14 Road Drainage and the Water Environment

14.1 Introduction

14.1.1 This chapter presents the Design Manual for Roads and Bridges (DMRB) Stage 2 Assessment of the route options in terms of the surface water environment, which includes hydrology, flood risk, fluvial geomorphology and water quality.

14.1.2 The chapter is supported by the following appendices, which are cross-referenced where relevant:

- Appendix A14.1: Baseline Conditions;
- Appendix A14.2: Surface Water Hydrology;
- Appendix A14.3: Water Quality Calculations; and
- Appendix A14.4: Impact Assessment Tables.

14.1.3 All of these appendices can be found in Part 6 (Appendices) of this report.

14.1.4 This chapter sets out the assessment methods in Section 14.2 (Approach and Methods), describes the baseline conditions in Section 14.4 (Baseline Conditions), and identifies potential impacts that could occur in the absence of mitigation in Section 14.5 (Impact Assessment). Mitigation to avoid, reduce or offset the potential impacts is then described in Section 14.6 (Potential Mitigation). Where possible, this section also includes an indication of potential residual impacts, taking into account likely mitigation measures.

14.1.5 The surface water environment is intrinsically linked to groundwater and ecological receptors. Potential impacts on groundwater and geomorphology, in the context of groundwater quality, solid and drift geology and the potential indirect impact on surface water features (via groundwater dewatering), are considered separately in Chapter 13 (Geology and Soils). Whilst the relevant designations have been considered in this chapter, potential impacts on ecological receptors as a result of the changes to the surface water environment are considered in Chapter 12 (Ecology and Nature Conservation).

14.2 Approach and Methods

Structure of Assessment

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

- Hydrology and Flood Risk: the assessment of potential impacts on the flow of water on or near the land surface, which is intrinsically linked to hydrogeology, water quality, geomorphology and ecology. Flood Risk includes risk from all potential sources of flooding, including from rivers and the sea, surface water, groundwater, sewers and the failure of water management infrastructure and drainage systems;
- Fluvial Geomorphology: the assessment of landforms associated with fluvial processes and sediment dynamics in river environments. Fluvial Geomorphology is intrinsically linked to hydrogeology, water quality, hydrology and ecology. Various factors have been assessed during the geomorphological assessment including flow dynamics, the structure and material of the bed and banks, lateral and longitudinal connectivity, erosional and depositional features, the structure of the riparian zone and anthropogenic impacts (e.g. structures); and
- Water Quality: the assessment of potential impacts on various attributes such as water quality/supply, dilution and removal of waste products and biodiversity.

Study Area

Hydrology and Flood Risk

14.2.2 The study area for flood risk principally comprises the land adjacent to the proposed route options; however, the impacts of the route options on flood risk may be felt a significant distance away. Consequently, the study area extends to include all areas where flood risk would be altered as a result of the proposed works. This includes any watercourse, surface water and groundwater catchments that may be impacted by the route options. The flood risk study area currently remains under review and may be subject to change during the DMRB Stage 3 assessment.

Fluvial Geomorphology

14.2.3 The fluvial geomorphology study area captures all watercourses crossed by the proposed route options, extending 500m upstream and downstream. This buffer ensures that potential geomorphological features both at the watercourse crossing and a suitable distance upstream and downstream of the watercourse crossing is captured. The study areas may be extended for some watercourses as required (based on professional judgement). For example, the study area is extended to 1km upstream and downstream of the route options for Water Framework Directive (WFD) designated water bodies.

Water Quality

14.2.4 The study area for water quality extends to a radius of at least 1km around the proposed route options; however, for some categories of data, the search may extend to significantly greater distances, depending on the location of features such as water quality sampling stations or protected areas.

Determination of Baseline Conditions

14.2.5 Baseline conditions were identified through a combination of consultation with statutory consultees, desk-based assessments and information obtained during a site walkover in April 2016. Details of the observations from this site visit are presented in Appendix A14.1 (Baseline Conditions).

14.2.6 The desk-based assessment has taken into account relevant DMRB guidance, legislation and regulations, including those listed below:

- River Geomorphology: A Practical Guide (Environment Agency 1998);
- WFD policy guidance 'The Future for Scotland's Waters, Guiding Principles on the Technical Requirements of the Water Framework Directive' (Scottish Environment Protection Agency (SEPA) 2002);
- Review of Impact Assessment Tools and Post Project Monitoring Guidelines, Report to SEPA (Haycocks Associates 2005);
- DMRB Volume 11, Section 3, Part 10 (HD45/09): Road Drainage and the Water Environment (The Highways Agency, Transport Scotland, Welsh Assembly Government and The Department for Regional Development Northern Ireland, 2009) (hereafter DMRB HD45/09);
- The Climate Change (Scotland) Act 2009;
- The Flood Risk Management (Scotland) Act 2009;
- The Water Environment (Controlled Activities) (Scotland) Regulations (CAR) 2011 (as amended);
- Scottish Planning Policy (SPP) (Scottish Government 2014);
- Technical Flood Risk Guidance for Stakeholders (SEPA 2015c); and
- The Controlled Activities Regulations (CAR) Practical Guide (SEPA 2016a).

Desk-based Assessment

14.2.7 Data was collated from the following sources:

- 1:25,000 Ordnance Survey (OS) maps;
- Low Flow Enterprise (LFE) flow duration curve percentiles supplied by Wallingford Hydro Solutions;
- Envirocheck Report (Landmark 2006; Landmark 2009);
- Flood Estimation Handbook (FEH) CD-ROMv3 (CEH 2009);
- A96 Inshes to Nairn DMRB Stage 2 Assessment Scoping Study (Jacobs 2011);
- A96 Dualling Inverness to Nairn (including Nairn Bypass): DMRB Stage 2 Scheme Assessment Report (Jacobs 2014);
- A96 Dualling Inverness to Aberdeen Strategic Flood Risk Assessment (SFRA) (CH2M 2015a);
- A96 Dualling Inverness to Aberdeen Strategic Environmental Assessment, Tier 2 Environmental Report (CH2M 2015b);
- A96 Dualling Inverness to Aberdeen Preliminary Engineering Assessment (Jacobs 2015b);
- SEPA Flood Maps (SEPA 2015a);
- SEPA's Interactive River Basin Management Plan (SEPA 2015b);
- A9/A96 Connections Study Transport Appraisal Report (Jacobs 2016);
- Scotland's Environment Interactive Water Map (Scottish Government 2016);
- SEPA's Water Environment Hub (SEPA 2016b);
- Historic Maps of Rivers (National Library of Scotland 2016);
- National River Flow Archive data (Centre for Ecology and Hydrology (CEH) 2016b);
- Flood Estimation Handbook Web Service (CEH 2016a); and
- CAR, Pollution Prevention and Control (PPC) and Waste Management Licence (WML) data sent by SEPA on 17 January 2016.

Consultation

14.2.8 Consultation with The Highland Council and SEPA has been undertaken in order to request relevant information on the potential impacts of the route options.

14.2.9 The Highland Council provided a written response to the A9/A96 Connections Study (Jacobs 2015a) in September 2014. In regard to the Road Drainage and Water Environment assessment, the Council's response highlighted key areas of baseline flood risk which may be impacted by the route options.

14.2.10 A consultation letter was sent to SEPA in April 2016. The purpose of this consultation was as follows:

- to notify them about the proposals for A9/A96 Inshes to Smithton;
- to inform them about the DMRB Stage 2 environmental assessment, including the proposed methodology;
- to provide them with an opportunity to comment on the Stage 2 route options and assessment methodology; and
- to request environmental data/information that is considered to be of relevance to the DMRB Stage 2 environmental assessment.

14.2.11 Data was requested from SEPA for the study area for the following: existing water quality information for all surface water features, including water hardness; and any WFD water body spatial data that is not currently available online. Further information on the consultation process is provided in Chapter 7 (Overview of Environmental Assessment).

Impact Assessment

14.2.12 The impact assessment has been carried out using the general approach outlined in Chapter 7 (Overview of Environmental Assessment) and in accordance with DMRB HD45/09.

14.2.13 The level of significance of an impact (both without and with mitigation) has been determined based on the sensitivity/importance of each attribute of each surface water feature combined with the magnitude of potential impacts, during both construction and operation.

Importance/Sensitivity

14.2.14 The importance or sensitivity of an attribute of a surface water feature (e.g. conveyance of flow/flood risk, fluvial geomorphology, water supply or biodiversity) was categorised on a scale of 'very high' to 'low', in accordance with the criteria provided in Table 14.1 (based on Table A4.3 – Estimating the Importance of Water Environment Attributes from DMRB HD45/09) and professional judgement, where appropriate. Attributes considered included conveyance of flow/flood risk, fluvial geomorphology, water quality or supply, dilution and removal of waste products and biodiversity.

Table 14.1: Typical Indicators of the Importance/Sensitivity of Surface Water Features

Importance/ Sensitivity	Criteria
Very High	Attribute has a high quality and rarity on regional or national scale. **Hydrology and Flood Risk:** Water feature with direct flood risk to the adjacent populated areas, with greater than 100 residential properties at risk or critical social infrastructure units such as hospitals, schools, safe shelters or other land use of great value. A water feature with hydrological importance to: i) sensitive and protected ecosystems of international status; ii) critical economic and social uses (e.g. water supply, navigation, recreation, amenity). A water feature or flood plain that provides critical flood alleviation benefits. **Fluvial Geomorphology:** A very high sensitive watercourse must show no, or limited signs, of previous modification and/or be experiencing no morphological pressures at the current time. Sediment regime: Watercourse appears to be in complete natural equilibrium. That is, it is operating as a sediment source, sink or transfer zone and is not undergoing excessive unnatural deposition and/or erosion. It may also be the case that such an environment supports a range of species and habitats which would be sensitive to a change in suspended sediment concentrations and turbidity such as migratory salmon or freshwater pearl mussels. Channel morphology: Watercourse exhibits a natural range of morphological features such as pools and riffles, active gravel bars and varied river bank types, with no signs of modifications or morphological pressures. Natural fluvial processes: A watercourse where there is a diverse range of fluvial processes which are free from any modification or anthropogenic influence, which would be highly vulnerable to changes as a result of modifications. **Water Quality:** Site is protected/designated under EC or UK habitat legislation (Special Area of Conservation (SAC), Special Protection Area (SPA), Site of Special Scientific Interest (SSSI), Water Protection Zone (WPZ), Ramsar site or salmonid water). WFD overall status of 'High'. No or only limited anthropogenic pressures, which are not significantly affecting the aims of the WFD. Water quality complies with Annual Average Environmental Quality Standards (AA-EQS). EC designated Salmonid/Cyprinid Fishery. Species protected under EC legislation. High use of watercourse for recreation, directly related to its quality (e.g. swimming, salmon fishery).
High	Attribute has a high quality and rarity on local scale. **Hydrology and Flood Risk:** Water feature with direct flood risk to the adjacent populated areas, with between 1 and 100 residential properties or industrial premises at risk from flooding. Critical social infrastructure not affected. A water feature with hydrological importance to: i) sensitive and protected ecosystems of national designation; ii) locally important economic and social uses (e.g. water supply, navigation, recreation, amenity). A water feature or flood plain providing significant flood alleviation benefits. **Fluvial Geomorphology**:

Importance/ Sensitivity	Criteria
	Sediment regime: A highly sensitive watercourse appears to be in natural equilibrium. That is, it is operating as a sediment source, sink or transfer zone and is not undergoing excessive unnatural deposition and/or erosion. It may also be the case that such an environment supports a range of species and habitats which would be sensitive to a change in suspended sediment concentrations and turbidity such as migratory salmon or freshwater pearl mussels. Channel morphology: Watercourse exhibits a natural range of morphological features such as pools and riffles, active gravel bars and varied river bank types, with very limited signs of modifications or morphological pressures. Natural fluvial processes: A watercourse where there is a diverse range of fluvial processes which have very limited signs of modifications or anthropogenic influences, which would be highly vulnerable to changes in fluvial processes as a result of modifications. **Water Quality:** WFD overall status of 'Good'. Water quality complies with EQS. Major cyprinid fishery. Species protected under EC or UK legislation. Moderate use of watercourse for recreation.
Medium	Attribute has a medium quality and rarity on local scale. **Hydrology and Flood Risk:** Water feature with a possibility of direct flood risk to less populated areas without any critical social infrastructure units such as hospitals, schools, safe shelters and/or utilisable agricultural fields. A water feature with some but limited hydrological importance to: i) sensitive or protected ecosystems; ii) economic and social uses; iii) the flooding of 10 or fewer industrial properties. A water feature or flood plain that provides some flood alleviation benefits. **Fluvial Geomorphology:** Sediment regime: Watercourse shows signs of modification and is recovering a natural equilibrium. That is, it is operating as a source, sink or transfer zone but may be undergoing elevated levels of deposition and/or erosion. It may also be the case that such an environment supports limited species and habitats which may be slightly sensitive to a change in suspended sediment concentrations and turbidity. Channel morphology: Watercourse exhibits a limited range of morphological features such as pools and riffles, few active gravel bars and relatively uniform bank types, with signs of modifications and morphological pressures. There may be signs of recovery of morphological features, such as the development of berms within an over wide channel. Natural fluvial processes: A watercourse where there is a limited range of fluvial processes which are influenced by modifications or anthropogenic influences, which would be vulnerable to changes in fluvial processes as a result of modifications. **Water Quality:** WFD overall status of 'Moderate'. Likely to exhibit a measurable degradation in water quality as a result of anthropogenic factors. May be subject to improvement plans by SEPA. Low use of watercourse for recreation, or recreation use not directly related to quality.
Low	Attribute has a low quality and rarity on local scale. **Hydrology and Flood Risk:** Water feature passing through uncultivated agricultural land. A water feature with minimal hydrological importance to: i) sensitive or protected ecosystems; ii) economic and social uses; iii) with a low probability of flooding of residential and industrial properties and is a water feature or flood plain that provides minimal flood alleviation benefits. **Fluvial Geomorphology**: Sediment regime: Watercourse that has a highly modified sediment regime. That is, the natural equilibrium of the watercourse as a source, sink or transfer zone has been changed by channel modifications or anthropogenic pressures. The watercourse may have insufficient capacity to recover its natural equilibrium and is stable acting as a transfer or sink of sediment. It may also be the case that such an environment does not support any significant species sensitive to changes in suspended solids concentration or turbidity. Channel morphology: Watercourse exhibits no morphological diversity; uniform flow, gravel bars are absent and bank types uniform. May have been subject to past modification such as bank protection and culverting. Likely to be stable with insufficient capacity to develop morphological features. Natural fluvial processes: A watercourse which shows no evidence of active fluvial processes and is not likely to be affected by modification to boundary conditions. **Water Quality:** WFD overall status of 'Poor' or 'Bad'. Highly likely to be affected by anthropogenic factors. May dry up during summer months. Fish sporadically present or restricted; no species of conservation concern. Not used for recreation purposes.

Magnitude of Impact

14.2.15 The magnitude of impact was assessed on a scale of major, moderate, minor and negligible based on professional judgement guided by the criteria and typical examples shown in Table 14.2. The magnitude of an impact is influenced by timing, scale, size and duration of change to the baseline conditions, and can be either adverse or beneficial, as defined in Table 14.2.

14.2.16 It should be noted that the DMRB guidance classifies the magnitude of potential impacts on flood level using the 1% Annual Exceedance Probability (AEP) (100 year return period) event. In Scotland the design standard (Scottish Government 2014) is the 0.5% AEP (200 year return period) event and therefore the magnitude of impacts has been assessed using the 0.5% AEP event to reflect the Scottish design standard.

14.2.17 For impacts on water quality, one of the aspects considered is whether the water quality in the receiving watercourse would achieve a 'Pass', when using the Highways Agency (now Highways England) Water Risk Assessment Tool (HAWRAT).

14.2.18 It should be noted that when any of the criteria are met from one of the more adverse categories of magnitude described in Table 14.2, then that magnitude of impacts is applied.

Table 14.2: Typical Criteria for Estimating the Magnitude of Impact on Surface Water Features

Magnitude	Typical Examples
Major Adverse	Results in loss of attribute and/or quality and integrity of the attribute. **Hydrology and Flood Risk:** Major changes to flow regime (low, mean and/or high flows – at the site, upstream and/or downstream). An alteration to a catchment area in excess of a 25% reduction or increase. Significant increase in the extent of 'medium to high risk' areas, classified by the Risk Framework of SPP (Scottish Government 2014, p.53, paragraph 263). This means there would be significantly more areas/properties at risk from flooding by the 0.5% or greater AEP (200-year) flow. An increase in peak flood level during a 0.5%AEP (200-year) event of >100mm. **Fluvial Geomorphology:** Causes deterioration in the overall water body status or WFD quality elements and prevents the water body from achieving an overall status of 'Good'. Failure of hydromorphological elements (morphology, quantity and dynamics of flow) as a result of the works. Significant increase in the extent of watercourse modification which has the potential to resulting in the following changes: Sediment regime: Major change to the natural equilibrium through modification, significantly changing the natural function of the watercourse (sediment source, sink or transfer zone). This may arise from a major increase in amount of fine sediment and turbidity. Channel morphology: Major impacts on channel morphology through the removal of a wide range of morphological features and/or replacing a large extent of the natural bed and/or banks with artificial material. Major channel realignment significantly altering the natural channel planform and bank profiles typically in the loss of sinuosity, increased channel gradient and higher stream powers. This poses erosion risk problems due to the higher stream energy. Major realignment impacts on natural channel processes, which has knock-on effects on sediment regime, flow diversity and depositional features. Natural fluvial processes: Major interruption to fluvial processes such as channel planform evolution or erosion and deposition. **Water Quality:** Major shift away from the baseline conditions. Equivalent to downgrading two WFD classes, e.g. from Good to Poor, or any change that downgrades a site in quality status as this does not comply with the WFD. Failure of both soluble and sediment-bound pollutants in HAWRAT and compliance failure with AA-EQS values. Calculated risk of pollution from a spillage >2% annually. Loss or extensive change to a fishery or a designated nature conservation site.
Moderate Adverse	Results in effect on integrity of attribute, or loss of part of attribute. **Hydrology and Flood Risk:** Moderate shift away from baseline conditions and moderate changes to the flow regime. An alteration to a catchment area in excess of 10% but less than 25%. Moderate increase in the extent of 'medium to high risk' areas (as defined by SPP). An increase in peak flood level (for a 0.5% AEP event) >10 mm resulting in an increased risk of flooding to >100 residential properties or an increase of >50 mm resulting in an increased risk of flooding to 1-100 residential properties. **Fluvial Geomorphology:** Prevents a water body from achieving an overall status of 'Good'. Failure of one or more hydromorphological elements (morphology, quantity and dynamics of flow) as a result of the works. Partial loss or damage to habitat due to modifications. Increases the extent of watercourse modification which has the potential to result in the following changes: Sediment regime: Moderate change to the natural equilibrium through modification, partially changing the natural function of the watercourse (sediment source, sink or transfer zone). This may arise from a moderate increase in amount of fine sediment and turbidity. Channel morphology: Moderate impact on channel morphology through the removal of a range of morphological features and/or replacing a medium extent of the natural bed and/or banks with artificial material. Channel realignment resulting in a moderate change in channel planform and bank profiles

Magnitude	Typical Examples
	typically resulting in some loss of sinuosity, increased channel gradient and higher stream powers. Erosion risk may increase as a result of the increased gradient and stream power. The realignment will partially change natural channel processes, including sediment regime, flow diversity and depositional features. Natural fluvial processes: Moderate interruption to fluvial processes such as channel planform evolution or erosion. **Water Quality:** Moderate shift from the baseline conditions that may be long-term or temporary. Equivalent to downgrading one WFD class, e.g. from Moderate to Poor. Failure of both soluble and sediment-bound pollutants in HAWRAT but compliance with AA-EQS values. Calculated risk of pollution from a spillage >1% annually and <2% annually. Partial loss in productivity of a fishery.
Minor Adverse	Results in some measurable change in attributes quality or vulnerability. **Hydrology and Flood Risk:** Slight changes to the flow regime. An alteration to a catchment area in excess of 1% but less than 10%. Slight increase in the extent of 'medium to high risk' areas (as defined by SPP). An increase in peak flood level (for a 0.5% AEP event) >10 mm resulting in an increased risk of flooding to fewer than 10 industrial properties. **Fluvial Geomorphology:** Potential for failure in one of the hydromorphological elements (morphology, quantity and dynamics of flow) as a result of the works. Slight change/deviation from baseline conditions or partial loss or damage to habitat due to modifications. This has the potential to result in: Sediment regime: Minor change to the natural equilibrium through modification, locally changing the natural function of the watercourse (sediment source, sink or transfer zone). This may arise from a slight increase in amount of fine sediment and turbidity. Channel morphology: Limited impact on channel morphology, through removal of some morphological features and/or replacing a small extent of the natural bed and/or banks with artificial material. Minor realignments, typically localised around structures such as culverts and bridges having limited impact on channel planform, gradient, bank profiles and channel processes. Natural fluvial processes: Slight change in fluvial processes operating in the river; any change is likely to be highly localised. **Water Quality:** Minor shift away from the baseline conditions. Equivalent to minor but measurable change within the WFD classification Scheme. Failure of either soluble or sediment-bound pollutants in HAWRAT but compliance with AA-EQS values. Calculated risk of pollution from a spillage >0.5% annually and <1% annually.
Negligible	The Scheme is unlikely to affect the integrity of the water environment. **Hydrology and Flood Risk:** Negligible changes to the flow regime (i.e. changes that are within the monitoring errors). An alteration to a catchment area of less than 1% reduction or increase in area. Negligible change in the extent of 'medium to high risk' areas (as defined by SPP). Negligible change in peak flood level (for a 0.5% AEP event) <±10mm. **Fluvial Geomorphology:** No direct engineering impact but potential indirect impact due to proximity of the watercourse to the proposed route options. Sediment regime: Negligible change to the natural equilibrium. Negligible amount of sediment released into the watercourse, with no noticeable change to the turbidity or bed substrate. Channel morphology: No significant impact on channel morphology in the local vicinity of proposed site. Natural fluvial processes: No change in fluvial processes operating in the river; any change is likely to be highly localised. **Water Quality:** No perceptible changes to water quality and no change within the WFD classification Scheme. No risk identified by HAWRAT (Pass both soluble and sediment-bound pollutants and compliance with AA-EQS values). Risk of pollution from a spillage <0.5%.
Minor Beneficial	Results in some beneficial effect on attribute or a reduced risk of negative effect occurring. **Hydrology and Flood Risk:** Minor improvement over baseline conditions. It will involve a reduction in peak flood level (for a 0.5% AEP event) >10 mm. **Fluvial Geomorphology:** Slight improvement of the river channel from baseline conditions as a consequence of the works. Note: beneficial impacts will only arise on impacted/modified/artificial water features. The greatest improvement will occur on water features that have a uniform morphology, acting as a transfer (larger watercourses) or sink (minor watercourses with limited flow and overgrown vegetation) of sediment and no signs of active fluvial processes. Sediment regime: Slight improvement towards natural equilibrium, which is returning the function of the watercourse (sediment source, sink or transfer of sediment) to a natural one. Channel morphology: Limited improvement to morphological diversity. Natural fluvial processes: Slight change to fluvial processes which results in improved river forms and habitats. **Water Quality:** Minor improvement over baseline conditions. HAWRAT assessment of either soluble

Magnitude	Typical Examples
	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 attribute quality. **Hydrology and Flood Risk:** A measurable improvement over baseline conditions involving a reduction in peak flood level (for a 0.5% AEP event) >50 mm. **Fluvial Geomorphology:** Improvement to a watercourse as a result of the works through means of some restoration or mitigation. This could provide a moderate improvement from baseline conditions. Sediment regime: Moderate improvement towards natural equilibrium, which is returning the function of the watercourse (sediment source, sink or transfer of sediment) to a natural one. Channel morphology: Moderate improvement to morphological diversity. Natural fluvial processes: Moderate change to fluvial processes which results in improved river forms and habitats. **Water Quality:** A moderate improvement over baseline conditions, which may result in the upgrade of quality status in line with the requirements of the WFD. 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:** Major improvement over baseline conditions. The reduction in peak flood level (for a 0.5% AEP event) of >100 mm. **Fluvial Geomorphology:** Significant improvement to a watercourse as a result of substantial restoration or mitigation. This could provide a major improvement from baseline conditions. Sediment regime: Major improvement towards natural equilibrium, which is returning the function of the watercourse (sediment source, sink or transfer of sediment) to a natural one. Channel morphology: Major improvement to morphological diversity. Natural fluvial processes: Major change to fluvial processes which results in improved river forms and habitats. **Water Quality:** Major improvement over baseline conditions, whereby the removal or likelihood of removal of existing pressures, results in a watercourse which meets the requirements of the WFD.

Significance of Impact

14.2.19 The significance of an impact (both without and with mitigation) was determined as a function of the importance/sensitivity of an attribute and the magnitude of a predicted impact on that attribute. An impact can be beneficial or adverse. The assessment of significance was carried out using the matrices set out in Table 14.3. In some instances, the use of these tables creates two potential outcomes, requiring a choice to be made in the level of significance (e.g. the significance of impact on an attribute of high importance can be either Moderate or Large when the magnitude is moderate). Where this occurs, professional judgement was used to determine the most likely significance.

Table 14.3: Matrix for Determining Impact significance (reproduced from Table A4.5 in DMRB HD45/09)

Magnitude / Importance/ 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

Specific Methodologies

14.2.20 Under DMRB HD45/09 it is mandatory to use the following procedures to assess the potential impacts from road projects on the water environment:

- Method A – Effects of Routine Runoff on Surface Waters;

- Method C – Effects of Routine Runoff on Groundwater (if discharges to groundwater are proposed);
- Method D – Pollution Impacts from Accidental Spillages; and,
- Methods E and F – Assessing Flood Impact.

14.2.21 Full methodologies are set out in DMRB HD45/09.

Hydrology and Flood Risk

14.2.22 Within the study area a total of twelve watercourses have been identified as having the potential to be impacted. The watercourses are all relatively small in size with numerous drainage ditches also being present across the study area. The watercourses all have catchment areas of less than 10km^2.

14.2.23 The hydrology and flood risk assessment consists of the determination of baseline conditions for the watercourses / water features identified as having the potential to be impacted by the route options (assessed in the absence of any influence or change due to the route options). An impact assessment was then undertaken assessing the hydrology and flood risk conditions post scheme development and forming a comparison. The baseline and post-impact assessments are discussed in further detail below.

Baseline Assessment

14.2.24 The baseline Hydrology and Flood Risk Assessment considered the hydrology of the catchments and the existing flood risk in the study area, assessed in the absence of any influence or changes resulting from the route options.

14.2.25 For each watercourse / water feature along the route options, the following flow estimates have been calculated for existing baseline conditions:

- QMED - the index flood;
- peak flows have been derived from the index flood for the following range of annual exceedance probability events: 50%, 20%, 10%, 3.33%, 2%, 1%, 0.5% and 0.1% (i.e. 1 in 2, 5, 10, 30, 50, 100, 200 and 1000-year return periods);
- Q_{95} – the 95-percentile flow has been estimated for all watercourses that may receive a routine runoff discharge; and
- Qmean – mean flow.

For details of the flow derivation methods refer to Appendix 14.2 Surface Water Hydrology.

14.2.26 The SEPA Flood Maps (SEPA 2016) were used where appropriate to assess the initial baseline flood risk of land within the study area to fluvial flooding from watercourses, coastal flooding, surface water flooding and groundwater flooding. It should be noted that SEPA Flood Maps provide a community level view of flood risk and are not intended to be used to identify if an individual property is affected by flooding. However, the maps do provide an indication of areas of land which may be likely to flood which helps identify potential high, medium and low flood risk areas.

14.2.27 A desk-based flood risk assessment was also undertaken in parallel with the review of the SEPA Flood Maps looking at potential flood risk to properties/infrastructure within the proposed route corridor. This desk-based assessment reviewed third party reports and local knowledge if readily available as well as assessing distance, position and elevation of any properties/infrastructure (using Ordnance Survey maps) to watercourses which could potentially be impacted by the route option. This was particularly relevant for watercourses which have catchments of 3km^2 or less as these are not included in the SEPA Flood Maps assessment for river flooding. Consideration was also given to the potential impact of the proposed Smithton and Culloden Flood Protection

Scheme, which is proposed to be built to the east of the study area, and to the proposed housing development at Stratton.

14.2.28 A review of the route options in relation to SEPA classified Potential Vulnerable Areas (PVAs) has also been undertaken. Parts of all route options are within PVA 01/20 and parts of Options 1A, 1B, 2A, and 2B lie in close proximity to PVA 01/21. This has been identified during the assessment of baseline conditions.

14.2.29 FEH statistical methodologies, in particular the pooling group method was used to derive growth curves to allow estimates of the peak flow for all ungauged catchments within the A96 Aberdeen – Inverness Trunk Road corridor for the range of annual exceedance probabilities noted above. Based on this analysis, a single growth curve was adopted for all ungauged watercourses in the A96 Dualling Inverness to Nairn (including Nairn Bypass) Environmental Statement. This growth curve was assessed and found to be suitable to apply to the ungauged watercourses within the A9/A96 Inshes to Smithton Scheme. The growth curve was therefore applied to the regionally adjusted QMED values for all watercourses allowing the derivation of the required design peak flows.

14.2.30 No river gauging stations are present within the study area.

14.2.31 Appendix A14.2 (Surface Water Hydrology) describes the development of flow characteristics and provides detailed methodology of the hydrological study.

Impact Assessment

14.2.32 In line with DMRB HD45/09 guidance, the A9/A96 Inshes to Smithton is classed as a new road scheme which has the potential to significantly affect flood plain capacity and so requires the assessment of the following impacts:

- reduction in flood plain capacity;
- effectiveness of any proposed mitigation works; and
- residual impacts of the route options on flood risk.

14.2.33 The potential impacts of new and revised watercourse crossings have been assessed using desk-based assessment.

14.2.34 Desk-based flood risk assessment was based on the distance, position and elevation difference between the proposed new or modified culvert and any properties upstream of the structure. Identification of land use upstream of the culvert was also considered.

14.2.35 Loss of flood storage has been assessed by considering the encroachment of the earthworks footprint onto the flood plain. Proposed mitigation measures have been justified by their inclusion in revisions to the impact assessment calculations.

14.2.36 The potential impacts of watercourse realignments have been assessed by desk-based assessment of potential impacts to identified watercourses (including the length of the watercourse realignment and potential impacts on associated watercourses/tributaries).

Allowance for Climate Change

14.2.37 Climate change considerations are required to be included in the Flood Risk Assessment. Based on the outcome of previous consultation with SEPA (A96 Dualling SFRA, CH2M 2015a), an allowance for climate change is not a required design criterion, but consideration of long-term sustainability for the route is required. Climate change considerations included as part of the assessment will be agreed with SEPA. At present a pragmatic approach to climate change is to increase estimates by 20% in order to take into consideration the potential increase in flood flows that may occur in future as a result of a warmer climate.

14.2.38 No climate change adjustment factor has been applied to the low flow estimates.

Fluvial Geomorphology

Baseline Assessment

14.2.39 A combination of field surveys and desk-based research informed the fluvial geomorphology assessment. As the DMRB does not outline a specific methodology to enable the geomorphological impacts to be evaluated, the methodology adopted in this assessment was developed using the guidelines from research and development programmes of the National Rivers Authority, Environment Agency (EA) and Scottish National Heritage (SNH), including:

- The Fluvial Design Guide (Environmental Agency 2010);
- River Geomorphology: A Practical Guide (Environment Agency 1998); and,
- Guidebook of Applied Fluvial Geomorphology (Sear, D., Newson, M.D. and Thorne C.R. 2010).

Impact Assessment

14.2.40 Various elements have been used to assess the sensitivity and importance of watercourses. Table 14.1 summarises how the sensitivity of watercourses is measured.

14.2.41 The magnitude of potential impacts to baseline conditions considers the timing, scale, size, type, location and duration (long term, temporary or permanent) of construction activities and operational structures. The criteria used to assess the magnitude of an impact is summarised in Table 14.2.

14.2.42 The significance of impact is determined as a function of the sensitivity of the water feature and the magnitude of impact, as defined in Table 14.3.

Water Quality

Baseline Assessment

14.2.43 A range of information was used to inform the baseline water quality assessment, including:

- Biological and physico-chemical water quality data from SEPA-monitored watercourses within the study area; and
- A review of information contained within the online SEPA RBMP Interactive map including the current WFD water quality classification status, existing anthropogenic pressures and any improvement measures identified, and fisheries designations of monitored water bodies within the study area. This is in line with the requirements of the WFD, as detailed in Section 14.3 (Policies and Plans).

Impact Assessment

14.2.44 The water quality assessment is primarily concerned with surface water. The assessment of groundwater quality is covered in Chapter 13: Geology and Soils.

14.2.45 The assessment of the magnitude of construction impacts has considered the types and extent of construction activities (e.g. watercourse crossings, channel realignments, outfall construction); proximity to watercourses (and requirements for in-channel works); and the relative size of the watercourse, with regard to its potential to dilute and disperse contaminants and potential spillages.

14.2.46 The assessment of operational impacts relating to routine runoff and spillage risk has been carried out in line with the methods contained in the DMRB. The criteria outlined in Tables 14.2 and 14.3 (taken directly from the DMRB) have been employed in conducting the assessment of magnitude and significance.

14.2.47 The impacts on various attributes of the different features of the water environment have been considered. These attributes include water quality, flow conveyance, protected areas, drinking water supply, effluent discharges and recreation.

14.2.48 The assessment of the magnitude and significance of operational impacts has taken into account the nature of the watercourses proposed to receive road drainage and the dilution or dispersal potential of the watercourses.

14.2.49 Following Method A of the DMRB, HAWRAT has been used to calculate whether the route options would 'pass' or 'fail' in terms of water quality in the receiving surface water features during operation. HAWRAT applies a number of factors to quantify the risk of pollution from routine runoff.

14.2.50 The HAWRAT routine runoff assessment has a three step approach, as follows:

- Step 1: pollutant concentrations in highway runoff only (i.e. before mixing in the watercourse);
- Step 2: pollutant concentrations after mixing (i.e. taking into account the flow in the watercourse); and
- Step 3: the effectiveness of proposed treatment systems mitigation measures is assessed.

14.2.51 HAWRAT results show both soluble acute and sediment chronic impacts; the results are shown as a pass, fail or alert.

14.2.52 An alert is given for outfalls that would otherwise pass the assessment for sediment-bound pollutants, were it not for the following features being present downstream:

- a protected site within 1km of the point of discharge;
- a structure, lake or pond within 100m of the point of discharge; and
- in both cases, the alert indicates the need for further consideration of the proposed outfall and the agreement of appropriate settlement measures with SEPA.

14.2.53 In Tables 14.8 to 14.16 (HAWRAT assessment results), alerts are reported as Alert 1, Alert 2 and Alert 3. The type of alert referred to is as follows:

- Alert 1: protected site downstream and within 1km of outfall;
- Alert 2: structure, lake or pond downstream and within 100m of outfall; and
- Alert 3: protected site and structure, lake or pond downstream and within the relevant distances of outfall.

14.2.54 Method D of the DMRB, which is also included in the HAWRAT tool, has been used to calculate spillage risk during operation and the associated probability of a serious pollution incident.

14.2.55 The results of the HAWRAT calculations have been used to help determine the magnitude and significance of the effects during operation.

Limitations to Assessment

14.2.56 There are certain limitations within each discipline with regards to the assessment methodologies, as outlined in the following paragraphs.

Hydrology and Flood Risk

14.2.57 All watercourses within the study area have small ungauged catchments. Flow estimation is complex especially for small ungauged catchments and open to greater uncertainty than for larger gauged catchments with a long quality controlled/checked flow record. Flow estimation would be greatly improved if gauged flow data was available for the ungauged catchments, however, suitable

FEH methodologies have been used to estimate flows for ungauged catchments within the study area. This approach follows standard methodologies for ungauged catchments.

14.2.58 Assessment presented in this chapter is based on a mix of desk studies, SEPA Flood Map data for less sensitive watercourse and baseline numerical flood modelling where initial assessments highlighted the possibility of flood risk being material to the decision making process.

14.2.59 Full details of whether new culverts/culvert extensions/channel realignments are required along the A9 and in the vicinity of Culloden Road have not been identified at this stage of assessment.

Fluvial Geomorphology

14.2.60 The walkover surveys provide a snapshot of the watercourses and processes occurring at one point in time. However, conditions which vary seasonally (such as vegetation growth, land use, and water levels) can affect fluvial processes and changes to the morphology of the channel. The predominant sediment regime and stability of the watercourse was inferred through the features observed. Where bank material was found to be obscured due to vegetation growth and limited access, observations were made at upstream and downstream locations to help indicate the boundary conditions.

Water Quality

14.2.61 Water quality baseline data were not available from SEPA for some of the minor/small watercourses that would be impacted by the route options. However, information obtained from site visit observations, surrounding land use and any downstream designations have been taken into consideration during the assessment.

14.2.62 HAWRAT is an indicative assessment tool only, and the pass/fail result is not intended to be rigid. Therefore, in any instances where a 'fail' result is registered during the DMRB Stage 3 assessment, the drainage design would be discussed with SEPA in order to ensure adequate protection of the water environment.

14.2.63 The HAWRAT routine runoff assessment has been completed for the drainage catchments along the proposed route options that are proposed to discharge to surface water. The assessment has not been completed for any of the local roads that would be altered by the route options. This is because HAWRAT is primarily designed for trunk roads and motorways with relatively high levels of traffic (>10,000 annual average daily traffic (AADT)).

14.2.64 Water hardness data was requested from SEPA for watercourses that flow within the study area. Data was only available for the River Ness, from samples taken in 2013, 2014 and 2015. The River Ness flows outside of the study area (approximately 1.8km west), within Inverness. The data showed that the River Ness has low hardness (less than 50mg of calcium carbonate per litre). As the River Ness flows close to the study area, it was considered reasonable to assume that the water hardness of the watercourses that flow within the study area is low.

14.2.65 For Options 2A and 2B, the routine runoff from Catchment 2 will drain to an existing drainage network on the A9. At this stage, information relating to the existing drainage of the A9 is not available. In the absence of information about the discharge of routine runoff from this section of road, the water quality impacts on the receiving surface water/groundwater could not be assessed either qualitatively or quantitatively (latter using the HAWRAT routine runoff tool). If one of these options is taken forward as the preferred option at DMRB Stage 3, information about the existing drainage, including the location of the outfall for highways runoff and the treatment prior to outfall, will be required.

14.2.66 Common to all options, the design includes a tie-in to a minor road that provides access to Inverness College (University of the Highlands and Islands Campus) from Caulfield Road North. This is known as Catchment 6 for options 1A, 1B, 3A and 3B, and Catchment 7 for options 2A and

2B. For all options, this catchment is proposed to drain to the existing drainage network along this road. At this stage, information relating to the existing drainage is not available. In the absence of information about the discharge of routine runoff from this section of road, the water quality impacts on the receiving surface water/groundwater could not be assessed either qualitatively or quantitatively (latter using the HAWRAT routine runoff tool). Information about the existing drainage, including the location of the outfall for highways runoff and the treatment prior to outfall, will be required at DMRB Stage 3 when assessing the preferred option.

14.2.67 Minor construction works are proposed along the A9, between Culloden Road and Raigmore Interchange (from south to north), associated with a lane gain/drop. At the time of writing, no information was available about the existing drainage along this section of the A9. In the absence of information about the discharge of routine runoff from this section of road, the water quality impacts on the receiving surface water/groundwater could not be assessed either qualitatively or quantitatively (latter using the HAWRAT routine runoff tool). However, as these works are common to all options and, therefore, are not considered to be differentiators between the options, this is not considered to be a significant limitation. Information about the existing drainage, including the location of the outfall for highways runoff and the treatment prior to outfall, will be required at DMRB Stage 3 when assessing the preferred option.

14.3 Policies and Plans

14.3.1 Part 6 (Appendices), Appendix A8.1 (Planning Policy Context for Environmental Assessment) of this report describes the planning policies and guidance from national to local level which are relevant to Road Drainage and the Water Environment. An assessment of the compliance of the route options against all development plan policies relevant to this environmental topic is reported in Part 6 (Appendices), Appendix A8.2 (Assessment of Development Plan Policy Compliance) and a summary overview is provided in Chapter 8 (Policies and Plans), Section 8.4 (Compliance with Policies and Plans).

Water Framework Directive (WFD)

14.3.2 The WFD (2000/60/EC), which is transposed into Scottish law by the Water Environment and Water Services (Scotland) Act 2003 (WEWS Act), sets targets for restoring and improving the ecological status of water bodies. Under the WFD, the status of water is assessed using a range of quality indicators (physico-chemical, biological and hydromorphological) to give a holistic assessment of aquatic ecological health. The objectives of the WFD are for all water bodies to achieve or maintain an overall status of 'good'. In 'Cycle 1' (2009 – 2015) the timescale for member states to meet this objective was 2015; however, it was recognised that longer timescales would be needed for some water bodies (due to disproportionate costs or technical infeasibility). In 'Cycle 2' (2015 - 2021), the timescale is to meet this objective by 2021 or agreed timescales up to or beyond 2027. Artificial or heavily modified water bodies (HMWB) have less stringent targets to meet; however, these water bodies need to achieve at least 'good ecological potential' over the same timescales.

14.3.3 The WFD includes five quality classes (High, Good, Moderate, Poor and Bad) and establishes a requirement to identify and monitor a range of existing pressures on water bodies which may threaten the objectives of the WFD. These pressures are generally anthropogenic and may include point source discharges, abstractions and morphological alterations such as culverts, impoundments and channel straightening. To help fulfil WFD aims, a planning process called river basin planning was implemented, involving the production of a River Basin Management Plan (RBMP) for the Scotland river basin district and supplementary Area Management Plans outlining how the water environment will be managed and improved to meet WFD objectives over time. Consideration has been given to the requirements of the WFD during assessment of the sensitivity of watercourses and selection of mitigation measures.

Controlled Activities Regulations (CAR)

14.3.4 One of the key tools in achieving the WFD objectives is the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended) (CAR). This legislation controls engineering works within inland surface waters, as well as point source discharges, abstractions and impoundments. There are three different levels of authorisation under CAR: General Binding Rules (GBR), Registration and Licence (either Simple or Complex). The level of regulation increases as the activity poses a higher risk to the integrity and status of the water environment. The level of authorisation under CAR for the proposed Scheme will depend on the specific activities involved, however, is likely to range from GBRs covering short road drainage discharges, to Simple Licences for longer road drainage discharges (draining over 1km in length), as well as larger watercourse crossings and realignments. Activities requiring CAR authorisation are required to be determined by SEPA prior to the start of construction.

Scottish Planning Policy (SPP)

14.3.5 Scottish Planning Policy (SPP) (Scottish Government 2014) requires planning authorities to take a precautionary approach and consider all sources of flooding (coastal, fluvial, pluvial, groundwater, reservoir, sewers and blocked culverts) and their associated risks when preparing development plans and reviewing planning applications. Climate change considerations are also required to be taken into consideration in the planning process.

14.3.6 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.

14.3.7 Exceptions may arise if a location is essential for operational reasons, including transport, and an alternative lower risk location is not achievable. Such infrastructure should be designed and constructed to remain operational during floods, appropriate measures to manage flood risk will be required and the loss of flood storage capacity should be mitigated to produce a neutral or better impact.

Highland-wide Local Development Plan

14.3.8 The Highland-wide Local Development Plan (HwLDP) (The Highland Council 2012) identifies a list of constraints to development in Highland, one of which is proposed development areas at medium to high risk of flooding. Where a proposed development is affected by any of the constraints detailed in the guidance, the development must demonstrate compatibility with the constraint or outline appropriate mitigation measures. The HwLDP also emphasises that development proposals within or bordering medium to high flood risk areas will need to demonstrate compliance with SPP. Sustainable Drainage Systems (SuDS) are also recommended by the plan for all new developments and maintenance arrangements are required to be in place so that there is a neutral or better impact of the proposed development on flood risk (both on and off site).

14.4 Baseline Conditions

Baseline Description and Evaluation

14.4.1 The following baseline conditions relating to the water environment are described in Appendix A14.1 (Baseline Conditions):

- surface water feature descriptions;
- nitrate vulnerable zones;

- water quality status;
- river flows;
- designated sites;
- discharge consents; and
- water abstractions.

14.4.2 In addition, water levels during the 0.5% AEP (200-year) plus climate change allowance design flood event are provided in Appendix A14.2 (Surface Water Hydrology).

14.4.3 The surface water features in the study area have been identified using 1:25,000 OS scale mapping.

14.4.4 During a site walkover undertaken in April 2016, baseline conditions were noted and described for the majority of surface water features identified in the study area. Where walkovers were not possible, a desk study approach was used to identify the baseline conditions. Full baseline descriptions along with photographs (where available) from the site visit can be found in Appendix A14.1 (Baseline Conditions).

14.4.5 Table 14.4 provides a description of the baseline conditions for each surface water feature identified within the study area. Surface water features are described from west to east. The table also assigns a level of importance/sensitivity to each attribute, based on the criteria outlined in Table 14.1. Table 2 in Appendix A14.1 (Baseline Conditions) includes additional information about the indicators of quality that have been used to determine the importance/sensitivity of each attribute.

Importance/Sensitivity

Table 14.4: Importance/Sensitivity of Each Attribute of a Surface Water Feature

Surface Water Feature (SWF)	Attribute	Sensitivity
SWF 01: Mill Burn	Hydrology and Flood Risk	Very High
	Fluvial geomorphology	High
	Water quality/supply	High
	Dilution and removal of waste products	Medium
	Biodiversity	High
SWF 02: Inshes Burn	Hydrology and Flood Risk	Very High
	Fluvial geomorphology	Low
	Water quality/supply	High
	Dilution and removal of waste products	High
	Biodiversity	Medium
SWF 03: Tributary of Scretan Burn (1)	Hydrology and Flood Risk	High
	Fluvial geomorphology	Low
	Water quality/supply	High
	Dilution and removal of waste products	High
	Biodiversity	Medium
SWF 04: Scretan Burn	Hydrology and Flood Risk	Very High
	Fluvial geomorphology	Medium
	Water quality/supply	High
	Dilution and removal of waste products	High
	Biodiversity	Medium
SWF 05: Tributary of Scretan Burn (2)	Hydrology and Flood Risk	High

Surface Water Feature (SWF)	Attribute	Sensitivity
	Fluvial geomorphology	Low
	Water quality/supply	High
	Dilution and removal of waste products	Low
	Biodiversity	Medium
SWF 06: Indirect tributary of Scretan Burn	Hydrology and Flood Risk	Low
	Fluvial geomorphology	Low
	Water quality/supply	High
	Dilution and removal of waste products	Low
	Biodiversity	Medium
SWF 07: Un-named drain	Hydrology and Flood Risk	High
	Fluvial geomorphology	Low
	Water quality/supply	High
	Dilution and removal of waste products	Low
	Biodiversity	Medium
SWF 08: Cairnlaw Burn	Hydrology and Flood Risk	Very High
	Fluvial geomorphology	Medium
	Water quality/supply	High
	Dilution and removal of waste products	Medium
	Biodiversity	Medium
SWF 09: Indirect tributary of Cairnlaw Burn	Hydrology and Flood Risk	Medium
	Fluvial geomorphology	Low
	Water quality/supply	High
	Dilution and removal of waste products	Medium
	Biodiversity	Medium
SWF 10: Tributary of Cairnlaw Burn (1)	Hydrology and Flood Risk	High
	Fluvial geomorphology	Medium
	Water quality/supply	High
	Dilution and removal of waste products	Medium
	Biodiversity	High
SWF 11: Tributary of Cairnlaw Burn (2)	Hydrology and Flood Risk	High
	Fluvial geomorphology	Low
	Water quality/supply	High
	Dilution and removal of waste products	Low
	Biodiversity	High
SWF 12: Kenneth's Black Well	Hydrology and Flood Risk	High
	Fluvial geomorphology	Low
	Water quality/supply	Medium
	Dilution and removal of waste products	High
	Biodiversity	Medium

14.5 Impact Assessment

Introduction

14.5.1 This section contains the following information:

- a brief description of those surface water features that flow within the study area but have been scoped out of the assessment;
- a summary of the construction works/operational structures relevant to each route option (Tables 14.5 to 14.7);
- an overview of the potential impacts during the construction and operation of road schemes in relation to hydrology and flood risk, fluvial geomorphology and water quality. This is to provide context to the impact assessment;
- a summary of the potential impacts that are common to all route options; and
- a summary of the additional potential impacts, by route option.

Scope

Construction

14.5.2 SWF 01, SWF 11 and SWF 12 flow within the study area but have been scoped out of the hydrology and flood risk assessment for construction impacts for all route options for the following reasons:

- Given the distance between the surface water features and the route options and /or intervening relief of the land, there are unlikely to be any impacts due to increased runoff entering the watercourses and there are no proposed construction activities within the identified surface water feature catchment.

14.5.3 SWF 01, SWF 09, SWF 11 and SWF 12 flow within the study area but have been scoped out of the water quality and fluvial geomorphology assessments for construction impacts for all route options for the following reasons:

- none off the route options include in-channel works within these surface water features; and
- given the distance between these surface water features and the route options and/or the intervening relief of the land, there are unlikely to be any impacts from accidental spillages and additional runoff suspended and associated fine sediment.

Operation

14.5.4 The following surface water features have been scoped out of the operational assessment for hydrology and flood risk because none of the route options would result in increased runoff into the watercourse or would have works within the watercourse catchment: SWF 01, SWF 11 and SWF 12.

14.5.5 The following surface water features have been scoped out of the operational assessment for fluvial geomorphology as none of the route options would have permanent structures (outfalls or culverts) within these surface water features and the surface water features are at a sufficient distance to not be impacted by additional runoff and associated fine sediment: SWF 01, SWF 11 and SWF 12.

14.5.6 The following surface water features have been scoped out of the operational assessment for water quality because none of the route options would discharge routine runoff into these surface water features: SWF 01, SWF 05, SWF 06, SWF 09, SWF 10, SWF 11 and SWF 12.

Proposed Construction Works/Operational Structures

14.5.7 Tables 14.5 to 14.7 provide a summary of the construction works/operational structures for each route option. This information has been used to determine the magnitude of potential impact, which, when combined with the sensitivity of the attribute, is used to determine the significance of the potential impact. However, at this stage, because the likely nature of the construction activities

is not fully known, the relative magnitude of the potential impact is assessed on the broad nature and extent of the channel engineering required.

Table 14.5: Proposed Construction Activities/Operational Structures Within, Over and Adjacent to Surface Water Features

Surface Water Feature (SWF)	Construction Activity	Option					
		1A	1B	2A	2B	3A	3B
SWF 02: Inshes Burn	Construction of carriageway	✓	✓	✓	✓	✓	✓
	Construction of culverts (No.)	1	1	1	1		
	Construction of outfalls (No.)	1	1	1	1	1	1
	Part channel realignment (No.)	1	1	1	1		
SWF 03: Tributary of Scretan Burn (1)	Construction of carriageway	✓	✓	✓	✓	✓	✓
	Construction of culverts (No.)	1	1	1	1	1	1
	Construction of outfalls (No.)	1	1	1	1	1	1
	Part channel realignment (No.)			1	1		
SWF 04: Scretan Burn	Construction of carriageway	✓	✓	✓	✓	✓	✓
	Construction of culverts (No.)	2	2	2	2	2	2
	Construction of outfalls (No.)	1	1	1	1	1	1
SWF 05: Tributary of Scretan Burn (2)	Construction of carriageway	✓	✓	✓	✓	✓	✓
	Construction of culverts (No.)	1	1	1	1	1	1
	Part channel realignment (No.)	1	1	1	1	1	1
SWF 06: Indirect tributary of Scretan Burn	Construction of carriageway	✓	✓	✓	✓	✓	✓
	Part channel realignment (No.)		1		1		1
SWF 07: Un-named drain	Construction of carriageway	✓		✓		✓	
	Construction of culvert (No.)	1		1		1	
	Construction of outfalls (No.)	1		1		1	
SWF 08: Cairnlaw Burn	Construction of carriageway	✓	✓	✓	✓	✓	✓
	Construction of culverts (No.)	1	2	1	2	1	2
	Construction of outfalls (No.)	1	2	1	2	1	2
	Part channel realignment (No.)	2	2	2	2	2	2
SWF 10: Tributary of Cairnlaw Burn (1)	Construction of carriageway	✓	✓	✓	✓	✓	✓

Table 14.6: Summary of Construction Works/Operational Structures

Construction and Operational Activities	Option					
	1A	1B	2A	2B	3A	3B
Number of culverts	7	7	7	7	6	6
Number of part channel realignments	4	5	5	6	3	4
Number of outfalls	5	5	5	5	5	5
Total number of in-channel activities	16	17	17	18	14	15
Number of SWFs requiring in-channel activities	6	6	6	6	6	6
Number of SWFs where construction works would be within, over or adjacent	8	7	8	7	8	7
Impermeable area draining to outfalls (ha)	5.25	5.54	5.24	5.53	4.29	4.58
Number of SWFs receiving new routine road runoff during operation	5	4	5	4	5	4

Table 14.7: Proposed Drainage Network by Route Option

Option	Outfall	Receiving Water Body	Approximate Impermeable Road Drainage Area (ha)
1A	1	SWF 02	0.75
	2	SWF 04	1.93
	3	SWF 07	1.23
	4	SWF 08	0.73
	5	SWF 03	0.61
	6	Unknown	0.13
	7	Unknown	0.34
1B	1	SWF 02	0.75
	2	SWF 04	1.99
	3	SWF 08	1.17
	4	SWF 08	0.77
	5	SWF 03	0.86
	6	Unknown	0.13
	7	Unknown	0.34
2A	1	SWF 02	0.74
	2	Unknown	0.68
	3	SWF 04	1.93
	4	SWF 07	1.23
	5	SWF 08	0.73
	6	SWF 03	0.61
	7	Unknown	0.13
	8	Unknown	0.35
2B	1	SWF 02	0.74
	2	Unknown	0.68
	3	SWF 04	1.99
	4	SWF 08	1.17
	5	SWF 08	0.77
	6	SWF 03	0.86
	7	Unknown	0.13
	8	Unknown	0.35
3A	1	SWF 02	0.29
	2	SWF 04	1.43

Option	Outfall	Receiving Water Body	Approximate Impermeable Road Drainage Area (ha)
	3	SWF 07	1.23
	4	SWF 08	0.73
	5	SWF 03	0.61
	6	Unknown	0.13
	7	Unknown	0.34
3B	1	SWF 02	0.29
	2	SWF 04	1.49
	3	SWF 08	1.17
	4	SWF 08	0.77
	5	SWF 03	0.86
	6	Unknown	0.13
	7	Unknown	0.34

Potential Impacts

14.5.8 The potential impacts detailed in this section are reported in line with the following:

- potential impacts represent those which could result from the construction or operation of the route options;
- potential impacts are described without mitigation, and therefore represent a worst-case scenario. Potential mitigation measures are considered in Section 14.6 (Potential Mitigation);
- the assessment of impacts includes those that are common to all route options and those that vary between the route options. The potential impacts that are common to all have been based on the level of significance. This means that although there may be some differences in the activity that would lead to a particular impact, if that impact would be of the same significance regardless of which option was selected, it is said to be common to all; and
- to ensure that the key impacts of each route option are highlighted, only impacts of Moderate or above significance have been reported in the assessment tables. Full details of the impact assessment are contained within Part 6 (Appendices), Appendix A14.4 (Impact Assessment Tables).

Construction Impacts

14.5.9 Construction impacts are generally short-term. However, some potential construction impacts such as deposition of sediments can have longer-term impacts. Construction impacts are likely to be more intense than the impacts realised during the long-term operational phase due to the heightened concentration of activities occurring in or near the surface water features.

Hydrology and Flood Risk

14.5.10 Potential construction impacts in relation to hydrology and flood risk include:

- increased runoff from soil compaction due to works traffic, sedimentation and disturbance/unintentional changes to channel dimensions which may impact on the hydraulic flow characteristics of a surface water feature;
- temporary surface water feature diversions to facilitate culvert or bridge construction and any associated temporary works;
- diversions and re-direction of surface water features through constructed realignments or into pre-earthwork ditches;
- loss of flood plain storage due to construction activities in close proximity to watercourses;

- temporary attenuation features at drainage outfalls; and
- temporary arrangements to control runoff.

Fluvial Geomorphology

14.5.11 Potential construction impacts in relation to fluvial geomorphology include:

- alterations to channel morphology during the construction of crossing structures, such as bridges or culverts, and associated channel modifications and the release of sediment; and
- sediment release during in-channel works, site clearance operations and earthworks in the vicinity of surface water features. This could result in reduced morphological diversity due to smothering of channel bed by sediment, an increase in turbidity and loss of active features such as gravel deposits.

14.5.12 The majority of these impacts would worsen with intense or prolonged rainfall events during the construction phase.

Water Quality

14.5.13 Potential construction impacts in relation to water quality include:

- siltation of surface water features during soil-stripping, compound preparation, soil storage and other earthworks, due to loosening of sediment;
- water pollution from silt-laden runoff (and enhanced nutrient loading) if allowed to drain untreated;
- spillage or accidental release of oils, fuels and chemicals from mobile or stationary plant, resulting in adverse impacts to water quality and freshwater ecology;
- erosion and sedimentation can result from construction works and adversely impact water quality;
- disturbance of potentially contaminated land with potential drainage pathways to surface waters; and
- changes in groundwater levels associated with road cuttings could result in the dewatering of water features reducing downstream flows, which could result in adverse impacts on aquatic ecosystems. Refer to Chapter 13 (Geology and Soils).

Operational Impacts

14.5.14 Operational impacts are generally long-term or permanent and would influence the surface water features after the Scheme is complete.

Hydrology and Flood Risk

14.5.15 Potential operational impacts on hydrology and flood risk include:

- introduction of new impermeable areas to the catchment area could potentially increase the volume and peak flow of surface runoff, as less would be lost to infiltration into the ground. The road and its drainage system may also act as a barrier to water movement within current catchments. In addition, a road scheme can potentially result in rain falling in one catchment being discharged to another via the road drainage system;
- impacts of surface water feature crossings on surface hydrology could occur through alteration of the physical flow and water level regimes;
- channel realignments could potentially change the discharge regime. However, with appropriate design in terms of hydraulic considerations, these realignments would not affect surface water hydrology unless the realignment significantly changes the catchment area; and

- where a route option crosses a flood plain on embankment, there would be a potential loss of flood storage volume.

Fluvial Geomorphology

14.5.16 Potential operational impacts on fluvial geomorphology include:

- road drainage can lead to increased discharge which may increase geomorphological activity within the channel. This could result in an increase in turbidity, greater sediment transport downstream, increased erosion of the channel bed and banks with morphological diversity being reduced or improved depending on sediment supply. In addition, the outfall structures alter the structure and material of the banks locally damaging the morphology of the river banks. They may also cause scour of the river banks by locally altering fluvial processes and increasing sediment supply;
- surface water feature crossings can cause an alteration to patterns of sediment transfer and deposition, and lead to loss of morphological features due to the land claim required for the footprint (e.g. bridge piers and embankments). Culverting can enhance sediment transfer at high flows, but cause sediment to accumulate at low flows if the gradient is lower or width wider than the natural channel. Where culverting increases the channel gradient, the scour of the bed and banks at culvert outlets often occurs, leading to an increase in the supply of sediment downstream. Morphological diversity is lost due to the artificial bed and banks of the culvert, and they prevent future lateral and vertical adjustment of the river; and
- channel realignment can cause a major change in the sediment regime and natural fluvial processes, increasing the rate of sediment supply, transfer downstream or deposition dependant on the design. The initial channel shape is typically devoid of morphological diversity. However, realignments offer an opportunity to restore the watercourse locally, improving its morphology.

Water Quality

14.5.17 Once the road is opened to traffic, it could lead to adverse impacts on the water environment, if appropriate mitigation measures were not incorporated into the design.

14.5.18 There are a wide range of pollutants found in road runoff which may have an effect on the receiving waters and associated ecology, including 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. Pollutants may reach surface water features through discharges of routine runoff from the proposed Scheme or from accidental spillages.

14.5.19 New or extended culverts could potentially change the riverbed morphological diversity and sediment regime of a watercourse and this could have an associated effect on water quality by mobilising suspended solids and releasing previously ‘locked’ contaminants into the water column.

14.5.20 New or extended culverts may also have an effect on water quality due to oxygen sags caused by the lack of light, which restricts aquatic plant photosynthesis, and rapid microbiological degradation of biodegradable matter. Structures that are relatively wide and/or short in length would tend to allow better light penetration and therefore have a lower effect on water quality. Any reduction in surface area through culverts is also likely to reduce the atmospheric oxygenation of the water.

14.5.21 Channel realignments could potentially change the sediment regime of a watercourse, resulting in increased effects of erosion or deposition, and this could have an associated effect on water quality by mobilising suspended solids and releasing previously ‘locked’ contaminants into the water column. Changes in turbulence can also affect atmospheric oxygenation of the water.

14.5.22 Operational impacts resulting from routine runoff and accidental spillage risk to the surface water features proposed to receive road drainage for each route option have been assessed using the

Highways Agency's (now Highways England) Water Risk Assessment Tool (HAWRAT), in line with DMRB HD45/09.

14.5.23 The detailed results of the HAWRAT spillage risk, and routine runoff assessments are shown in Part 6 (Appendices), Appendix A14.3 (Water Quality Calculations). Only assessments that result in impacts of Moderate or above significance are reported in this section.

Impacts Common to All Route Options

14.5.24 This section describes the potential impacts of Moderate and above significance (un-mitigated) that are common to all route options for both construction or operation.

14.5.25 The full list of potential impacts (un-mitigated) can be found in Part 6 (Appendices), Appendix A14.4 (Impact Assessment Tables).

Hydrology and Flood Risk

14.5.26 The following potential impacts are common to all route options in relation to hydrology and flood risk:

- SWF 04 and SWF 08 would have a potential impact of Very Large significance during construction as a result of the very high sensitivities of these watercourses and due to the works proposed for all route options (e.g. construction of culvert(s)/outfall(s)/channel realignment);
- SWF 05 would have a potential impact of Large significance during construction as a result of the high sensitivity of this watercourse and due to the works proposed as part of each route option (construction of culvert and length of channel realignment);
- SWF 04, SWF 05 and SWF 08 would have a potential impact of Large significance during operation as a result of the very high/high sensitivity of the watercourses and due to the impacts on the watercourses as a result of each route option (including potential loss of flood plain storage, culvert on all watercourses, outfalls into SWF 04 and SWF 08, and realignment of SWF 05 and SWF 08); and
- SWF 03 would have a potential impact of Moderate significance during operation as a result of the high sensitivity of the watercourse and due to the impacts on the watercourse as a result of each route option (including loss of flood plain storage due to the route options, construction of a culvert and an outfall).

Fluvial Geomorphology

14.5.27 The following potential impacts are common to all route options in relation to fluvial geomorphology:

- SWF 04 and SWF 08 would have a potential impact of Moderate significance during construction and operation due to their Medium sensitivity and the construction of two culverts, an outfall and a section of realignment.

Water Quality

14.5.28 Table 14.8 shows the potential impacts that are common to all route options in relation to construction impacts on water quality.

Table 14.8: Potential Impacts during Construction for Water Quality Attributes - Common to All Route Options

Surface Water Feature (SWF)	Water Quality Attribute	Significance of Impact
SWF 02 Inshes Burn	Water quality/supply	Large
	Dilution and removal of waste products	Large
	Biodiversity	Large
SWF 03 Tributary of Scretan Burn (1)	Water quality/supply	Large
	Dilution and removal of waste products	Large
	Biodiversity	Large
SWF 04 Scretan Burn	Water quality/supply	Large
	Dilution and removal of waste products	Large
	Biodiversity	Large
SWF 05 Tributary of Scretan Burn (2)	Water quality/supply	Large
	Dilution and removal of waste products	Moderate
	Biodiversity	Large
SWF 08 Cairnlaw Burn	Water quality/supply	Large
	Dilution and removal of waste products	Large
	Biodiversity	Large
SWF 10 Tributary of Cairnlaw Burn (1)	Water quality/supply	Moderate
	Dilution and removal of waste products	Moderate
	Biodiversity	Moderate

14.5.29 With the exception of SWF 10, the potential impacts are due to in-channel construction works in addition to construction of the carriageway. The potential impacts on SWF 10 are due to the construction of carriageway only (Table 14.5).

14.5.30 The 'dilution and removal of waste products' attribute of SWF 05 would have potential impacts of Moderate significance in comparison to the other attributes, due to the lower sensitivity of this attribute for this surface water feature.

14.5.31 In addition, any construction related water quality impacts associated with the lane gain/drop would be common to all options. These impacts could not be assessed for the reasons given in paragraph 14.2.67.

14.5.32 Table 14.9 provides details of the potential impacts that are common to all route options in relation to operational impacts on water quality. These potential impacts are due to direct discharges of road runoff into surface water features.

Table 14.9: Potential Impacts during Operation for Water Quality Attributes - Common to All Route Options

Surface Water Feature (SWF)	Water Quality Attribute	Significance of Impact
SWF 03 Tributary of Scretan Burn (1)	Water quality/supply	Moderate
	Dilution and removal of waste products	Moderate

14.5.33 For all route options, the proposed outfall into SWF 03 passed the HAWRAT routine runoff assessment for dissolved copper, dissolved zinc and the assessment against EQSs, but failed the assessment for sediment-bound pollutants.

14.5.34 In addition, any operational water quality impacts associated with the lane gain/drop would be common to all options. These impacts could not be assessed for the reasons given in paragraph 14.2.67.

Additional Impacts for Option 1A

14.5.35 This section presents the potential impacts of Moderate and above significance that are specific for Option 1A and hence are additional to those reported as common to all route options (Table 14.8 and Table 14.9 and paragraphs 14.5.28 to 14.5.33).

Hydrology and Flood Risk

14.5.36 Table 14.10 provides details of the potential impacts for Option 1A in relation to construction impacts on hydrology and flood risk.

Table 14.10: Potential Impacts during Construction for Hydrology and Flood Risk - Specific for Option 1A

Surface Water Feature (SWF)	Significance of Impact
SWF 02 Inshes Burn	Very Large
SWF 03 Tributary of Scretan Burn (1)	Moderate
SWF 07 Un-named drain	Large

14.5.37 The potential impacts on hydrology and flood risk are due to construction in proximity to the surface water features (construction of a culvert and an outfall within each surface water feature). SWF 02 and SWF 03 would also be realigned. There may be increased runoff to these watercourses, flow may be constrained due to works and the flood storage area may be reduced.

14.5.38 Table 14.11 provides details of the potential impacts for Option 1A in relation to operational impacts on hydrology and flood risk.

Table 14.11: Potential Impacts during Operation for Hydrology and Flood Risk - Specific for Option 1A

Surface Water Feature (SWF)	Significance of Impact
SWF 02 Inshes Burn	Large
SWF 07 Un-named drain	Moderate

14.5.39 The potential impacts on SWF 02 are due to changes to flood risk resulting from the construction of a new culvert, increased impervious areas, realignment of the watercourse and potential alterations to catchment drainage as a result of the road and due to one outfall discharging routine runoff into this surface water feature. During operation there is potential for the loss of flood plain storage due to the construction of the road and associated infrastructure.

14.5.40 The potential impacts on SWF 07 are due to changes to flood risk resulting from the construction of a new culvert, increased impervious areas and possible alterations to drainage due to the road cutting across the catchment and an outfall discharging routine runoff into the watercourse. During operation there is potential for the loss of flood plain storage due to the construction of the road and associated infrastructure.

Fluvial Geomorphology

14.5.41 There are no potential additional construction or operation impacts of Moderate or above significance in relation to fluvial geomorphology for Option 1A.

Water Quality

14.5.42 Table 14.12 provides details of the potential impacts for Option 1A in relation to construction impacts on water quality.

Table 14.12: Potential Impacts during Construction for Water Quality Attributes - Specific for Option 1A

Surface Water Feature (SWF)	Water Quality Attribute	Significance of Impact
SWF 06 Indirect tributary of Scretan Burn	Water quality/supply	Moderate
	Biodiversity	Moderate
SWF 07 Un-named drain	Water quality/supply	Large
	Dilution and removal of waste products	Moderate
	Biodiversity	Large

14.5.43 The potential impacts on SWF 06 are due to the construction of carriageway only (Table 14.5).

14.5.44 The potential impacts on SWF 07 are due to in-channel construction works in addition to construction of the carriageway.

14.5.45 The 'dilution and removal of waste products' attribute of SWF 07 would have a lower potential significance of impact in comparison to the other attributes due to the lower sensitivity of this attribute for this surface water feature.

14.5.46 Table 14.13 provides details of the potential impacts for Option 1A in relation to operational impacts on water quality. These potential impacts are due to direct discharges of road runoff into these surface water features.

Table 14.13: Potential Impacts during Operation for Water Quality Attributes - Specific for Option 1A

Surface Water Feature (SWF)	Water Quality Attribute	Significance of Impact
SWF 02 Inshes Burn	Water quality/supply	Large
	Dilution and removal of waste products	Large
	Biodiversity	Moderate
SWF 07 Un-named drain	Water quality/supply	Large
	Dilution and removal of waste products	Moderate
	Biodiversity	Large

14.5.47 The potential impacts are determined by the results of the HAWRAT routine runoff and spillage risk assessments (which inform the determination of magnitude) and the importance/sensitivity of the receiving surface water feature.

14.5.48 Outfall 1 into SWF 02 passed the Step 2 individual assessment for dissolved copper and the assessment against EQSs. However, this option failed the assessment for dissolved zinc and sediment-bound pollutants. The 'biodiversity' attribute of SWF 02 would have a potential impact of Moderate significance in comparison to the other attributes due to the lower sensitivity of this attribute for this surface water feature.

14.5.49 Outfall 3 into SWF 07 failed the Step 2 individual assessment dissolved copper, dissolved zinc, sediment-bound pollutants and the assessment against EQSs. The 'dilution and removal of waste products' attribute of SWF 07 would have a potential impact of Moderate significance in comparison to the other attributes due to the lower sensitivity of this attribute for this surface water feature.

Additional Impacts for Option 1B

14.5.50 This section presents the potential impacts of Moderate and above significance that are specific for Option 1B and hence are additional to those reported as common to all route options (Table 14.8 and Table 14.9 and paragraphs 14.5.28 to 14.5.33).

Hydrology and Flood risk

14.5.51 Table 14.14 provides details of the potential impacts for Option 1B in relation to construction impacts on hydrology and flood risk.

Table 14.14: Potential Impacts during Construction for Hydrology and Flood Risk - Specific for Option 1B

Surface Water Feature (SWF)	Significance of Impact
SWF 02 Inshes Burn	Very Large
SWF 03 Tributary of Scretan Burn (1)	Moderate

14.5.52 The potential impacts on both surface water features are due to changes to flood risk resulting from the construction of a culvert and an outfall within the surface water feature. There may be increased runoff into the watercourse, flow may be constrained due to works and the flood storage area may be reduced due to the works.

14.5.53 Table 14.15 provides details of the potential impacts for Option 1B in relation to operational impacts on hydrology and flood risk

Table 14.15: Potential Impacts during Operation for Hydrology and Flood Risk - Specific for Option 1B

Surface Water Feature (SWF)	Significance of Impact
SWF 02 Inshes Burn	Large
SWF08 Cairnlaw Burn	Very Large

14.5.54 The potential impacts on SWF 02 are due to changes to flood risk resulting from the construction of a new culvert, increased impervious areas, realignment of the watercourse and potential alterations to the area draining to catchment as a result of the road drainage and due to one outfall discharging into this surface water feature. During operation there is potential for the loss of flood plain storage due to the construction of the road and associated infrastructure.

14.5.55 The potential for impact on SWF08 and associated floodplain is due to the risk from the road acting as a flow path for flow that comes over land from out of bank flow arising up gradient from the scheme.

Fluvial Geomorphology

14.5.56 There are no potential additional construction or operation impacts of Moderate or above significance in relation to fluvial geomorphology for Option 1B.

Water Quality

14.5.57 Table 14.16 provides details of the potential impacts for Option 1B in relation to construction impacts on water quality.

Table 14.16: Potential Impacts during Construction for Water Quality Attributes - Specific for Option 1B

Surface Water Feature (SWF)	Water Quality Attribute	Significance of Impact
SWF 06 Indirect tributary of Scretan Burn	Water quality/supply	Large
	Dilution and removal of waste products	Moderate
	Biodiversity	Large

14.5.58 These potential impacts are due to the construction of the carriageway and in-channel construction works (Table 14.5).

14.5.59 The 'dilution and removal of waste products' attribute of SWF 06 would have a potential impact of Moderate significance in comparison to the other attributes due to the lower sensitivity of this attribute for this surface water feature.

14.5.60 Table 14.17 provides details of the potential impacts for Option 1B in relation to operational impacts on water quality. These potential impacts are due to direct discharges of road runoff into these surface water features.

Table 14.17: Potential Impacts during Operation for Water Quality Attributes - Specific for Option 1B

Surface Water Feature (SWF)	Water Quality Attribute	Significance of Impact
SWF 02 Inshes Burn	Water quality/supply	Large
	Dilution and removal of waste products	Large
	Biodiversity	Moderate
SWF 08 Cairnlaw Burn	Water quality/supply	Moderate

14.5.61 The potential impacts are determined by the results of the HAWRAT routine runoff and spillage risk assessments (which inform the determination of magnitude) and the importance/sensitivity of the receiving surface water feature.

14.5.62 Outfall 1 into SWF 02 passed the Step 2 individual assessment for dissolved copper and the assessment against EQSs. However, this option failed the assessment for dissolved zinc and sediment-bound pollutants. The 'biodiversity' attribute of SWF 02 would have a potential impact of Moderate significance in comparison to the other attributes due to the lower sensitivity of this attribute for this surface water feature.

14.5.63 Outfalls 3 and 4 into SWF 08 failed the Step 2 cumulative assessment for dissolved zinc; however, they passed the assessment for dissolved copper and the assessment against EQSs. Therefore, the 'water quality/supply' attribute of SWF 08 would have a potential impact of Moderate significance in comparison to non-significant impacts for the other attributes due to the higher sensitivity of this attribute for this surface water feature.

Additional Impacts for Option 2A

14.5.64 This section presents the potential impacts of Moderate and above significance that are specific for Option 2A and hence are additional to those reported as common to all route options (Table 14.8 and Table 14.9 and paragraphs 14.5.28 to 14.5.33).

Hydrology and Flood risk

14.5.65 Table 14.18 provides details of the potential impacts for Option 2A in relation to construction impacts on hydrology and flood risk.

Table 14.18: Potential Impacts during Construction for Hydrology and Flood Risk - Specific for Option 2A

Surface Water Feature (SWF)	Significance of Impact
SWF 02 Inshes Burn	Very Large
SWF 03 Tributary of Scretan Burn (1)	Large
SWF 07 Un-named drain	Large

14.5.66 The potential impacts on hydrology and flood risk are due to construction in proximity to the surface water features (construction of a culvert and an outfall within each surface water feature). SWF 02 and SWF 03 would also be realigned. There may be increased runoff into the watercourses, flow may be constrained due to works (increasing flood risk) and flood storage area may be reduced due to the works.

14.5.67 During operation, Option 2A would have the same potential additional impacts as Option 1A. Table 14.11 and paragraphs 14.5.38 to 14.5.39 provide a description of the potential impacts.

Fluvial Geomorphology

14.5.68 There are no potential additional construction or operation impacts of Moderate or above significance in relation to fluvial geomorphology for Option 2A.

Water Quality

14.5.69 During construction, Option 2A would have the same potential additional impacts of Moderate significance or above as Options 1A and 3A. Table 14.12 and paragraphs 14.5.42 to 14.5.44 provides a description of the potential impacts.

14.5.70 During operation, Option 2A would have the same potential additional impacts as Option 1A. Table 14.13 and paragraphs 14.5.46 to 14.5.48 provide a description of the potential impacts.

Additional Impacts for Option 2B

14.5.71 This section presents the potential impacts of Moderate and above significance that are specific for Option 2B and hence are additional to those reported as common to all route options (Table 14.8 and Table 14.9 and paragraphs 14.5.28 to 14.5.33).

Hydrology and Flood risk

14.5.72 Table 14.19 provides details of the potential impacts for Option 2B in relation to construction impacts on hydrology and flood risk.

Table 14.19: Potential Impacts during Construction for Hydrology and Flood Risk - Specific for Option 2B

Surface Water Feature (SWF)	Significance of Impact
SWF 02 Inshes Burn	Very Large
SWF 03 Tributary of Scretan Burn (1)	Large

14.5.73 The potential impacts on hydrology and flood risk are due to construction in proximity to the surface water features (construction of a culvert and an outfall within each surface water feature). Both watercourses would also be realigned. There may be increased runoff into the surface water features, flow may be constrained due to works (increasing flood risk) and the flood storage area may be reduced due to the works.

14.5.74 During operation, Option 2B would have the same potential additional impacts as Option 1B. Table 14.15 and paragraphs 14.5.53 to 14.5.54 provide a description of the potential impacts.

Fluvial Geomorphology

14.5.75 There are no potential additional construction or operation impacts of Moderate or above significance in relation to fluvial geomorphology for Option 2B.

Water Quality

14.5.76 During construction, Option 2B would have the same potential additional impacts as Options 1B and 3B. Table 14.16 and paragraphs 14.5.57 to 14.5.59 provide a description of the potential impacts.

14.5.77 During operation, Option 2B would have the same potential additional impacts as Option 1B. Table 14.17 and paragraphs 14.5.60 to 14.5.62 provide a description of the potential impacts.

Additional Impacts for Option 3A

14.5.78 This section presents the potential impacts of Moderate and above significance that are specific for Option 3A and hence are additional to those reported as common to all route options (Table 14.8 and Table 14.9 and paragraphs 14.5.28 to 14.5.33).

Hydrology and Flood risk

14.5.79 Table 14.20 provides details of the potential impacts for Option 3A in relation to construction impacts on hydrology and flood risk.

Table 14.20: Potential Impacts during Construction for Hydrology and Flood Risk - Specific for Option 3A

Surface Water Feature (SWF)	Significance of Impact
SWF 02 Inshes Burn	Large
SWF 03 Tributary of Scretan Burn (1)	Moderate
SWF 07 Un-named drain	Large

14.5.80 Potential impacts on SWF 02 are due to construction of the carriageway near this surface water feature and the construction of an outfall into the burn. This may result in increased runoff rates into the surface water feature during construction. Given the Very High sensitivity of this watercourse this has resulted in an impact of Large significance.

14.5.81 Potential impacts on SWF 03 are due to the construction of a culvert, an outfall and the carriageway near this surface water feature, which may result in increased runoff going into the watercourse, flow may be constrained due to works (increasing flood risk) and the flood storage area may be reduced due to the works.

14.5.82 The potential impacts on SWF 07 are due to the construction of a culvert and an outfall within this surface water feature) and the construction of the carriageway in close proximity to this surface water feature. This may result in increased runoff going into the watercourse, flow may be constrained due to works (increasing flood risk) and the flood storage area may be reduced due to the works.

14.5.83 Table 14.21 provides details of the potential impacts for Option 3A in relation to operational impacts on hydrology and flood risk.

Table 14.21: Potential Impacts during Operation for Hydrology and Flood Risk - Specific for Option 3A

Surface Water Feature (SWF)	Significance of Impact
SWF02 Inshes Burn	Moderate
SWF 07 Un-named drain	Moderate

14.5.84 The potential impacts on SWF 02 are due to changes to flood risk resulting from increased impervious areas and due to an outfall discharging routine runoff into the surface water feature.

14.5.85 The potential impacts on SWF 07 are due to changes to flood risk resulting from the construction of a new culvert, increased impervious areas and possible alterations to drainage due to the road cutting across the catchment and an outfall discharging routine runoff into the surface water feature. During operation there is potential for the loss of flood plain storage due to the construction of the road and associated infrastructure.

Fluvial Geomorphology

14.5.86 There are no potential additional construction or operation impacts of Moderate or above significance in relation to fluvial geomorphology for Option 3A.

Water Quality

14.5.87 During construction, Option 3A would have the same potential additional impacts of Moderate significance or above as Options 1A and 2A. Table 14.12 and paragraphs 14.5.42 to 14.5.44 provides a description of the potential impacts.

14.5.88 Table 14.22 provides details of the potential impacts for Option 3A in relation to operational impacts on water quality. The potential impacts are due to direct discharges of road runoff into these surface water features.

Table 14.22: Potential Impacts during Operation for Water Quality Attributes - Specific for Option 3A

Surface Water Feature (SWF)	Water Quality Attribute	Significance of Impact
SWF 07 Un-named drain	Water quality/supply	Large
	Dilution and Removal of Waste Products	Moderate
	Biodiversity	Large

14.5.89 The potential impacts are determined by the results of the HAWRAT routine runoff and spillage risk assessments (which inform the determination of magnitude) and the importance/sensitivity of the receiving surface water feature.

14.5.90 Outfall 3 into SWF 07 failed the Step 2 individual assessment dissolved copper, dissolved zinc, sediment-bound pollutants and the assessment against EQSs, resulting in an impact of Large significance for Water quality/supply and Biodiversity. The 'dilution and removal of waste products' attribute of SWF 07 would have a potential impact of Moderate significance in comparison to the other attributes due to the lower sensitivity of this attribute for this surface water feature.

Additional Impacts for Option 3B

14.5.91 This section presents the potential impacts of Moderate and above significance that are specific for Option 3B and hence are additional to those reported as common to all route options (Table 14.8 and Table 14.9 and paragraphs 14.5.28 to 14.5.33).

Hydrology and Flood risk

14.5.92 Table 14.23 provides details of the potential impacts for Option 3B in relation to construction impacts on hydrology and flood risk.

Table 14.23: Potential Impacts during Construction for Hydrology and Flood Risk - Specific for Option 3B

Surface Water Feature (SWF)	Significance of Impact
SWF 02 Inshes Burn	Large
SWF 03 Tributary of Scretan Burn (1)	Moderate

14.5.93 Potential impacts on SWF 02 are due to construction of the carriageway near this surface water feature and the construction of a road drainage outfall into the burn. This may result in increased runoff rates into the surface water feature during construction. Given the very high sensitivity of this watercourse this has resulted in an impact of Large significance.

14.5.94 Potential impacts on SWF 03 are due to construction of a culvert, an outfall and the carriageway near this surface water feature, which may result in increased runoff going into the watercourse, flow may be constrained due to works (increasing flood risk) and flood storage area may be reduced due to the works.

14.5.95 Table 14.24 provides details of the potential impacts for Option 3B in relation to operational impacts on hydrology and flood risk.

Table 14.24: Potential Impacts during Operation for Hydrology and Flood Risk - Specific for Option 3B

Surface Water Feature (SWF)	Significance of Impact
SWF 02 Inshes Burn	Moderate
SWF08 Cairnlaw Burn	Very Large

14.5.96 The potential impacts on SWF02 are due to changes to flood risk resulting from increased impervious areas and due to an outfall discharging routine runoff into the surface water feature.

14.5.97 The potential for impact on SWF08 and associated floodplain is due to the risk form the road acting as a flow path for flow that comes overland from out of bank flow arising up gradient from the scheme.

Fluvial Geomorphology

14.5.98 There are no potential additional construction or operation impacts of Moderate or above significance in relation to fluvial geomorphology for Option 3B.

Water Quality

14.5.99 During construction, Option 3B would have the same potential additional impacts as Options 1B and 2B. Table 14.16 and paragraphs 14.5.57 to 14.5.59 provide a description of the potential impacts.

14.5.100 Table 14.25 provides details of the potential impacts for Option 3B in relation to operational impacts on water quality. The potential impacts are due to direct discharges of road runoff into SWF 08.

Table 14.25: Potential Impacts during Operation for Water Quality Attributes - Specific for Option 3B

Surface Water Feature (SWF)	Water Quality Attribute	Significance of Impact
SWF 08 Cairnlaw Burn	Water quality/supply	Moderate

14.5.101 The potential impacts are determined by the results of the HAWRAT routine runoff and spillage risk assessments (which inform the determination of magnitude) and the importance/sensitivity of the receiving surface water feature.

14.5.102 Outfalls 3 and 4 into SWF 08 failed the Step 2 cumulative assessment for dissolved zinc; however, they passed the assessment for dissolved copper and the assessment against EQSs. Therefore, the 'water quality/supply' attribute of SWF 08 would have a potential impact of Moderate significance in comparison to non-significant impacts for the other attributes due to the higher sensitivity of this attribute for this surface water feature.

14.6 Potential Mitigation

14.6.1 As this is a DMRB Stage 2 assessment, the designs for each route option have not been sufficiently developed to allow mitigation measures to be defined in detail. The objective of this section is to identify potential mitigation taking into account best practice, legislation and guidance, which would be developed and refined during the DMRB Stage 3 assessment. As part of DMRB Stage 3, the design of the preferred option would be reviewed and, where possible, the preferred option would be further developed (pre-DMRB Stage 3 Assessment mitigation) to minimise impacts on the water environment.

Construction

14.6.2 All of the route options are likely to require the same types of construction activities and as such there are no activities that are unique to one specific route option. However, the extent of the works within/adjacent to each surface water feature, and the surface water features that are impacted, are different for each of the route options. Therefore, the level of mitigation that is required during construction is different for each route option, and this should be developed for the preferred option during the DMRB Stage 3 assessment.

14.6.3 None of the options are expected to require mitigation measures over and above good practice activities. Mitigation measures during construction that are relevant to all of the route options include:

- undertaking potentially polluting activities (e.g. concrete batching and mixing) away from watercourses, ditches and surface water drains;
- watercourse crossing works to be undertaken using appropriate methods to reduce the risk of pollution;
- appropriate method of working for outfall construction, including adherence to SG-28 Good Practice Guide: Construction of Outfalls (SEPA 2007);
- site sewage disposal to follow good practice and any service diversions to be carried out using good engineering practices;
- minimising the duration and spatial extent of works and ensuring adequate sediment control measures are in place around the works;
- progressive rehabilitation of exposed areas throughout the construction period as soon as possible after the work has been completed to reduce the risk of sediment release and additional runoff into the channel;
- installation of temporary treatment ponds, where required, to ensure the protection of water quality throughout construction. Details regarding any temporary construction treatment ponds should be agreed with SEPA prior to commencement of construction. Guidance detailed in The SUDS Manual (CIRIA 2007) should be followed relating to temporary SUDS;
- during temporary construction works, consideration should be given to flood impacts. For example, construction yards and storage areas should be located above the flood plain, and the aim should be for temporary construction works to be resistant to flood impacts in order to prevent movement or damage during potential flooding events;
- develop a Pollution Prevention Plan, identifying appropriate storage of oils, fuels and chemicals and including spillage response measures, prior to construction;

- prepare appropriate Method Statements for working with and storing oils and chemicals in line with the requirements of the Water Environment (Oil Storage) (Scotland) Regulations 2006;
- contractor to prepare and implement a Construction Environmental Management Plan (CEMP), to be approved by SEPA prior to commencement of works;
- design an Environmental Incident Control Plan (EICP) to ensure protective measures are implemented to deal with both normal and emergency situations;
- follow SEPA's pollution prevention guidance;
- install temporary treatment facilities, in agreement with SEPA and The SUDS Manual (CIRIA 2007);
- develop a permanent drainage system early in construction; and
- for any in-channel works, apply for CAR licence(s) from SEPA under the requirements of The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended).

Operation

Hydrology and Flood Risk

14.6.4 Where flood plain is lost or connectivity reduced, compensatory flood storage should be provided, where possible, to remove any increase in flood risk. Appropriate attenuation of surface runoff through correctly sized SUDS would also limit flood risk from the introduced impermeable area.

14.6.5 Culverts and bridges should be designed to cause no increase in water level and if embankments are required in the flood plain the provision of flood culverts or other measured to maintain connectivity should be considered.

14.6.6 On-going inspections and maintenance of structures should be undertaken to them keep clear of blockages.

Fluvial Geomorphology

14.6.7 In-channel works including outfalls, culverts and realignments should be correctly positioned and designed, through consultation with a geomorphologist or appropriately qualified person, in order to limit the potential for scour. The location and design of in-channel structures should be such that there would be no significant alteration to flow patterns which may lead to turbulence and/or excessive deflection of flow towards the bed or banks of the channel. In-channel structures should not project out into the channel and should not be located where flow converges with river banks causing higher shear stresses or where active bank erosion is occurring.

14.6.8 Where channel realignment is proposed the following principles should be followed where possible: minimise the length of the realignment, maintain gradient of watercourse and increase sinuosity of channel, create low flow channel to narrow channel and reduce siltation potential. In some cases, channel realignment can be an opportunity to improve the geomorphology of the watercourse, particularly if it has previously undergone high impact realignment.

14.6.9 Follow best practice identified in: The SUDS Manual (CIRIA 2007); DMRB Volume 4, Section 2, Part 7 (HA107/04): Design of Outfall and Culvert Details (The Highways Agency, Scottish Executive, Welsh Assembly Government and The Department for Regional Development Northern Ireland 2009); and the Engineering in the Water Environment Good Practice Guide: Intakes and Outfalls (SEPA 2008).

Water Quality

14.6.10 All of the route options would include a number of outfalls that would discharge routine road runoff and it is likely that some form of SUDS treatment would be needed for these outfalls. The

treatment efficiencies and degree of settlement required would be dependent on the sensitivity of the receiving watercourse, the AADT and the impermeable area draining to the outfall. A suitable form of treatment for routine runoff prior to outfall would be required and the outfall and method of treatment should be appropriately maintained.

14.7 Summary of Route Options

14.7.1 This section provides a summary of the impact assessment and includes those impacts which are common to all and those that vary between the options for construction and operation.

14.7.2 As noted above, only impacts of Moderate and above significance have been summarised to provide comparison of the main differences between the route options. Full details of the impact assessment are contained within Part 6 (Appendices), Appendix A14.4 (Impact Assessment Tables) of this report.

14.7.3 A discussion of the potential residual impacts is included, taking into account the potential mitigation measures outlined in Section 14.6 (Potential Mitigation). However, as a detailed assessment of residual impacts has not been completed at this stage (due to the stage of the design and mitigation development), only an indication of residual significance has been provided.

Hydrology and Flood Risk

14.7.4 For all route options, the greatest number of potential impacts of Very Large/Large significance would occur during construction, as a result of the likely construction activities impacting more surface water features and to a greater extent than during road operation.

14.7.5 Table 14.26 provides a summary of the potential impacts of Moderate or above significance during construction, by route option.

Table 14.26: Summary of Potential Impacts on Hydrology and Flood Risk during Construction (Un-mitigated)

Significance		Option				
	1A	1B	2A	2B	3A	3B
Very Large	3	3	3	3	2	2
Large	2	1	3	2	3	2
Moderate	1	1	0	0	1	1
Total	6	5	6	5	6	5

14.7.6 Option 3B has the least impact on surface water hydrology during construction with overall fewer impacts of Very Large/Large significance. The least favourable route in terms of hydrology and flood risk appears to be Option 2A.

14.7.7 It should be noted that the impacts on hydrology and flood risk during construction would generally be short-term impacts.

14.7.8 Table 14.27 provides a summary of the potential impacts of Moderate or above significance during operation, by route option.

Table 14.27: Summary of Potential Impacts on Hydrology and Flood Risk during Operation (Un-mitigated)

Significance	Option					
	1A	1B	2A	2B	3A	3B
Very Large	**0**	**1**	**0**	**1**	**0**	**1**
Large	**4**	**4**	**4**	**4**	**3**	**3**
Moderate	**2**	**1**	**2**	**1**	**3**	**2**
Total	**6**	**6**	**6**	**6**	**6**	**6**

14.7.9 Each of the B Variant options has a Very Large significance impact relating to the potential for the road, cut into existing ground level, to act as a flood receptor and flow path. Of the A variant options Option 3A has the least number of Large significant impacts.

14.7.10 Mitigation would be required, such as compensatory flood storage if flood storage is deemed to be impacted by the Scheme. The impacts of the route options are therefore likely to decrease when mitigation measures have been investigated.

Fluvial Geomorphology

14.7.11 The assessment identified very few differences between the proposed route options on fluvial geomorphology.

14.7.12 During both construction and operation there are two potential impacts of Moderate significance common to all route options (impacts on SWF 04 and SWF 08).

14.7.13 No additional potential construction or operation impacts of Moderate significance or above, specific to a route option, in relation to fluvial geomorphology have been identified.

Water Quality

14.7.14 For all route options, the greatest number of potential impacts of Large and Moderate significance would occur during construction, as a result of the likely construction activities impacting more surface water features than the operational activities.

14.7.15 Table 14.28 provides a summary of the potential impacts of Moderate and above significance for construction. This combines the impacts for all water quality attributes ('water quality/supply', 'dilution and removal of waste products' and 'biodiversity').

Table 14.28: Summary of Potential Impacts on Water Quality during Construction (Un-mitigated)

Significance	Option					
	1A	1B	2A	2B	3A	3B
Large	16	16	16	16	16	16
Moderate	7	5	7	5	7	5
Total	**23**	**21**	**23**	**21**	**23**	**21**

14.7.16 During construction there are 14 potential impacts of Large significance and 2 of Moderate significance common to all route options for 6 surface water features. These impacts are common to all route options because all would require similar works within these surface water features (e.g. some form of in-channel work).

14.7.17 All of the route options would have the same number of potential construction impacts of Large significance. This is because all options would require in-channel works within six surface water features.

14.7.18 Each of the A variant options would have a greater number of potential construction impacts of Moderate significance and above than the B variant options. These impacts are largely due to these route options involving works within, over or adjacent to a greater number of surface water features (eight surface water features compared to seven).

14.7.19 Potential impacts during construction would be short-term and, with appropriate mitigation in place, the magnitude of impact arising from the construction of the carriageway on water quality attributes is expected to be reduced to a residual magnitude of minor adverse (or less) for all route options. Impacts with minor adverse magnitude can vary in significance from neutral to large, depending upon the sensitivity of the surface water feature. However, as additional mitigation can be put in place where required, it is expected that residual adverse construction impacts of Moderate to Large significance could be avoided for all route options.

14.7.20 Table 14.29 provides a summary of the potential impacts of Moderate or above significance during operation.

Table 14.29: Summary of Potential Impacts on Water Quality during Operation (Un-mitigated)

Significance	Option					
	1A	1B	2A	2B	3A	3B
Large	4	3	4	3	2	1
Moderate	4	5	4	5	3	4
Total	**8**	**8**	**8**	**8**	**5**	**5**

14.7.21 The potential significance of an operational impact is determined by the results of the Step 2 HAWRAT routine runoff assessment (pass or fail) (which informs the determination of magnitude) and the importance/sensitivity of the receiving watercourse.

14.7.22 During operation there are two potential impacts of Moderate significance on water quality common to all route options for one surface water feature (SWF 03). All route options would involve a direct discharge of road runoff into this SWF 03. This impact is common to all route options because, for all route options, the proposed outfall into SWF 03 would pass the Step 2 HAWRAT routine runoff assessment for dissolved copper, dissolved zinc and the assessment against EQSs, but fail the assessment for sediment-bound pollutants.

14.7.23 All of the options include five (known) new outfalls into surface water features. However, Options 1A, 1B, 2A and 2B would have a greater number of potential operational impacts of Moderate significance and above compared to Options 3A and 3B. This is largely due to the impact of each option on SWF 02. All of the options include a proposed outfall into SWF 02. However, Options 1A, 1B, 2A and 2B fail the Step 2 HAWRAT routine runoff assessment for dissolved copper, dissolved zinc, sediment-bound pollutants and the assessment of compliance against EQSs, whilst Options 3A and 3B pass all of these aspects. This is because the impermeable area discharging to SWF 02 is greater for Options 1A, 1B, 2A and 2B.

14.7.24 Options 1A and 2A would have the greatest number of potential impacts of Large significance. This is because these options include an outfall into SWF 07, which was calculated to have a very low Q_{95} at the point of discharge (Part 6: Appendices; Appendix 14.1: Baseline Conditions; Section 1.4: River Flows). With the exception of Option 3A, none of the other options are proposed to outfall to this SWF. Options 1A and 2A failed the Step 2 HAWRAT assessment for this outfall for dissolved copper, dissolved zinc, sediment-bound pollutants and the assessment against EQSs. This means that, in total, these options have recorded the greatest number of failures within the HAWRAT routine runoff assessment (across all proposed outfalls).

14.7.25 Options 3A and 3B would have the lowest number of potential impacts of Moderate significance and above. This is largely due to the reasons outlined in paragraph 14.7.24. Option 3B would have the lowest number of potential impacts of Large significance. It has a lower number of potential impacts of Large significance compared to Option 3A because it does not include an

outfall into SWF 07. Similar to Options 1A and 2A, Option 3A failed the Step 2 HAWRAT assessment for the proposed outfall into SWF 07 for dissolved copper, dissolved zinc, sediment-bound pollutants and the assessment against EQSs. This means that, in total, Option 3A recorded a greater number of failures within the HAWRAT routine runoff assessment than Option 3B (across all proposed outfalls).

14.7.26 With the adoption of appropriate treatment measures, the magnitude of impact arising during operation (from the discharge of routine road runoff into receiving surface water features) would be reduced from those presented above. The magnitude of these impacts will vary dependent on the impermeable area draining to the surface water feature, the dilution capacity of the receiving surface water feature and the sensitivity/importance of that surface water feature. However, as the drainage design should be appropriate to the particular characteristics of the area drained and the receiving surface water feature, it is expected that adverse residual impacts of Moderate to Large significance could be avoided for all route options.

14.8 Scope of DMRB Stage 3 Assessment

Hydrology and Flood Risk

14.8.1 DMRB HD45/09 assessment methods are listed in paragraph 14.2.21. The DMRB Stage 3 Assessment should consist of a full quantitative assessment of the preferred option in accordance with Methods E and F in DMRB HD45/09.

14.8.2 This should include hydrological and hydraulic modelling (if deemed appropriate) which would require detailed topographic surveys of all watercourses crossed by the route, both upstream and downstream, including extension to any key features where flood impacts may propagate. Local flow gauging may be required to understand the characteristics of the small watercourses. Target areas for the provision of compensatory flood storage should be identified at an early stage for inclusion in the modelling.

Fluvial Geomorphology

14.8.3 As DMRB HD45/09 does not outline a specific methodology to enable the geomorphological impacts to be evaluated, and there are no Interim Advice Notes on the subject, the assessment should follow industry-accepted standards. The methodology adopted would be similar to that found within this DMRB Stage 2 Assessment, which was developed using the guidelines from Research and Development Programmes of the National Rivers Authority, Environment Agency and SNH including River Geomorphology: A Practical Guide (Environment Agency 1998) and the Guidebook of Applied Fluvial Geomorphology (Sear, Newson and Thorne 2010).

14.8.4 The DMRB Stage 3 Assessment is likely to involve a further site visit to those watercourses that are expected to be impacted by the preferred option. Typically, this would involve a site walkover 500m upstream and downstream of the proposed road crossing point. This would enable geomorphological sensitivities to be assigned with more certainty and would provide input to future CAR licence applications.

14.8.5 For sensitive watercourses, a more detailed geomorphological impact assessment may be required in order to satisfy the requirements of future CAR licence applications. For CAR licence applications, cross sectional and flow data may be required in order to calculate stream power. In addition, sediment samples may be required for sensitive watercourses to provide a more accurate indication of stream bed composition. In addition, sediment transport calculations may be required to help inform culvert design in order to dissipate energy and to retain a natural stream-bed composition within the culverted sections.

Water Quality

14.8.6 The water quality assessment of the preferred option should be conducted in line with the methodology outlined in DMRB HD45/09. The assessment should consider pollution impacts from routine runoff to surface waters (and groundwater, if applicable) and spillage risk.

14.8.7 Following Method A of DMRB HD45/09, the HAWRAT tool should be used to calculate whether the Scheme would 'pass' or 'fail' in terms of water quality in the receiving surface water features during operation.

14.8.8 Method C should be used if any discharges to groundwater are included in the drainage strategy for the preferred option.

14.8.9 Method D of DMRB HD45/09, which is also included in the HAWRAT tool, should be used to calculate spillage risk during operation and the associated probability of a serious pollution incident. The risk is calculated assuming that an accident involving spillage of pollutants onto the carriageway would occur at an assumed frequency, expressed as annual probabilities, based on calculated traffic volumes and the type of road/junction. The annual probability of a serious accidental spillage leading to a serious pollution incident also depends upon the emergency services response time. A risk factor is applied depending on the location and likely response time and the type of receiving water body.

14.8.10 The results of the HAWRAT calculations should be used to help determine the magnitude and significance of the effects during operation.

14.8.11 The criteria outlined in Tables 14.1 and 14.2 (Section 14.2: Approach and Methods) should be employed in conducting the assessment of sensitivity and magnitude. The results of the HAWRAT and spillage risk calculations should be used to help determine the magnitude and significance of the effects during operation. The assessment should consider the types and extent of likely construction activities (e.g. crossing points, channel realignments, outfall construction); proximity to watercourses (and requirements for in-channel works); and the relative size of the watercourse in regards to its potential to dilute and disperse contaminants and spillages after mixing. The assessment of the magnitude of operational effects should be informed by the nature of the watercourses proposed to receive road drainage and the dilution or dispersal potential of the watercourse.

14.9 References

Centre for Ecology and Hydrology (2009). Flood Estimation Handbook (FEH) CD-ROM, Volume 3.

Centre for Ecology and Hydrology (2016a). Flood Estimation Handbook Web Service. [Online]: Available from www.fehweb.ceh.ac.uk [Accessed on June 2016].

Centre for Ecology and Hydrology (2016b). National River Flow Archive Data. [Online]: Available from www.ceh.ac.uk. [Accessed June 2016].

CH2M (2015a). A96 Dualling Inverness to Aberdeen Strategic Flood Risk Assessment.

CH2M (2015b) (*on behalf of Transport Scotland*). A96 Dualling Programme: Strategic Environmental Assessment - Tier 2 Environmental Report.

CIRIA (2007). The SUDS Manual, CIRIA C697. Woods-Ballard, B., Kellagher, R., Martin, P., Jefferies, C., Bray, R. and Shaffer, P.

Landmark (November 2006). Envirocheck Report.

Landmark (October 2009). Envirocheck Report.

Environment Agency (1998). River Geomorphology: A Practical Guide.

Environment Agency (2010). The Fluvial Design Guide.

Haycocks Associates (2005). Review of Impact Assessment Tools and Post Project Monitoring Guidelines.

Highways Agency, Scottish Executive, Welsh Assembly Government and The Department for Regional Development Northern Ireland (2004). HA107/04: Design Manual for Roads and Bridges, Volume 4, Section 2, Part 7, Design of Outfall and Culvert Details, 2004.

Highways Agency, Scottish Executive, Welsh Assembly Government and The Department for Regional Development Northern Ireland (2006). DMRB Volume 11 Section 3 Part 10 (HA216/06) Environmental assessment. Environmental assessment techniques. Road drainage and the water environment (correction issued Nov 2008).

Highways Agency, Transport Scotland, Welsh Assembly Government and The Department for Regional Development Northern Ireland (2009). HD45/09: Design Manual for Roads and Bridges, Volume 11, Section 3, Part 10, Road Drainage and the Water Environment, 2009.

Jacobs (2011) (*on behalf of Transport Scotland*). A96 Inshes to Nairn DMRB Stage 2 Assessment Scoping Study [unpublished].

Jacobs (2014) (*on behalf of Transport Scotland*). A96 Dualling Inverness to Nairn (including Nairn Bypass): DMRB Stage 2 Scheme Assessment Report.

Jacobs (2015a) (*on behalf of Transport Scotland*). A9/A96 Connections Study.

Jacobs (2015b) (*on behalf of Transport Scotland*). A96 Dualling Inverness to Aberdeen Preliminary Engineering Assessment.

Jacobs (2016) (*on behalf of Transport Scotland*). A9/A96 Connections Study Transport Appraisal Report.

Jacobs (2016) (*on behalf of Transport Scotland*). A96 Dualling Inverness to Nairn (including Nairn Bypass) Environmental Statement [Unpublished].

National Library of Scotland (2016). Historic Maps of Rivers. [Online] Available from www.maps.nls.uk/ [Accessed June 2016].

Scottish Environment Protection Agency (2002). The Future for Scotland's Waters, Guiding Principles on the Technical Requirements of the Water Framework Directive.

Scottish Environment Protection Agency (2007). Engineering in the Water Environment Good Practice Guide: Construction of Outfalls, First edition.

Scottish Environment Protection Agency (2008). Engineering in the Water Environment Good Practice Guide: Construction of Outfalls, First edition.

Scottish Environment Protection Agency (2015a). Flood Maps [Online]: Available from www.map.sepa.org.uk/floodmap/map.htm [Accessed June 2016].

Scottish Environment Protection Agency (2015b). SEPA's River Basin Management Plan Interactive Map [Online]: Available from www.gis.sepa.org.uk/rbmp [Accessed June 2016].

Scottish Environment Protection Agency (2015c). Technical Flood Risk Guidance for Stakeholders (Reference: SS-NFR-P-002).

Scottish Environment Protection Agency (2016a). The Water Environment (Controlled Activities)

(Scotland) Regulations 2011 (as amended): A Practical Guide, Version 7.4.

Scottish Environment Protection Agency (2016b). Water Environment Hub [Online]: Available from http://www.sepa.org.uk/data-visualisation/water-environment-hub/ [Accessed June 2016].

Scottish Government (2014). Scottish Planning Policy.

Scottish Government (2016). Scotland's Environment State of the Environment Water Map [Online] Available from http://map.environment.scotland.gov.uk/seweb/map.htm [Accessed June 2016].

Sear, D., Newson, M.D., Thorne C.R. (2010). Guidebook of Applied Fluvial Geomorphology. Thomas Telford.

EU Directives and National Legislation

Directive 2000/60/EC of 23 October 2000 of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy [2000].

Water Environment and Water Services (Scotland) Act 2003.

Water Environment (Oil Storage) (Scotland) Regulations 2006.

The Climate Change (Scotland) Act 2009.

The Flood Risk Management (Scotland) Act 2009.

The Water Environment (Controlled Activities) (Scotland) Regulations 2011.

The Water Environment (Controlled Activities) (Scotland) Amendment Regulations 2013.