacts, as well as the recommendation of measures that limit the impacts on the water environment. For further details refer to Chapter 4 (Iterative Design Development).

11.5.5 An engineering solution has been developed at each watercourse crossing, which is considered to be consentable under CAR based on the DMRB Stage 3 design; refer to Appendix 11.8 (Watercourse Crossing Report). A Specimen Design will be developed, in consultation with SEPA, to support the CAR authorisation process following the completion of the DMRB Stage 3 Assessment. This will allow for the development of the design to include provision of fish passage and scour protection as required.

Land Made Available for Construction

11.5.6 A preliminary review of construction drainage requirements has been undertaken in order to inform the land required to provide adequate surface water management during construction.

11.5.7 This review has assessed the land required to accommodate the 10% AEP (10-year) return period rainfall event, as would reasonably be expected to occur during the period of construction, for each construction drainage catchment within each construction phase. An additional volume to account for the estimated soil loss from each corresponding construction drainage catchment has also been considered in the assessment, using methods as detailed in CIRIA (2006a). The inclusion of the soil loss volume provides an increased treatment volume on catchments that will be more susceptible to soil erosion.

11.5.8 The results of the review have been used in the planning of the Compulsory Purchase Orders (CPO) and will form a baseline for the Contractor to develop a construction drainage strategy.

Mainline, Junctions, Side Roads and Access Tracks

11.5.9 The proposed scheme has been designed to be above the 0.5% AEP (200-year) plus CC flood level with an additional 600mm of freeboard where reasonably practicable. Unsurfaced access tracks would remain unchanged from existing ground elevations and as a result may have lower flood design standards.

11.5.10 The mainline dual carriageway alignment was moved 25m south from the River Garry between ch8900 and ch10500 to form a localised offline alignment to safeguard the proposed scheme from fluvial erosion. This provides a buffer zone to allow geomorphological processes to continue in an area where

the existing A9 is as risk of river erosion, as well as providing adequate space for the construction of a mitigation solution intended to protect the proposed scheme should the River Garry continue to erode south eastwards at this location.

SuDS

11.5.11 SuDS are a legal requirement in Scotland under WEWS and CAR and SuDS features were included within the DMRB Stage 3 design. The proposed scheme includes 22 SuDS outfalls discharging to 10 water features. SuDS are designed to treat pollutants and attenuate runoff to acceptable levels before discharge to watercourses. SuDS features were located where practical outside the 0.5% AEP (200-year) functional floodplain; where this is not possible, they were designed to ensure that they are not inundated by the 3.33% AEP (30-year) flood event. They were designed to attenuate the 0.5% AEP (200-year) rainfall event plus CC with appropriate freeboard and discharge at the 50% AEP (2-year) 'greenfield' runoff rate.

11.5.12 Engineering and environmental factors were considered to confirm the drainage design and the types and locations of SuDS features. The results from the HAWRAT assessment also contributed to this process and the outcomes are reported in Table 11.19. For the purposes of the water quality assessments, discharges are reported in the absence of treatment by SuDS in section 11.4 (Potential Impacts) above and with treatment by SuDS in section 11.6 (Residual Impacts) below.

Culverts

11.5.13 The culvert design for the watercourse crossings of the A9 mainline takes account of three different design conditions in the hydraulic analysis as follows:

- All new replacement watercourse crossings (i.e. where it is proposed that an existing culvert is fully removed and replaced with a new culvert) were sized in accordance with the Design Manual for Roads and Bridges (DMRB) HA107/04. This includes the minimum requirement to freely pass the 1% AEP (100-year) design fluvial event with appropriate freeboard within the culvert barrel.
- The culverts for the replacement crossings, as well as those that are extended based on their existing geometry, have also been tested in the 0.5% AEP (200-year) event to confirm that they remain free flowing (i.e. they are not surcharged) in this event, and that there is appropriate culvert freeboard, taking account of other factors influencing culvert design.
- All culverts have also been assessed against the design flood event i.e. 0.5% AEP (200-year) plus an allowance for climate change, to confirm that there is a minimum 600mm freeboard to road level as reported in Appendix A11.3 (Flood Risk Assessment).

11.5.14 All new (or replaced) side road (unsurfaced tracks) culverts are sized to freely pass the 2% AEP (50-year) design event (with appropriate freeboard within the culvert barrel). The flood design standard for unsurfaced access track (Tier 3) culverts is lower than for mainline culverts as these tracks are mainly unsurfaced, with a low traffic volume, which only serve as access to a few agricultural properties. Unsurfaced access tracks are also to be set at existing ground level (which may or may not already be elevated above existing flood levels), to avoid changing the local risk of flooding.

Pre-earthworks Drainage

11.5.15 Pre-earthworks drainage will likely take the form of ditches and will be constructed at the top of cuttings and the base of embankments where surface water and sub-surface pathways from adjoining land will flow towards the proposed scheme or other receptors, thus intercepting the flow. The purpose of the pre-earthworks drainage is to collect runoff from the natural catchments surrounding the proposed scheme and convey overland flow to the nearest watercourse, maintaining the existing hydrological regime of the natural catchment, where possible.

11.5.16 Pre-earthworks drainage was sized to convey the 1.3% AEP (75-year) rainfall runoff event, however where practicable, the sizing of PED drainage at the top of the cuttings should be increased to accommodate the design flood event to minimise the risk of overtopping and flood risk to the road. Once operational, this system does not require any formal treatment or attenuation prior to discharge, beyond the treatment and attenuation that is provided by the drain itself, as it is draining the natural catchment

and kept separate from any polluted carriageway runoff. However, mitigation during construction is required, which is detailed in Table 11.18.

Standard Mitigation

11.5.17 Standard mitigation commitments during construction (SMC-S1 to SMC-S4) are set out in Chapter 21 (Schedule of Environmental Commitments) and consist predominantly of best practice measures. The standard construction and operational mitigation commitments for Road Drainage and Water Environment are detailed in Table 11.17 and Chapter 21 (Schedule of Environmental Commitments).

Table 11.17: Standard Mitigation for Road Drainage and the Water Environment.

Mitigation Item	Description
Standard Construction Mitigation	
SMC-W1	In relation to authorisations under CAR, the Contractor will be required to provide a detailed Construction Method Statement which will include proposed mitigation measures for specific activities including any requirements identified through the pre-CAR application consultation process.
SMC-W2	In relation to flood risk, the Contractor will implement the following mitigation measures during construction: · The Flood Response Plan (as part of the CEMP, refer to **Mitigation Item SMC-S1** in Table 21.1 of Chapter 21 (Schedule of Environmental Commitments)) will set out the following mitigation measures to be implemented when working within the functional floodplain (defined here as the 0.5% AEP (200-year) flood extent): Ø Routinely check the MET office Weather Warnings and the SEPA Floodline alert service for potential storm events (or snow melt), flood alerts and warnings relevant to the area of the construction works. Ø During periods of heavy rainfall or extended periods of wet weather (in the immediate locality or wider river catchment) river levels will be monitored using for example SEPA Water Level Data when available/visual inspection of water features. The Contractor will assess any change from base flow condition and be familiar with the normal dry weather flow conditions for the water feature, and be familiar with the likely hydrological response of the water feature to heavy rainfall (in terms of time to peak, likely flood extents) and windows of opportunity to respond should river levels rise. Ø Should flooding be predicted, works close or within the water features should be immediately withdrawn (if practicable) from high risk areas (defined as: within the channel or within the bankfull channel zone - usually the 50% (2-year) AEP flood extent). Works should retreat to above the 10% AEP (10-year) flood extent) with monitoring and alerts for further mobilisation outside the functional floodplain should river levels continue to rise. · Plant and materials will be stored in areas outside the functional floodplain where practicable, with the aim for temporary construction works to be resistant or resilient to flooding impacts, to minimise/prevent movement or damage during potential flooding events. Where this is not possible, agreement will be required with the Environmental Clerk of Works (EnvCoW). · Stockpiling of material within the functional floodplain, if unavoidable, will be carefully controlled with limits to the extent of stockpiling within an area, to prevent compartmentalisation of the floodplain, and stockpiles will be located >10m from watercourse banks. · Temporary drainage systems will be implemented to alleviate localised surface water flood risk and prevent obstruction of existing surface runoff pathways. Where practicable, temporary haul routes will be located outside of the functional floodplain.
SMC-W3	In relation to construction site runoff and sedimentation, the Contractor will adhere to GPPs/PPGs (SEPA, 2006-2017) and other good practice guidance (Table 11.1), and implement appropriate measures which will include, but may not be limited to: · avoiding unnecessary stockpiling of materials and exposure of bare surfaces, limiting topsoil stripping to areas where bulk earthworks are immediately programmed; · installation of temporary drainage systems/SuDS (or equivalent) including pre-earthworks drainage; · pre-earthworks drainage/SuDS with appropriate outfalls to be in place prior to any earthworks activities; · treatment facilities to be scheduled prior to any works which may generate site run-off and sedimentation, to allow settlement and treatment of any pollutants contained in site runoff and to control the rate of flow before water is discharged into a receiving watercourse; · the adoption of silt fences, check dams, settlement lagoons, soakaways and other sediment trap structures as appropriate; · the maintenance and regrading of haulage route surfaces where issues are encountered with the breakdown of the existing surface and generation of fine sediment; · provision of wheel washes at appropriate locations (in terms of proposed construction activities) and >10m from water features; · protecting soil stockpiles using bunds, silt fencing and peripheral cut-off ditches, and location of stockpiles at distances >10m from water features; and · restoration of bare surfaces (seeding and planting) throughout the construction period as soon as possible after the work was completed, or protecting exposed ground with geotextiles if to be left exposed.

Mitigation Item	Description
SMC-W4	In relation to in-channel working, the Contractor will adhere to GPPs/PPGs (SEPA, 2006-2017) and other good practice guidance (Table 11.1), and implement appropriate measures which will include, but may not be limited to: · undertaking in-channel works during low flow periods (i.e. when flows are at or below the mean average) as far as reasonably practicable to reduce the potential for sediment release and scour; · no in-channel working during the salmonid spawning seasons unless permitted within any CAR license; · minimise the length of channel disturbed and size of working corridor, with the use of silt fences or bunds where appropriate to prevent sediment being washed into the water feature; · limit the removal of vegetation from the riparian corridor, and retaining vegetated buffer zone wherever reasonably practicable; and · limit the amount of tracking adjacent to watercourses and avoid creation of new flow paths between exposed areas and new or existing channels.
SMC-W5	Where channel realignment is necessary the Contractor will adhere to good practice guidance (Table 11.1) and implement appropriate measures which will include, but may not be limited to: · Once a new channel is constructed, the flow should, where practicable, be diverted from the existing channel to the new course under normal/low flow conditions; · diverting flow to a new channel should be timed to avoid forecast heavy rainfall events at the location and higher up in the catchment (the optimum time will be the spring and early summer months to allow vegetation establishment to help stabilise the new channel banks); · with offline realignments, the flow will be diverted with a steady release of water into the newly constructed realignment to avoid entrainment of fine sediment or erosion of the new channel; and · any proposed realignment works will be supervised by a suitably qualified fluvial geomorphologist.
SMC-W6	In relation to refuelling and storage of fuels the Contractor will adhere to GPPs/PPGs (SEPA, 2006-2017) and other good practice guidance (Table 11.1), and implement appropriate measures which will include, but may not be limited to: · only designated trained and competent operatives will be authorised to refuel plant; · refuelling will be undertaken at designated refuelling areas (e.g. on hardstanding, with spill kits available, and >10m from water features) where practicable; · appropriate measures will be adopted to avoid spillages (refer to **Mitigation Item SMC-W7**); and · compliance with the Pollution Incident Control Plan (refer to **Mitigation Item SMC-S1**).
SMC-W7	In relation to oil/fuel leaks and spillages, the Contractor will adhere to GPPs/PPGs (SEPA, 2006-2017) and other good practice guidance (Table 11.1), and implement appropriate measures which will include, but may not be limited to: · stationary plant will be fitted with drip trays and emptied regularly; · plant machinery will be regularly inspected for leaks with maintenance as required; · spillage kits will be stored at key locations on-site and detailed within the Construction Environmental Management Plan (CEMP) (refer to **Mitigation Item SMC-S1**); and · construction activities will comply with the Pollution Incident Control Plan (refer to **Mitigation Item SMC-S1**).
SMC-W8	In relation to chemical storage, handling and reuse the Contractor will adhere to GPPs/PPGs (SEPA, 2006-2017) and other good practice guidance (Table 11.1), and implement appropriate measures which will include, but may not be limited to: · chemical, fuel and oil storage will be undertaken within a site compound, which will be located on stable ground at a low risk of flooding and >10m from any watercourse; · chemical, fuel and oil stores will be locked and sited on an impervious base within a secured bund with 110% of the storage capacity; and · pesticides, including herbicides, will only be used if there are no alternative practicable measures, and will be used in accordance with CAR requirements, the manufacturer's instructions and application rates.
SMC-W9	In relation to concrete, cement and grout the Contractor will adhere to GPPs/PPGs (SEPA, 2006-2017) and other good practice guidance (Table 11.1), and implement appropriate measures which will include, but may not be limited to: · concrete mixing and washing areas will: Ø be located more than 10m from water bodies; Ø have settlement and re-circulation systems for water reuse; and Ø have a contained area for washing out and cleaning of concrete batching plant or ready-mix lorries. · wash-water will not be discharged to the water environment and will be disposed of appropriately to the foul sewer (with permission from Scottish Water) or through containment and disposal to an authorised site; · where concrete pouring is required within a channel, a dry working area will be created; · where concrete pouring is required within 10m of a water feature or over a water feature, appropriate protection will be put in place to prevent spills entering the channel (e.g. isolation of working area, protective sheeting); and · quick setting products (cement, concrete and grout) will be used for structures that are in or near to watercourses.

Mitigation Item	Description
SMC-W10	Sewage from site facilities will be disposed appropriately either to a foul sewer (with the permission of Scottish Water) or via appropriate treatment and discharge as agreed with SEPA in advance of construction and in accordance with 'PPG04 Treatment and Disposal of Sewage' (SEPA, 2003 – 2013).
SMC-W11	In relation to service diversions and to avoid damage to existing services from excavations and ground penetration, including temporary severance of public and private water supplies through potential damage to infrastructure, the Contractor will: · locate and map all private or public water supply assets and other service infrastructure prior to construction; · take measures to prevent damage to services and to avoid pollution during service diversions, excavations and ground works; and · provide a temporary alternative water supply (e.g. bottled or tankered) if services are to be disrupted or diverted by the works.
SMC-W12	For works within areas identified as potentially containing contaminated land and sediment the Contractor will reduce the risk of surface water pollution to an acceptably low level through: · further site investigation to determine the level of contamination prior to construction beginning; · the installation of temporary treatment facilities to enable removal of pollutants from surface waters; and · adoption of mitigation measures relating to contaminated land as outlined in Chapter 10 (Geology, Soils, Contaminated Land and Groundwater).
Standard Operation Mitigation	
SMC-W13	In relation to bank reinforcement, design principles and mitigation measures will adhere to good practice (SEPA, 2008a), which will include, but may not be limited to: · non-engineering solutions and green engineering (e.g. vegetation, geotextile matting) to be the preference during options appraisal; · requirements for grey engineering to control/prevent scour (e.g. rock armour, rip-rap, gabion baskets) to be minimised; and · post project appraisal to identify if there are issues that can be investigated and addressed at an early stage.
SMC-W14	In relation to outfalls, specimen and detailed design will ensure compliance with good practice (e.g. CIRIA, 2015b; The Highways Agency et al., 2004; SEPA, 2008b), which will include, but may not be limited to: · directing each outfall downstream to minimise impacts to flow patterns; · avoiding projecting the outfall into the watercourse channel; · avoid installation of outfalls at locations of known historical channel migration; · avoid positioning in flow convergence zones or where there is evidence of active bank erosion/instability; · directing an outfall away from the banks of a river to minimise any potential risk of erosion (particularly on the opposite bank); · minimising the size/extent of the outfall headwall where possible to reduce the potential impact on the banks; and · post project appraisal to identify if there are issues that can be investigated and addressed at an early stage.
SMC-W15	In relation to watercourse crossings, specimen and detailed design will ensure compliance with good practice (SEPA, 2010b), which will include, but may not be limited to: · Detailed design will mitigate flood risk impacts through appropriate hydraulic design of culvert structures. Flood risk will be assessed against the 0.5%AEP (200-year) plus an allowance for climate change design flood event. Detailed design will mitigate any loss of existing flood plain storage volume, where required, by appropriate provision of compensatory storage. Where culvert extension is not practicable or presents adverse impact on the water environment, appropriately designed replacement culverts will be installed. · Detailed design will mitigate impacts on the water environment through appropriate design of culvert structures and watercourse modifications (e.g. realignments) with respect to fluvial geomorphology, and both riparian and aquatic ecology. · Detailed design of culverts and associated watercourse modifications will incorporate wherever practical: Ø adherence to design standards and good practice guidance (Table 11.1); Ø allowance for the appropriate conveyance of water and sediment for a range of flows (including at low flow conditions); Ø maintenance of the existing channel gradient to avoid erosion at the head (upstream) or tail (downstream) end of a culvert; Ø avoidance of reduction of watercourse length through shortening of watercourse planform; Ø minimisation of culvert length; Ø close alignment of the culvert with the existing water feature; Ø depressing the invert of culverts to allow for formation of a more natural bed (embedment of the culvert invert to a depth of at least 0.15m to 0.3m); and Ø roughening of culvert or inverts to help reduce water velocities. · Post project appraisal of watercourse crossings will be undertaken to identify if there are issues that can be investigated and addressed at an early stage.
SMC-W16	In relation to channel realignments, specimen and detailed design will ensure compliance with good practice (Table 11.1), which will include, but may not be limited to:

Mitigation Item	Description
	· minimising the length of the realignment, with the existing gradient maintained where possible; · design of the realignment in accordance with channel type and gradient; · if required, low flow channels or other design features to reduce the potential for siltation and provide an opportunity to improve the geomorphology of the water feature; · realignment designs will be led by a suitably qualified fluvial geomorphologist; · where realignments result in an increase or decrease of channel gradient, the following principles will be applied: Ø an increased gradient within the channel (resulting in higher stream energies) will require mitigation in the form of energy dissipation, which could include the creation of a step-pool sequence; boulder bed-checks; plunge pools at culvert outlets; and/or; increased sinuosity; and Ø a decrease in gradient within the channel will require mitigation in the form of the construction of a low flow channel to minimise the impacts on locally varying flow conditions and reduce the risk of siltation of the channel. · post project appraisal of watercourse crossings will be undertaken to identify if there are issues that can be investigated and addressed at an early stage.
SMC-W17	In relation to SuDS, the following design principles and mitigation measures will be implemented: · detailed design to adhere to design standards and good practice guidance (Table 11.1), including The SuDS Manual (CIRIA, 2015b) and SuDS for Roads (SCOTS, 2010); · for each drainage run, a minimum of two levels of SuDS treatment within a 'treatment train' (see Table 11.18 for further details) to limit the volume of discharge and risk to water quality; · management of vegetation within ponds and drains through grass cutting, pruning of any marginal or aquatic vegetation (as appropriate to the SuDS component) and removal of any nuisance plants, especially trees; · SuDS retention ponds will be designed with an impermeable liner to maintain a body of standing water and provide treatment volume; · inspect inlets, outlets, banksides, structures and pipework for any blockage and/or structural damage and remediate where appropriate; · regular inspection and removal of accumulated sediment, litter and debris from inlets, outlets, drains and ponds to avoid sub-optimal operation of SuDS; and · adherence to the maintenance plans specific to each SuDS component type as detailed within The SuDS Manual (CIRIA, 2015b).

Specific Mitigation

11.5.18 Construction and operation mitigation measures, which go beyond standard industry best practice, are required to reduce impacts to non-significant and are detailed in Table 11.18 for road drainage and water environment and in Chapter 21 (Schedule of Environmental Commitments). Each recommended mitigation measure has been assigned a reference and a detailed description is provided.

Table 11.18: Project specific Mitigation for Road Drainage and the Water Environment.

Mitigation Item	Description	Water Features
Specific Construction Mitigation		
P05-W18	Measures to control sources of suspected sediment and other contaminants will be set out within a site specific Sediment Management and Pollution Prevention Plan (or similar such document), that will be submitted to SEPA for approval prior to construction as part of the CAR authorisation process for site discharges. Specific measures will include, but need not be limited to: · Soil stripping schedule and plans which show how the works will be phased to avoid unnecessary stockpiling of materials and exposure of bare surfaces. · Minimisation of soil stripping and bank disturbance activities. Frequent use of weather forecasts should be made to inform the timing of specific activities. · Rapid restoration of areas of exposed ground, including implementing reseeding plans during the growing season (spring to autumn). Geotextiles, mulch and the roughening of exposed ground will be adopted where reseeding cannot be rapidly undertaken. · Proposed protection (bunds or silt fencing) for stockpiles, which will be located out with the 0.5% AEP (200 year) floodplain (as modelled by Jacobs), at a distance of >50m from any water features and over stable and flat ground (as far as reasonably practicable). · Minimisation of the extent, length and gradient of drainage ditches, and erosion control measures within the ditches to include lining and check dams. · Use of an appropriate grade of material on temporary haul routes that will be clean, have a limited fines content and will be durable under heavy trafficking; this may necessitate importing appropriate material if the on-site sources are assessed as being inadequate.	ALL

Mitigation Item	Description	Water Features
	· Frequent monitoring of the condition of haul routes, and maintenance and regrading as necessary. · Use of biodegradable fuels, oils and chemicals on site, as far as reasonably practicable. If flocculants are considered necessary to aid settlement of fine suspended solids, such as clay particles, only natural organic flocculants will be used for surface water treatment, and permission will be obtained from SEPA for the use of such chemicals. · A protection buffer distance of 50m from any surface water feature will be applied to all handling, storage and use of oils, fuels and chemicals (including concrete batching), as far as reasonably practicable. · Protocols will be developed for ceasing or reducing construction activities during periods of high rainfall to reduce the risks of erosion, sedimentation and pollution.	
P05-W19	Specific measures to remove suspended sediment and other contaminants from construction runoff will be included within a site specific Surface Water Management Plan (or similar such document) that would be approved by SEPA prior to construction as part of the CAR authorisation process for site discharges. Specific measures will include, but need not be limited to: · Provision of temporary drainage measures during construction which will take into consideration the phasing of works, topography, land available for treatment of surface water and the location of surface water features. · Construction runoff will be discharged to land via temporary treatment measures (e.g. settlement ponds and/or soakaways) at frequent intervals along the working corridor to prevent unmanageable volumes of untreated runoff collecting at a single location. · Prior to the completion of operational SuDS features, direct discharge of construction phase drainage (including pre-earthworks drainage) to watercourses will be avoided, with an appropriate filter strip (10m where practicable) maintained between any drainage discharges and watercourses. Daily inspections of buffer strips will be undertaken during periods of high rainfall to ensure surface flow pathways do not develop. · For instances where the levels of fine sediment and volume of surface water cannot be treated using conventional methods, including where topography or land available is a constraint, an alternative treatment procedure may be used which could include: the use of portable settlement tanks, flocculants or dynamic separators. · Settlement features will be sized appropriately to accommodate the maximum volume of run-off that would be reasonably expected to occur on any occasion during the period of construction (as to be agreed with SEPA). · All features associated with the temporary drainage system, including settlement ponds, settlement tanks, ditches and silt traps, will be maintained in a good state of repair and monitored and inspected by the Contractor. · Requirements for surface water management and pollution prevention, including maintenance, monitoring and inspection requirements of temporary drainage systems will be communicated to all relevant staff on site by the Contractor.	ALL
P05-W20	To measure the effectiveness of implemented mitigation measures in protecting downstream water quality and aquatic ecological interests, monitoring protocols during the construction phase will be developed within a site specific Water Quality Monitoring Plan, which will be submitted to SEPA for approval prior to construction. This will include, but need not be limited to: · Appointment of a suitably qualified (minimum of 3 years' experience supervising construction sites, monitoring water quality and drainage design) Hydrological Clerk of Works (HCoW), who will review the scheduling of earthworks, storage of materials, implementation of drainage and surface water treatment measures, and undertake monitoring of water quality. The HCoW will be provided with the authority to stop works and implement remedial action with immediate effect. · Water quality monitoring one year prior to construction, during construction and one year post construction. The monitoring regime to include monthly laboratory analysis, visual inspections and real time monitoring. · Water quality criteria and standards to be achieved for all site discharges during construction, and sampling locations, to be agreed in consultation with SEPA and SNH. The contractor will ensure compliance with these standards through the adoption of standard mitigation (Table 11.18) and **Mitigation Items P05-W18 and P05-W19.** · Real-time monitoring of electrical conductivity and turbidity to detect suspended solid concentrations in exceedance of baseline levels. An automated alert system will alert the HCoW and site staff of any pollution incidents, informing where further sampling is required to confirm compliance with the limits agreed with SEPA, and allow remedial actions to be implemented at specific locations.	ALL
P05-W21	To ensure the protection of surface water fed PWS a site specific Private Water Supply Protection Plan will be developed and submitted to SEPA for approval prior to construction. This will include, but need not be limited to: · Identification and mapping of all PWS sources and infrastructure that could be impacted by the proposed scheme.	ALL

Mitigation Item	Description	Water Features
	· Development of a PWS water quality monitoring programme preconstruction, during construction and post construction. · Development of a PWS contingency plan including provision of an emergency hotline telephone and arrangements for an alternative water supply (tankers or similar) if necessary. · Providing affected properties with a temporary alternative supply (e.g. bottled or tankered water) during construction, temporary disruptions or temporary diversions.	
P05-W22	Careful phasing of works will be required on WF136, WF134 and WF132 to avoid flood risk to the residential properties in Calvine in the event of a flood event. A temporary diversion of the existing culvert at WF132 will be required to be constructed in advance of replacement of any of the exiting culverts. As the new culverts are constructed in turn, flows from these watercourses will be diverted through this temporary culvert, or over-pumped via this routing during flood flow conditions. This will allow work to proceed on the 3 new culverts which can be in turn completed and re-diverted to the respective channels.	WF132 WF134 WF136
P05-W23	Construction drainage systems/SuDS will be implemented prior to any significant earthworks to control/attenuate/treat runoff during construction. Regular maintenance of construction SuDS and associated outfalls will be undertaken to ensure the basins are not susceptible to flood damage, and that flood risk is not increased locally during construction. In advance of extreme flood events (e.g. 0.5% AEP (200-year) + CC event), in stream working areas will be evacuated and allowed to flood to prevent any increases in flood levels from constriction of flows.	ALL
P05-W24	To avoid exacerbating bank erosion, construction works will remain 10m from the River Garry where possible. Exceptions include where works are required within the channel; but these will be avoided during heavy rainfall or flood events. In-stream works will be minimised by the use of a dry working area. Any pumping or abstraction from the dry working area will require adequate treatment as per the standards detailed under **Mitigation Item P05-W19**. Works involving disturbance of the channel bed will not be permitted prior to the establishment of a dry working area. In addition, a rapid evacuation plan will be required including daily weather updates and a response plan to ensure that in the event of rising water levels, plant and personnel can rapidly vacate in stream working areas.	WF100
P05-W25	As part of the proposed channel realignment, any natural bed substrate removed during construction will be stored for re-use in the proposed small diversion and cascade to tie-in with the culvert inlet.	WF111
P05-W26	During construction, the tracking of machinery along the banks (left bank in particular) will be avoided to reduce the potential for excessive erosion. Removal of the existing structure is likely to require in-channel works. As a result, erosion control measures such as creating a dry-working area, replanting of the banks prior to completion of works, and steady release of flows into the new channel will be implemented.	WF115
Specific Operation Mitigation		
P05-W27	To achieve a 'neutral' flood risk impact and allow for the safe operation of the proposed scheme during the 0.5%AEP (200-year) plus climate change event, the following will be undertaken: · As part of the embedded design, the existing culvert on WF92 will be replaced with a new culvert that will maintain the existing capacity, in order to achieve a 'neutral' flood risk impact downstream. · Surcharged floodwater from the WF92 crossing will be diverted to the Allt Girnaig (WF89) watercourse via a 0.7m diameter concrete pipe, to prevent uncontrolled flooding upstream and flood risk to the proposed scheme. Construction of a new outfall will be required to discharge surcharged flows from WF92 into the Allt Girnaig (WF89). · A new dry mammal underpass adjacent to WF92 may be required to provide mammal connectivity, should it prove impractical to include a mammal ledge within the new culvert.	WF92 WF89
P05-W28	Culvert (under the U521) downstream of the proposed scheme to be cleared of debris to minimise flood risk to the local road.	WF156
P05-W29	Design of the Essangal Underbridge scour protection will include approximately 0.9m of natural bed material above the scour protection. The scour protection will have a smooth transition with the natural bed morphology (as far as practicable). The upstream and downstream extent of the scour protection will be angled downwards to tie in with the existing bed profile, minimising scour risk of the natural bed. Specific mitigation for the River Garry Underbridge will include re-planting of vegetation around outfall structures (**Mitigation Item P05-LV9**) and tying in with natural vegetation, including planting of trees where they are removed for enabling works.	WF100
P05-W30	Create flow pathways to the channel of the water feature from the outfalls located at the top of the steep valley to prevent erosion of the slopes. Re-establish riparian vegetation.	WF89
P05-W31	Creation of a 'natural' step-pool sequence using boulders to tie-in the existing channel to the new inlet upstream. Re-establish riparian vegetation.	WF102

Mitigation Item	Description	Water Features
P05-W32	Re-grade upstream length between side road culvert and main carriageway culvert to tie-in the water feature with the new inlet. Use of natural step-pool sequence (i.e. using boulders to form steps) to grade the channel and minimise potential for scour. Re-establish an appropriately vegetated riparian corridor, particularly where trees were removed.	WF103 WF104
P05-W33	Re-establish riparian vegetation along realigned channel, particularly tree lining.	WF108 WF149 WF158 WF164
P05-W34	Re-grade upstream length to tie-in the water feature with the new inlet. Use of natural step-pool sequence (i.e. using boulders to form steps) to grade the channel and minimise potential for scour. Diversion will have a natural planform, tying in with the side road culvert.	WF111
P05-W35	Sensitive design of channel cross-sections to allow for low and high flows. Tie-in of the new channel cross-section to the upstream and downstream sections of the existing water feature to minimise potential erosion. Fencing along channel margins to prevent the erosion of bank tops from livestock trampling, limiting erosion of earth banks and providing a buffer along the water feature. Further information on fencing requirements is detailed in **Mitigation Items SMC-CP6 and SMC-CP7.**	WF115
P05-W36	Reinstatement of catchpit at culvert inlet.	WF131
P05-W37	Channel downstream of culvert outlet to be regraded using a 'natural' step-pool cascade to prevent potential for scour. Channel tie-in upstream of culvert inlet to include at least two 'natural' step-pools to minimise potential for scour.	WF132 WF134
P05-W38	Tie-in the culvert extension with a step-pool sequence downstream to reduce and even out the gradient changes, preventing excessive erosion. Detailed design of the channel realignment to create a channel suitable for the gradient and prevent excessive erosion. The naturalised channel and removal of existing concrete bed will also mitigate for the proposed concrete culvert.	WF151
P05-W39	Replacement of existing cascade with a natural step-pool cascade, removing hard engineering. Tie-in new culvert outlet with existing channel using step-pools within the design to check the gradient.	WF154
P05-W40	Design of diversion and step-pool cascade to be as natural as possible, with no hard engineering. Replacement box culvert to include baffles (300mm high) to create a naturalised bed.	WF156
P05-W41	Operational SuDS based on DMRB Stage 3 design: Treatment Train 1 comprising filter drains and a detention basin. The calculated treatment efficiencies are provided in Appendix A11.6 (Water Quality). These calculations were used in the HAWRAT Step 3 routine runoff assessment. This treatment train will be adopted for drainage runs D(2) and J(2).	WF100 WF178
P05-W42	Operational SuDS based on DMRB Stage 3 design: Treatment Train 2 comprising filter drains and a retention pond (wet). The calculated treatment efficiencies are provided in Appendix A11.6 (Water Quality). These calculations were used in the HAWRAT Step 3 routine runoff assessment. This treatment train will be adopted for drainage runs D(1), E(1) + E(2), I, J(1), K and L.	WF89 WF98 WF99 WF100
P05-W43	Operational SuDS based on DMRB Stage 3 design: Treatment Train 3 comprising filter drains and a wetland. Two levels of treatment are required due to the combined effects of two road drainage outfalls in close proximity to salmonid spawning habitat. The calculated treatment efficiencies are provided in Appendix A11.6 (Water Quality). These calculations were used in the HAWRAT Step 3 routine runoff assessment. This treatment train will be adopted for drainage runs C, F, G, H, M, N, O, P, Q, R and S	WF98 WF100 WF115 WF158 WF164 WF167
P05-W44	Upstream of the main carriageway culvert re-grade channel with a natural step-pool sequence (cascade) avoiding use of hard engineering. Culvert invert to be tied into natural channel bed using natural substrate (using that removed during construction). Baffles (approximately 300mm) to be placed through new culvert on alternating sides extending approximately 0.5m from edge to centre of culvert. Creation of a scour pool downstream of new outlet recommended.	WF114
P05-W45	Re-establish riparian vegetation along realigned channel. Bed of new extended culvert to include baffles to encourage deposition of natural material. Baffle to be 300mm deep. Channel realignment to re-use bed substrate removed from existing channel to recreate a natural cross-section. Realignment will mimic step-pool sequence from existing water feature.	WF87
P05-W46	Re-establish riparian vegetation along realigned channel. Set-back bridge abutments for new and extended bridge as far back as practicable from back top. Sensitive design of right bank re-profiling to allow for access track under existing bridge. Use of soft engineering to protect asset	WF98

Mitigation Item	Description	Water Features
	and prevent erosion. Removal of debris (man-made) and some select woody material from the upstream channel to improve channel capacity and minimise potential erosion of the banks.	
P05-W47	New cascade upstream of main carriageway culvert inlet to be formed of a natural step-pool cascade.	WF121
P05-W48	Cascade upstream of new culvert inlet will be designed with a natural step-pool sequence. Maintain length of water feature where possible.	WF140
P05-W49	Tie-in to the inlet and outlet to remove ineffective reinforcement and re-creating a natural channel to provide betterment and a more stable channel. Diversion to mimic upstream channel characteristics with a naturalised design, limiting use of hard engineering.	WF159
P05-W50	To reduces the impact of the extended bridge abutments at WF88/167 any sediment or established deposits removed from the river bed will be re-introduced to ensure it remained within the catchment.	WF167
P05-W51	Between approximately ch9900 and ch10500, a requirement has been identified to protect the proposed scheme from potential channel migration and erosion from the River Garry (WF100) at this location. The proposed solution would be a gravity wall combined with a rock armour toe which would be constructed at the rear of the verge adjacent to the proposed southbound carriageway. The exact details of the protection works will be influenced by the ground conditions and in particular the presence, or otherwise, of bedrock at river bed level. They will also be influenced by the presence, or otherwise, of a solution to safeguard the existing A9 that is currently being investigated by the Trunk Road Operator. A further phase of detailed ground investigation will be undertaken and details of any measures implemented to protect the existing A9 will be given to the Contractor, to inform the detailed design of the mitigation for the proposed scheme.	WF100
P05-W52	For tier 3 accesses (unpaved access tracks), an operational SuDS arrangement will consist of open drains or infiltration trenches (where they can be accommodated adjacent to the access track), followed by dispersal of collected runoff over dense vegetation, to allow for natural infiltration into groundwater.	ALL

11.5.19 In relation to mitigation items P05-W41, P05-W42 and P05-W43 described in Table 11.18, further detail on the proposed SuDS features and discharge locations are detailed in Table 11.19 below.

Table 11.19: Proposed SuDS and levels of treatment

Drainage Catchment	Receiving Water Feature	SuDS Treatment Level 1	SuDS Treatment Level 2
A	Allt Girnaig (WF89)	Filter Drains	Retention Pond
B	Allt Girnaig (WF89)	Filter Drains	Retention Pond
C	Allt Chluain (WF98)	Filter Drains	Wetland
D(1)	Allt Chluain (WF98)	Filter Drains	Retention Pond
D(2)	WF178	Filter Drains	Detention Basin
E(1) + E(2)	WF99	Filter Drains	Retention Pond
F	River Garry (WF100)	Filter Drains	Wetland
G	Allt Bhaic (WF115)	Filter Drains	Wetland
H	Allt Bhaic (WF115)	Filter Drains	Wetland
I	River Garry (WF100)	Filter Drains	Retention Pond
J(1)	River Garry (WF100)	Filter Drains	Retention Pond
J(2)	River Garry (WF100)	Filter Drains	Detention Basin
K	River Garry (WF100)	Filter Drains	Retention Pond
L	WF136	Filter Drains	Retention Pond
M	River Garry (WF100)	Filter Drains	Wetland
N	River Garry (WF100)	Filter Drains	Wetland
O	River Garry (WF100)	Filter Drains	Wetland
P	Allt Crom Bhruthaich (WF167)	Filter Drains	Wetland
Q	Allt Anndeir (WF158)	Filter Drains	Wetland
R	Allt Anndeir (WF158)	Filter Drains	Wetland
S	Allt Geallaidh (WF164)	Filter Drains	Wetland

11.6 Residual Impacts

11.6.1 Following implementation of the mitigation measures outlined in Section 11.5 (Mitigation), the potential for significant impacts on the surface water environment would be avoided/prevented, reduced or offset.

11.6.2 The residual impacts likely to occur during either the construction and/or operational phases following the application of mitigation measures are identified for each water feature in terms of hydrology and flood risk, fluvial geomorphology and water quality in Appendix A11.7 (Impact Assessment).

11.6.3 A summary of the residual impacts detailed within Appendix A11.7 (Impact Assessment) is provided below.

Construction

Hydrology and Flood Risk

11.6.4 As the receptors during construction are predominantly the construction works themselves, the majority of potential hydrology and flood risk impacts arising from the construction of the proposed scheme would be Neutral or Slight provided all mitigation recommendations to increase flood resilience are adhered to. However, adverse residual impacts with **Moderate** significance for flood risk were identified for WF100 (River Garry lower) and WF115 (Allt Bhaic), due to the inherent risks associated with the requirement to locate temporary structures within the functional floodplain during the construction.

Fluvial Geomorphology

11.6.5 No residual significant fluvial geomorphology impacts are expected from construction of the proposed scheme.

Water Quality

11.6.6 No residual significant water quality impacts are expected from construction of the proposed scheme.

Operation

Hydrology and Flood Risk

11.6.7 The majority of potential impacts arising from the operation of the proposed scheme would have a Neutral or Slight significance.

11.6.8 However residual impacts with **Moderate**, **Large** and **Very Large** significance for flood risk were identified for the operational phase of the proposed scheme as follows:

- Residual adverse impacts of **Very Larg**e significance are attributed to WF100 (River Garry) and WF115 (Allt Bhaic) due to increases in the fluvial flood depth from the 0.5% AEP (200-year) plus CC event on agricultural land and terrestrial habitat that is not deemed sensitive to increased flood depths. The land would be returned to the landowner with appropriate burdens restricting development, protecting the area for flood storage. This approach avoids potential impacts on other sensitive receptors associated with the provision of dedicated flood storage areas, and enables landowners/tenants to use the land post-scheme construction for agricultural use outside of periods of inundation.
- Residual adverse impacts of **Moderate** significance were assessed for WF136 due to a highly localised increase in flood risk to the B847 (+57mm increase in flood depth from a baseline depth of 58mm for the 0.5% AEP (200-year) plus CC event). The increase in flood risk to the B847 would only increase predicted flood depths to 115mm indicating that access would still be possible.
- Residual beneficial impacts of **Large** significance are reported for WF136 due to a number of residential properties being taken out of the flood extent for the design flood event. This results in a net minor beneficial magnitude of impact on WF136.

- Residual beneficial impacts of **Moderate** significance were assessed for WF92 due to a residential property being taken out of the flood extent for the design flood event, in addition to general decreases in flood depth of >10mm and <50mm. This results in a net beneficial magnitude of impact reported for WF92.
- Residual beneficial impacts of **Moderate** significance were assessed for WF134 due to a localised reduction in flood risk to properties in the vicinity of the Calvine Underpass.

11.6.9 It is emphasised that the potential impact on flood risk to sensitive receptors (residential properties and critical infrastructure) was removed or reduced, at the expense of localised increases in flood depths on agricultural land and minor roads which are already inundated during the design flood event. Therefore, a net beneficial effect on flood risk is reported from the proposed scheme. Further detail on the residual flood risk is contained within Appendix A11.3 (Flood Risk Assessment).

Fluvial Geomorphology

11.6.10 No significant residual fluvial geomorphology impacts are envisaged during operation of the proposed scheme, with the adherence to mitigation measures.

Water Quality

11.6.11 After mitigation by the proposed SuDS mitigation measures, the HAWRAT Step 3 assessments have concluded that at all of the proposed outfalls, no residual impacts significant impacts on water quality are expected during the operational phase.

11.6.12 For water features currently receiving routine runoff from the existing A9 that are included within the drainage design for the proposed scheme, beneficial impacts are anticipated. Detailed information on the drainage network of the existing A9 is not available and therefore the potential beneficial impacts cannot be quantified.

11.6.13 Refer to Appendix A11.6 (Water Quality) for detailed post-mitigation results for the HAWRAT water quality assessments.

11.7 Statement of Significance

Hydrology and Flood Risk

11.7.1 During construction of the proposed scheme impacts on the following water features of **Moderate** or greater significance were assessed: WF100 (River Garry lower), WF115 (Allt Bhaic)

11.7.2 During operation of the proposed scheme, adverse impacts of **Very Large** significance on WF100 (River Garry lower) and WF115 (Allt Bhaic) were assessed, whilst WF136 would experience adverse impacts of **Moderate** significance. Beneficial impacts of **Moderate** significance were assessed for WF134 and WF92, and beneficial impacts of **Large** significance were assessed for WF136.

Fluvial Geomorphology

11.7.3 No residual significant impacts on fluvial geomorphology are anticipated, provided all mitigation is adhered to.

Water Quality

11.7.4 No residual significant impacts on water quality (including ‘water quality’, ‘water supply’, ‘dilution and removal of waste products’ and ‘biodiversity’) are considered to be significant in accordance with the EIA regulations.

11.8 References

British Geological Survey (2016). Geology of Britain viewer. Available at: http://www.bgs.ac.uk/data/mapViewers/home.html

British Standards (2009). BS 6031:2009 Code of Practice for Earthworks.

Centre for Ecology and Hydrology (2015). National River Flow Archive. Available at: http://www.ceh.ac.uk/news-and-media/news/uk-river-flow-data-now-web-accessible

Construction Industry Research and Information Association (1994). Control of pollution from highway drainage discharge, CIRIA R142.

Construction Industry Research and Information Association (2004). Sustainable drainage systems: Hydraulic, structural and water quality advice, CIRIA C609.

Construction Industry Research and Information Association (2006a). Control of water pollution from linear construction projects: Technical Guidance, CIRIA C648.

Construction Industry Research and Information Association (2006b). Control of water pollution from linear construction projects: Site guide, CIRIA C649.

Construction Industry Research and Information Association (2007). Site handbook for the construction of SUDS, CIRIA C698.

Construction Industry Research and Information Association (2010). Culvert Design and Operation Guide, CIRIA C689.

Construction Industry Research and Information Association (2015a). Environmental good practice on site guide (fourth edition), CIRIA C741

Construction Industry Research and Information Association (2015b). The SuDS Manual, CIRIA C753.

Environment Agency (1999). Waterway Bank Protection: a guide to erosion assessment and management (Environment Agency)

Environment Agency (2010). The Fluvial Design Guide. Available at: http://evidence.environment-agency.gov.uk/FCERM/en/FluvialDesignGuide.aspx

Environment Agency (2013). Climate Change Allowances for Planners.

Hydro International (undated). Downstream Defender Operation and Maintenance Manual. Available at: <http://www.hydro-int.com/sites/default/files/operations_maintenance_manual.pdf> [Last accessed 20/12/2016]

Jacobs (2014). DMRB Stage 1 Assessment A9 Dualling: Preliminary Engineering Support (PES) Services

Jacobs (2016a). A9 Dualling Killiecrankie to Pitagowan: DMRB Stage 2 Scheme Assessment Report, Volume 1: Main Report and Appendices, Part 3: Environmental Assessment

Jacobs (2016b). A9 Dualling Pitagowan to Glen Garry: DMRB Stage 2 Scheme Assessment Report, Volume 1: Main Report and Appendices, Part 3: Environmental Assessment

Luker, M. and Montague, K. (1997). Control of Pollution from Highway Drainage Discharges, CIRIA

Mustow, S. E., Burgess, P. F. and Walker, N. (2005). Practical Methodology for Determining the Significance of Impacts on the Water Environment. Water and Environment Journal, 19: 100–108. doi:10.1111/j.1747-6593.2005.tb00557.x

National Library of Scotland (2015). Map images. Available at: http://maps.nls.uk/.

Scotland's Environment (2016). Interactive State of the Environment Report Map (Water). Available at: http://www.environment.scotland.gov.uk/get-interactive/map-view/

SCOTS (2010). SUDS for Roads. Society of Chief Officers of Transportation in Scotland. Available at: http://www.scotsnet.org.uk/documents/SudsforRoads. Published Aug2009_001.pdf [1 July 2015].

Scottish Government (2003). Water Environment Water Services (WEWS) Act 2003. Available at: http://www.legislation.gov.uk/asp/2003/3/contents.

Scottish Government (2003). Water Environment Water Services (WEWS) Act 2003. Available at: http://www.legislation.gov.uk/asp/2003/3/contents.

Scottish Government (2009a). Flood Risk Management (Scotland) Act 2009. Available at: http://www.legislation.gov.uk/asp/2009/6/pdfs/asp_20090006_en.pdf.

Scottish Government (2009b). Climate Change (Scotland) Act 2009. Available at: http://www.legislation.gov.uk/asp/2009/12/pdfs/asp_20090012_en.pdf.

Scottish Government (2011). Water Environment (Controlled Activities) (Scotland) Regulations (2011) (CAR). Available at: http://www.legislation.gov.uk/ssi/2011/209/made.

Scottish Government (2013). Water Environment (Controlled Activities) (Scotland) Regulations (2013) (as amended) (CAR). Available at: http://www.legislation.gov.uk/ssi/2013/176/contents/made

Scottish Government (2014). Scottish Planning Policy. Available at: http://www.gov.scot/Resource/0045/00453827.pdf

Scottish Government (2015). The River Basin Management Plan for the Scotland River Basin District: 2015–2027. Available at: http://www.sepa.org.uk/media/163445/the-river-basin-management-plan-for-the-scotland-river-basin-district-2015-2027.pdf [Accessed 21 June 2016].

Sear, D.A.; Newson, M. D.; Thorne, C. R.; Soar, P. J. and Skinner, K. S. (2010). Guidebook of Applied Fluvial Geomorphology. ICE Publishing

SEPA (2002). The Future for Scotland's Waters: Guiding Principles on the Technical Requirements of the Water Framework Directive. Available at: http://www.fwr.org/WQreg/Appendices/future_for_scotlands_waters(1).pdf [Accessed 21 June 2016]

SEPA (2006). Code of Practice for installers, owners and operators of underground storage tanks and pipelines.

SEPA (2006-2017). Guidance for Pollution Prevention (PPGs). Available at: http://www.netregs.org.uk/environmental-topics/pollution-prevention-guidelines-ppgs-and-replacement-series/guidance-for-pollution-prevention-PPGs-full-list/

SEPA (2007). Pollution Prevention Guidelines: PPG5: Works and maintenance in or near water. Available at: https://www.sepa.org.uk/media/60112/ppg-5-works-and-maintenance-in-or-near-water.pdf

SEPA (2008a). Engineering in the Water Environment Good Practice Guide: Bank Protection Rivers and Lochs (WAT-SG-23). Available at: http://www.sepa.org.uk/media/150971/wat_sg_23.pdf [Accessed 23 April 2015].

SEPA (2008b). Engineering in the Water Environment Good Practice Guide: Intakes and Outfalls (WAT-SG-28). Available at: http://www.sepa.org.uk/media/150984/wat_sg_28.pdf [Accessed 23 April 2015].

SEPA (2009a). Pollution Prevention Guidance: PPG21: Incident Response Planning. Available at: https://www.sepa.org.uk/media/100557/ppg-21-pollution-incident-response-planning.pdf

SEPA (2009b). Good Practice Guide: Temporary Construction Methods. Available at: https://www.sepa.org.uk/media/150997/wat_sg_29.pdf

SEPA (2010a) Improving the quality of Scotland's water environment Tay area management plan 2009–2015 Supplementary to the river basin management plan for the Scotland [Accessed 06 March 2017] www.sepa.org.uk/media/38103/tay_area-management-plan.pdf

SEPA (2010b). Engineering in the Water Environment: Good Practice Guide: River Crossings (WAT-SG-25). Available at: http://www.sepa.org.uk/media/151036/wat-sg-25.pdf [Accessed 23 April 2015].
SEPA (2011a). Water Environment (Controlled Activities) (Scotland) Regulations (2011) (as amended) (CAR) A Practical Guide. Available at: http://www.sepa.org.uk/media/34761/car_a_practical_guide.pdf.

SEPA (2011b). Pollution Prevention Guidance: PPG2: Above ground oil storage tanks. Available at: http://www.sepa.org.uk/media/60073/ppg-2-above-ground-oil-storage.pdf

SEPA (2011c). Pollution Prevention Guidance: PPG22: Dealing with spills. Available at: https://www.sepa.org.uk/media/60177/ppg-22-incident-response-dealing-with-spills.pdf

SEPA (2011d) Pollution Prevention Guidance: PPG26: Drums and intermediate bulk containers. Available at: http://www.sepa.org.uk/media/60190/ppg-26-safe-storage-drums-and-intermediate-bulk-containers.pdf

SEPA (2012a). Supporting Guidance (WAT-SG-21) Environmental Standards for River Morphology.

SEPA (2012b). Pollution Prevention Guidelines: PPG6: Working at construction and demolition sites. Available at: https://www.sepa.org.uk/media/60125/ppg-6-working-at-construction-and-demolition-sites.pdf

SEPA (2012c). Position Statement to Support the Implementation of the Water Environment (Controlled Activities) (Scotland) Regulations 2011: WAT-PS-07-02: Bank Protection. Available at: http://www.sepa.org.uk/media/150932/wat_ps_07_02.pdf [Accessed 23 April 2015].

SEPA (2013). Pollution Prevention Guidance: PPG1. Available at: https://www.sepa.org.uk/media/60060/ppg-1-general-guide-to-the-prevention-of-pollution.pdf

SEPA (2014). Flood Maps. Available at: http://map.sepa.org.uk/floodmap/map.htm.

SEPA (2015a). SEPA Position Statement to Support the Implementation of the Water Environment (Controlled Activities) (Scotland) Regulations 2011. WAT-PS-06-02 Culverting of Watercourses Available at: https://www.sepa.org.uk/media/150919/wat_ps_06_02.pdf

SEPA (2015b). Technical Flood Risk Guidance for Stakeholders (SS-NFR-P-002). Available at: http://www.sepa.org.uk/media/162602/ss-nfr-p-002-technical-flood-risk-guidance-for-stakeholders.pdf

SEPA (2015c) Flood maps. Available at: https://www.sepa.org.uk/environment/water/flooding/flood-maps/

SEPA (2016c). River gauging data records from 1990 to 2015 for station 15034 (River Garry at Killiecrankie) and associated hydrometric data.

SEPA (2016d). SEPA Water Environment Hub. Available at: http://www.sepa.org.uk/data-visualisation/water-environment-hub/ [Accessed 25 September 2016]

SEPA (2017a). The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended) A Practical Guide. Available at: http://www.sepa.org.uk/media/34761/car_a_practical_guide.pdf

SEPA (2017b). SEPA Regulatory Method (WAT-RM-08), Sustainable Urban Drainage Systems. Available at: http://www.sepa.org.uk/media/219048/wat-rm-08-regulation-of-sustainable-urban-drainage-systems-suds.pdf

SEPA (undated). RBMP Interactive Map. Available at: http://gis.sepa.org.uk/rbmp/ [Accessed 25 September 2016].

Skinner, A., Young, M. & Hastie L. (2003). Ecology of the Freshwater Pearl Mussel. Conserving Natura 2000 Rivers Ecology Series No. 2 English Nature, Peterborough.

The Highways Agency et al. (2004). Design Manual for Roads and Bridges, Volume 4, Section 2, Part 7 (HA 107/04): Design of Outfall and Culvert Details. Available at: http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol4/section2/ha10704.pdf

The Highways Agency et al. (2009). Design Manual for Roads and Bridges, Volume 11 Section 3, Part 10 (HD 45/09): Road Drainage and the Water environment. Available at: http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol11/section3.htm.

The Highways Agency et al. (2009b). Interim Advice Note (IAN) 125/09: Supplementary Guidance for Users of DMRB Volume 11 Environmental Assessment

Transport Scotland (2013). A9 Dualling Programme Strategic Environmental Assessment (SEA) – Environmental Report

Transport Scotland (2014a). A9 Dualling Programme Strategic Environmental Assessment (SEA) – Environmental Report Addendum

Transport Scotland (2014b). A9 Dualling Programme Strategic Environmental Assessment (SEA) – Post Adoption SEA Statement

Transport Scotland (unpublished) Digital Terrain Model (DTM) 5m horizontal resolution (derived from 2013 photogrammetry data).

Werritty, A. and Hoey, T. (2004) Geomorphological changes and trends in Scotland: river channels and processes. Scottish Natural Heritage Commissioned Report No. 053