Aberdeen Western Peripheral Route

A9.4 - Water Quality

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Contents

1 Water Quality

1.1 General Background

1.1.1 Water is a resource that is essential to all animal and plant life. It is also necessary for industry, agriculture, waste disposal, many forms of transport, recreation and sport. The maintenance and improvement of the quality of our drinking water, watercourses, groundwater resources and coastal waters is central to Government and European policy.

1.1.2 The EC Water Framework Directive (WFD), which is transposed into Scottish law by the Water Environment and Water Services (Scotland) Act, 2003. The WFD aims to classify surface waters according to their ecological status and sets targets for restoring/improving the ecological status of waterbodies. Under the WFD, the status of water is to be assessed using a range of parameters including chemical, ecological, morphological and hydrological measures, which provides a holistic evaluation of the aquatic ecological health. Furthermore, there is a requirement under the WFD for natural water features to reach good ecological status by 2015 (WFD, 2000/60/EC). Some waterbodies may be designated as artificially/heavily modified and will have less stringent targets to meet. However, these areas will still need to demonstrate 'good ecological potential' by the year 2015 (SEPA, 2002).

1.1.3 In addition, under the WFD the Controlled Activities (Scotland) Regulations 2005 (CAR) state that it is an offence to discharge to all wetlands, surface waters and groundwaters without CAR authorisation. There are three different types of authorisation under CAR, General Binding Rules (GBR), Registration and License (both simple and complex). The level of regulation increases as the activity poses a progressively deleterious impact on the water environment. The level of authorisation required for the AWPR is dependent on the activity proposed, but is likely to range from GBR, covering some construction activities and outfalls, to licenses required for outfalls (draining over 1km of road in length), culverting and watercourse realignment.

1.1.4 Controlled Activities (Scotland) Regulations 2005 (CAR) are regulatory controls that were passed by Scottish Parliament on 01 June 2005 and came into force on 01 April 2006. The regulations state that it is an offence to discharge to all wetlands, surface waters and groundwaters without CAR authorisation. There are three different types of authorisation under CAR – General Binding Rules (GBR), Registration and License (both simple and complex). The level of regulation increases as the activity poses a progressively deleterious impact on the water environment. The level of authorisation required for the AWPR is dependent on the activity proposed, but is likely to range from GBR covering some construction activities and outfalls, to licenses required for outfalls (draining over 1km of road in length), culverting and watercourse realignment. Further information can be found in 'The Water Environment (Controlled Activities) (Scotland) Regulations 2005: A Practical Guide' (SEPA, 2007).

1.1.5 In 1974 a river quality classification scheme was developed to monitor the quality of all rivers in Scotland. The scheme has been expanded over the years to reflect the implementations of a number of EC Directives: the EC Directive 75/440/EEC relating to the quality of water for abstractions from watercourses for human consumption, the EC Dangerous Substances Directive 76/464/EEC, the EC Freshwater Fishery Directive 78/659/EEC, the Nitrates Directive 91/676/EEC, and others, all of which were recently incorporated within the Water Framework Directive 2000/60/EC. In addition to the requirements of the WFD for promotion and maintenance of good aquatic ecological health, the atlantic salmon (*Salmo salar*) (a European and UK protected species) is present in the River Don. Salmon is typically used as a biological indicator of high quality water (SEPA guide to best practice).

1.1.6 Since the formation of the Scottish Environment Protection Agency (SEPA) in 1996 the river classification scheme has been enhanced and specific targets have been set up to protect watercourses with good and excellent water quality and to improve the quality of rivers classed as poor or seriously polluted (see SEPA website, www.sepa.org.uk).

1.1.7 This report presents the baseline conditions, potential impacts, mitigation proposals and predicted residual impacts for the water quality of receiving watercourses within the vicinity of the Northern Leg of the proposed scheme.

1.2 Assessment Aims

1.2.1 The aim of the water quality report is to assess the impact of the proposed scheme drainage system and outfalls on the water quality of the receiving watercourses.

1.2.2 The report presents the baseline water quality conditions of all the watercourses situated within the study area, followed by a pollution assessment. Using the procedure set out in the Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 10, pollution calculations were performed for each of the designed road drainage outfalls. The potential annual average (AA) and 95-percentile in the receiving watercourse concentrations for designated major indicator pollutants were calculated to identify the levels of mitigation required.

2 Approach and Methods

2.1 General Approach

2.1.1 This section sets out the methodology by which the water quality assessment will be undertaken and should be read in conjunction with those covering geomorphology, hydrodynamics, freshwater ecology and hydrology.

2.1.2 The Environmental Impact Assessment was carried out using the general methodology detailed in Chapter 9 (Water Environment), where the level of significance of an impact is assessed based on the sensitivity of the receptor and the magnitude of impact. The system of assessment used followed the basic methodology detailed below:

- assess the baseline;
- determine the potential impacts on water quality of water features:
  - pollution (both soluble and insoluble).
  - accidental spillage.
- suggest mitigation measures for the potential impacts; and
- assess the residual impacts taking into account the stated mitigation measures.

2.1.3 Potential impacts of the proposed scheme on surface hydrology (Appendix A9.1), flood risk (Appendix A9.2), and fluvial geomorphology (Appendix A9.3) have been assessed separately. The potential impacts to watercourses from fine sediment release is discussed in detail in the Fluvial Geomorphology assessment (Appendix A9.3).

2.1.4 An impact to water quality may have associated impacts upon aquatic ecology. These impacts are discussed in more detail in Chapter 10 (Ecology and Nature Conservation) and its associated appendices.

2.1.5 For the purpose of this assessment the criteria used to assess the sensitivity of surface water features and the magnitude of the potential impact are defined in Table 2-1 and Table 2-2 respectively. As part of the water quality criteria, the ecological designations of the watercourses and the surrounding areas (as detailed in Appendix A10.16: Freshwater) have also been included to assist in building a more comprehensive sensitivity. The resultant impact significance is defined by reference to both the sensitivity of the feature and the magnitude of impact, according to the matrix presented in Table 2-3.

Table 2-1 – Criteria to Assess the Sensitivity of Water Features

Sensitivity	Surface Water Quality Criteria
High	Large or medium watercourse with pristine or near pristine water quality, Class A1 and A2 (A9.5, Annex 26), respectively. Water quality not significantly affected by anthropogenic factors. Water quality complies with Dangerous Substances Environmental Quality Standards (EQS). Water quality does not affect the diversity of species of flora and fauna. Natural or semi-natural ecosystem with sensitive habitats and sustainable fish population. Includes sites with international and European nature conservation designations due to water dependent ecosystems: e.g. Special Protection Area, Special Area of Conservation, Ramsar Site and EC designated freshwater fisheries. Also includes all nature conservation sites of national and regional importance designated by statute including Sites of Special Scientific Interest, National Nature Reserves and Natural Areas (part of the Regional BAP).
Medium	Medium or small watercourse with a measurable degradation in its water quality as a result of anthropogenic factors (may receive road drainage water), Class A2 or B (A9.5, Annex 26). Ecosystem modified resulting in impacts upon the species diversity of flora and fauna in the watercourse. Moderately sensitive habitats. Includes non-statutory sites of regional or local importance designated for water dependent ecosystems.
Low	Heavily modified watercourses or drainage channel with poor water quality, resulting from anthropogenic factors, corresponding to Classes B, C and D. Major change in the species diversity of flora and fauna due to the significant water quality degradation. May receive road drainage water. Fish sporadically present. Low sensitivity ecosystem of local and less than local importance.

Table 2-2 – Criteria to Assess the Magnitude of Impacts on Water Features

Magnitude	Surface Water Quality Criteria
High	<u>General Operational Impact</u> Major shift away from the baseline conditions, fundamental change to water quality condition either by a relatively high amount over a long-term period or by a very high amount over an episode such that watercourse ecology is greatly changed from the baseline situation. Equivalent to downgrading from Class B to D or any change that downgrades a site from good status as this does not comply with the Water Framework Directive. <u>Routine Runoff</u> Specifically for the purposes of the soluble pollution assessment, a high impact will be classed as an increase to copper or zinc concentrations of 100% or greater over the baseline situation, plus/or a failure of EQS for either pollutant. <u>Accidental Spillage</u> For the purposes of this assessment, a high impact will be classed as an accidental spillage risk below the probability threshold level of 1 in 100 or 1 in 50 years (see the Impact Assessment Methodology section below).
Medium	<u>General Operational Impact</u> A measurable shift from the baseline conditions that may be long-term or temporary. Results in a change in the ecological status of the watercourse. Equivalent to downgrading one class, for example from C to D. <u>Routine Runoff</u> Specifically for the purposes of the soluble pollution assessment a medium impact will be classed as an increase to copper or zinc concentrations of 60-99% over the baseline situation, plus/or a failure of EQS for either pollutant. <u>Accidental Spillage</u> For the purposes of this assessment, a medium impact will be classed as an accidental spillage risk above the probability threshold level of 1 in 100 or 1 in 50 years (see the Impact Assessment Methodology section below) with up to 1 in 200 years.
Low	<u>General Operational Impact</u> Minor shift away from the baseline conditions. Changes in water quality are likely to be relatively small, or be of a minor temporary nature such that watercourse ecology is slightly affected. Equivalent to minor, but measurable change within a class. <u>Routine Runoff</u> Specifically for the purposes of the soluble pollution assessment a low impact will be classed as an increase to copper or zinc concentrations of 25-59% from the baseline situation but all EQS levels are met.

Magnitude	Surface Water Quality Criteria
	Accidental Spillage For the purposes of this assessment, a low impact will be classed as an accidental spillage risk above 1 in 200 and below 1 in 1000 years.
Negligible	General Operational Impact Very slight change from the baseline conditions such that no discernible effect upon the watercourse's ecology results. No change in classification. Potential impact through diffuse means, e.g. pollution via sub-surface paths or deposits from air borne road pollution near river crossings. Routine Runoff Specifically for the purposes of the soluble pollution assessment, a negligible impact will be classed as an increase to copper or zinc concentrations of 24% or less over the baseline situation but all EQS levels are met. Accidental Spillage For the purposes of this assessment, a negligible impact will be classed as an accidental spillage risk above probability threshold level of 1 in 1000 years.

Table 2-3 – Impact Significance Matrix

Sensitivity / Magnitude	High	Medium	Low
High	Substantial	Moderate/Substantial	Moderate
Medium	Moderate/Substantial	Moderate	Slight
Low	Moderate	Slight	Negligible
Negligible	Slight / Negligible	Negligible	Negligible

2.2 Background to Potential Pollutants

2.2.1 Potential sources of road runoff contamination are diverse and may be generated from road construction works, traffic, maintenance (including the application of de-icing salts), accidental spillage and from other sources such as atmospheric deposition. Road-associated contaminants that are considered to have the greatest potential impact on receiving waters include suspended solids, hydrocarbons, metals, pesticides and herbicides, de-icing agents, nutrients and those arising from accidental spills. Although the pollutants present in road runoff are very diverse in form and origin, they can be grouped into categories (DMRB, The Highways Agency et al., 1993):

- insoluble (likely to settle on the bed or float on the surface of a watercourse);
- soluble (affecting water quality and/or aesthetic values); and
- those arising from accidental spillage (which are concentrated).

2.2.2 The insoluble pollutants include vehicle oil and other hydrocarbons and suspended solids (the solid fraction of the road runoff). The solid fraction of a road discharge may contain up to 70% of the oil deposited onto a road by moving vehicles, over 90% of the inorganic lead, 70% of the copper and 56% of the cadmium. Removing coarse solids and a significant proportion of the fine (insoluble) solids from the road discharge is understood to remove much of the potentially polluting load.

2.2.3 The soluble pollutants group comprise of dissolved metals, organic toxic substances such as most herbicides and pesticides, rock salt and alternative de-icing agents and nutrients. Some of these may enter the watercourse in high concentrations causing localised acute impact on the aquatic environment (e.g. accidental spillage) or could accumulate in the freshwater habitats and cause long term chronic damage to the organisms living in the river (e.g. heavy metals entering the watercourse through road drainage discharge). The DMRB sets out accepted methods for quantifying the risk of pollution arising from accidental spillage and indicative soluble pollutants, zinc and copper, in the road runoff. Additionally new research (Patel & Drieu, 2005) indicates that more determinants may be considered in the future, particularly total suspended solids (TSS), nutrients and biological oxygen demand (BOD). Where possible, this report and the Fluvial Geomorphology report (Appendix A9.3) include qualitative assessment of the potential impacts to watercourses from TSS.

2.2.4 The adopted methods for carrying out the assessment are described in DMRB. Quantification of the impacts of road drainage on water quality is based on calculating the accidental spillage risk (expressed as return periods) and the predicted concentrations of dissolved copper and total zinc in the receiving waters in the Design Year (2027) of the proposed scheme. These metals are used as indicators of the level of impact as they are generally the main metallic pollutants associated with road drainage and can be toxic to aquatic life in certain concentrations. DMRB states that lead is not included as it has low solubility and when it is in its insoluble form it has low toxicity such that biological impacts would not be anticipated.

2.2.5 For the rest of the soluble pollutants (nutrients, de-icing agents, herbicides and pesticides), there are no uniform evaluation methods described in the DMRB, therefore the assessment was made qualitatively. Their adverse impact magnitude on water quality is considered to be localised and seasonal. The use of de-icing agents during the winter months would be rapidly diluted and dispersed causing temporary and highly localised adverse ecological effect. Nutrients (ammonia, oxidised nitrogen and phosphates) are found in very small quantities in road runoff. Herbicides and pesticides treatment of the verge during road maintenance is also a potential source of contamination and should follow best environmental practice guidance with the selection of degradable compounds.

2.2.6 The water quality assessment of the operational phase impact of insoluble pollutants, such as suspended solids and hydrocarbons, was made using dilution factor criteria of the average flow Q_{mean} in the receiving watercourse (Table 2-2). Further assessment was conducted in the fluvial geomorphology assessment (Appendix A9.3: Fluvial Geomorphology).

2.2.7 The requirements of the EC Water Framework Directive have also been taken into account when assessing the impacts of the proposed scheme on water resources, using the recent policy guidance ‘The Future for Scotland’s Waters, Guiding Principles on the Technical Requirements of the Water Framework Directive’ (SEPA, 2002).

2.3 Impact Assessment Methodology

Baseline Assessment

2.3.1 Water quality baseline conditions for watercourses were identified through consultation with statutory consultees, review of relevant published literature, site visits and physiochemical and freshwater habitat sampling data collection undertaken in 2004/2005.

2.3.2 Baseline conditions for watercourses are reported by SEPA following their River Classification Scheme (A9.5; Annex 26: SEPA Classification Scheme). This categorises watercourses on the basis of monitoring water chemistry, biology, nutrient status, aesthetic condition and concentration of toxic substances (A9.5; Annex 26: SEPA Classification Scheme). There are five classes; A1, A2, B, C and D in decreasing order of quality. Class A1 is excellent and Class D is seriously polluted. The class allocated to a particular reach of watercourse defaults to the poorest class determined from the water chemistry, biology, nutrient, aesthetics and toxicity assessments. No attempt is made to assign zones of intermediate quality between stretches differing by more than one class (A9.5; Annex 26 SEPA: Classification Scheme).

2.3.3 The SEPA classification includes all rivers with a catchment area of 10 km^2 or more and specific smaller rivers where known pollution problems exist. This is called the ’classification network‘ (SEPA website: www.sepa.org.uk). The classification network is divided into river stretches at confluences and pollution pressures. Every stretch is assigned a monitoring point where chemical and ecological surveys are taken and the aesthetic appearance recorded (A9.5; Annex 26 SEPA Classification Scheme). The quality or ‘class’ of a length of river is calculated from the monitoring point results.

2.3.4 The freshwater habitat sampling was conducted as to provide a snap-shot of the biological and chemical conditions of the watercourses. The adopted methodology included a macroinvertebrate spot sampling (method described in detail in Appendix A10.16: Freshwater) to identify abundance and species richness and water chemistry measurements for dissolved oxygen, pH, conductivity, temperature and water hardness. Although the chemical measurements provide only information for the water quality of the passing water at the time of the sampling the biological samples indicate the longer term impact of the water quality on the freshwater organisms.

Impact Assessment

2.3.5 There are six main types of impacts to watercourses that could potentially arise from the proposed scheme:

- impacts on surface waters due to routine road runoff (both soluble and insoluble pollution);
- impacts of accidental spillage to surface waters;
- impacts on groundwater resources (which will be discussed in detail in Chapter 8 Geology, Contaminated Land and Groundwater);
- where necessary the impacts on fluvial geomorphology and sediment release (discussed in detail in a separate Appendix A9.3: Fluvial Geomorphology);
- impacts on hydrology and flood risk (discussed in detail in Appendices A9.1 and A9.2 respectively); and
- impacts on water quality during construction.

2.3.6 These may cause indirect impacts upon freshwater ecology and fisheries (see Appendix A10.16: Freshwater, and Appendix A10.15: Fish). Groundwater resources have been assessed in Chapter 8 (Geology, Contaminated Land and Groundwater). The methods of assessment for potential impacts on water quality from routine runoff, accidental spillage and during construction works are outlined below.

<u>Routine Runoff</u>

2.3.7 Routine runoff is surface water collected from the road as a result of rain falling on the road and draining into the highway drainage system. Routine runoff contains some of the pollutants deposited on the road surface but does not include seriously polluted runoff assessed separately as a result of vehicular collision (accidental spillage).

General

2.3.8 The water quality assessment was carried out in accordance with the methods set out in DMRB, taking cognisance of more recent research such as ‘Pollutant Build up and Runoff on Highways; Expanding the Current The Methodology for Additional Determinants’ (Patel and Drieu, 2005). The DMRB method assesses the impact of the main metallic pollutants copper and zinc on the water quality of the receiving waters, following series of calculations to predict the concentrations of dissolved copper and total zinc in the receiving watercourse. The predicted concentrations are compared with the baseline conditions and the Environmental Quality Standards (EQS). The EQS are principally ecological standards, specified for a range of parameters at levels required to protect aquatic life. They are set by the Freshwater Fisheries Directive (FWFD) and Dangerous Substances Directive (DSD), List II Substances and transposed into the Scottish law by Statutory Documents Circular No34/1995 (SEPA, personal communication, D. Caffrey, 2005).

Calculations of the 95-percentile Concentration

2.3.9 The DMRB methodology specify that the potential pollution in the receiving watercourse should be calculated assuming a high rainfall event coinciding with a low flow event in the receiving watercourse (Q_{95} low flow parameter). The DMRB states that this calculated concentration can then be compared to the statutory EQS that exist for the FWFD. These are expressed as 95-percentile values. The 95^{th} percentile is the concentration that is exceeded for only 5% of the time and would only be expected to occur very rarely.

Calculations of the Annual Average Concentration

2.3.10 In addition to the FWFD, the DSD sets statutory Environmental Quality Standards for dissolved copper and total zinc. These are expressed as annual average values. To ensure that the drainage proposals conform to the DSD the DMRB methodology requires a modification to predict a likely annual average concentration in the receiving watercourse. Consultation and ongoing discussion with SEPA, for this and other projects, resulted in an agreed modification to predict potential, indicative, annual average values in the receiving watercourse (SEPA, personal communication D Clark, 2004 and SEPA, personal communication N Abrams, 2005). The modified methodology specifies that the potential pollution in the receiving watercourse is calculated assuming the annual average rainfall occurs on one day coinciding with a mean flow event in the receiving watercourse (Q_{mean} average flow in the watercourse). These replace the depth of rainfall indicated in Figure A1 of the DMRB (2006) (95% storm) and the Q_{95} flow in the receiving watercourse.

Assessment Process

2.3.11 A precautionary approach has been adopted for the assessment of water quality along the route and both annual average and 95-percentile potential pollution calculations were performed for all receiving watercourses. These predicted concentrations were then used to inform the impact assessment, and therefore the mitigation design. Following the precautionary approach, the more stringent of the two methods annual average and 95-percentile was used to design mitigation.

2.3.12 The impact assessment of routine runoff requires data on:

- the upstream concentrations of dissolved copper and total zinc in each watercourse;
- an indication of receiving water's hardness;
- an estimate of the road surface area to be drained to each outfall;
- the runoff coefficient of the road scheme;
- traffic flow data;
- rainfall data;
- the mean flow (Q_{mean}) of the receiving watercourse and the 95th percentile flow (Q_{95}); and
- the relevant statutory EQS values for the receiving watercourse (provided by SEPA, Table 2-4).

2.3.13 Where there was an absence of long term monitoring data specific to the watercourses in the study area, the following approach was adopted:

- the upstream concentration for the River Don for dissolved copper and total zinc were obtained as average and 95% concentrations using the long-term monitoring data provided by SEPA. For watercourses with no monitoring data available, the upstream concentrations are assumed to be half the EQS (as detailed in DMRB guidance);
- receiving water hardness is assumed to be between 50-100mg/l for all the watercourses situated in the Northern Leg (SEPA, personal communication, 2004);

- a sensitivity check on the assumed hardness bandings was performed, i.e. calculations were undertaken for the assumed hardness banding, in addition to the bandings immediately above and below where possible. This was taken into consideration when designing the mitigation.
- the total impermeable area of road surface is provided by highways design engineers;
- the runoff coefficient of the road scheme is 0.75 (Maidment, 1993);
- traffic flow data for the design year used traffic predictions for 2025, provided by traffic modellers;
- rainfall data were obtained from the DMRB (2006) and DMRB (1993): Figure A1 Depth of Rain for Assessing Pollutant Runoff (95% storm) and Figure 3.2 Average Annual Rainfall 1941 – 1970 respectively;
- the Q_{95} and Q_{mean} were estimated, using methods detailed in Appendix A9.1 Surface Water Hydrology;
- relevant EQS for dissolved copper and total zinc are provided in Table 2-4. The assessment uses the statutory guidance to determine the level of impact of the scheme upon the receptor (receiving watercourse).

2.3.14 The magnitude of impact is assigned based on the criteria set out in Table 2-2. The reported values represent the more stringent target of either the DSD or the FWFD.

Environmental Quality Standards

2.3.15 The EQS for freshwater vary with water hardness, as hardness affects the solubility of metals. The relevant EQS for the protection of all freshwater aquatic life are given in Table 2-4 (SEPA, personal communication, D Caffrey, 2005 and Statutory Instrument (SI) Circular No34/1985). These values differ slightly to those published on the SEPA website (www.sepa.org.uk). However, SEPA (SEPA, personal communication, D Caffrey, 2005) directly advised Jacobs to use the values reported in Table 2-4 (SI Circular No34/1985) in preference to those published on the website, as it is understood that those on the website are not yet statutory.

Table 2-4 – National Environmental Quality Standards for the Protection of all Freshwater Life

Parameter	Hardness Range (mg/l $CaCO_3$)	EQS (µg/l) (annual average)	EQS (µg/l) (95 percentile)
Copper (dissolved)	0-10	1	5
	10- 50	6	22
	50-100	10	40
	100-250	28	112
	> 250	28	112
Total Zinc	0-10	8	30
	10- 50	50	200
	50-100	75	300
	100-250	125	500
	> 250	125	500

Source: Guidelines for Copper and Total Zinc from DMRB, Table 2 River Ecosystem Classification (The Highways Agency et al., 1993) and Statuatory Levels as provided by SEPA (personal communication, SEPA, 2005). Taken from the statutory documents (Circular No34/1985) accompanying the DSD and FWFD.

Insoluble Pollutants, Suspended Solids

2.3.16 Currently, there are no sediment quality or quantity standards recommended for use as reference points for assessing the impacts of the solid load of road runoff. The removal of coarse and a significant proportion of the fine (settleable) solids from road discharges, using appropriate treatment systems, will remove much of the potentially polluting load. As most of the polluting load is associated with the solid and settleable phase of treatment, insoluble pollutants are considered to be of greater importance in assessing the environmental effects of runoff (The Highways Agency *et al.*, 1993). The assessment of the impact of solids on the watercourses is qualitative, with the greatest potential impacts being likely to occur in the following situations, where:

- the flow pattern in the receiving water is such that fine sediments may accumulate to significant levels within a short distance downstream of the proposed outfall and that area of watercourse has significant ecological or high amenity value;
- available dilution for the road discharge is low;
- the receiving waterbody has existing discharges which are causing solids pollution in the immediate vicinity of the discharge; and
- there is water abstraction downstream of the outfall that could be affected.

2.3.17 Further assessment of physical conditions downstream of proposed outfalls was conducted in the fluvial geomorphology and sediment modelling assessments (Appendix A9.3: Fluvial Geomorphology and Appendix A9.5; Annex 30: Sediment Modelling Report respectively).

Risk of Accidental Spillage

2.3.18 Along any road, there is a risk of vehicular collision that can result in spillage of fuels, oils or chemicals, particularly if tankers are involved. A risk assessment of a serious spillage causing pollution was undertaken using the methodology outlined in the DMRB guidance.

2.3.19 The risk was calculated assuming that an accident involving spillage of pollutants onto the carriageway will occur at a frequency, based on the predicted traffic volumes for the design year and the type of road/junction (Table 2-5). It is also assumed that pollutants spilled on the carriageway will subsequently pass through the road drains and cause a pollution incident in the receiving watercourse without mitigations. The probability of a serious accidental spillage leading to a serious pollution incident depends upon the emergency services response time. A risk factor is applied depending on the response time and the quality of the receiving watercourse (Table 2-6).

Table 2-5 – Serious Accidental Spillages per Million HGV (km/year)

Junction Type	Urban Motorway	Rural Motorway	All Purpose Road (Urban)	All Purpose Road (Rural)
No junction	0.0022	0.0014	0.0039	0.0017
Slip Road*	0.0032	0.0023	0.0058	0.0035
Side Road*	-	-	0.0106	0.0042
Roundabout*	-	-	0.0296	0.0119
Cross Road*	-	-	0.0159	0.0044
Overall	0.0024	0.0019	0.0075	0.0025

Source: DMRB Volume 11, Section 3 (The Highways Agency et al., 1993) – A3/4 Table 3.2.
Note: * Risk factor applies to all road lengths within 100 m of these junction types and for a 200m length of the all purpose road centred on the junction itself.

Table 2-6 – Probability of a Serious Accidental Spillage Leading to a Serious Pollution Incident

Receiving Watercourse	Emergency services' response time to site is within 20 minutes	Emergency services' response time to site exceeds 20 minutes
High Quality Watercourse	0.45	0.75
Moderate Quality Watercourse	0.3	0.5
Aquifer	0.3	0.3

Source: DMRB Volume 11, Section 3 (The Highways Agency et al., 1993). Table 3.3

2.3.20 The probability of serious accidental spillage was calculated as follows:

$$P_{acc} = RL \times SS \times (AADT \times 365 \times 10^{-6}) \times (\%HGV \div 100)$$

where:

P_{acc} = probability of a serious accidental spillage in 1yr over a given road length

RL = road length in kilometres

SS = serious spillage rates from Table 2-5 (or local data if available)

AADT = annual average daily traffic

%HGV = percentage of Heavy Goods Vehicles

2.3.21 The probability that a spillage will cause a pollution incident is calculated thus:

$$P_{pol}/year = P_{acc} \times P_{pol}$$

2.3.22 Where:

P_{pol} = the risk reduction factor, dependent upon emergency services response times, which determines whether a serious spillage will cause a serious pollution incident.

2.3.23 The value is to be selected from Table 2-6 using the quality of the reach proposed to receive the discharge.

2.3.24 The acceptable risk of pollution incident should normally be at a level of 1 in 100 years for discharges to aquifers and to reaches of sensitive watercourses. For all other receiving waters, the acceptable risk should normally be 1 in 50 years. The calculations were performed using the worst-case scenario data (The Highways Agency et al., 1993).

Pre-Earthworks Drainage

2.3.25 Pre-earthworks drainage comprises unlined or lined ditches, or filter drains. These drainage systems are constructed at the top of cutting slopes, or at the toe of embankments, subject to the requirements of the design in order to prevent surface water or groundwater entering the works. When placed at the toe of embankments, surface water carried by the pre-earthworks drainage will contain sediment from runoff from the embankments under construction and will be required to discharge water to temporary settlement ponds prior to it being discharged to a watercourse.

2.3.26 Some small watercourses and field drains will be taken into pre-earthworks. They will be crossed by the road in their very upper reaches. Therefore the upper catchment would be diverted and connected to the new drainage system. Due to the small size of these watercourses and field drains they have been scoped out of this assessment. However SEPA will need to approve the process through the CAR procedure.

Construction Impact

2.3.27 The construction impact assessment was carried out qualitatively. For the purpose of this assessment, the combination of different engineering activities (construction of water crossings, realignment of the watercourse channel, modification of the riverbanks, vegetation removal) that would be carried out within the vicinity of a watercourse, as well as the extent of the proposed works, was taken into consideration. Available dilution of the watercourse was also considered when assessing the potential impact of suspended solids and accidental spillage during construction. Flow patterns, fisheries or environmental status of the watercourse, receiving body and existing abstractions were also considered in the assessment.

2.4 Limitations to Assessment

2.4.1 The water quality assessment is limited by the amount of available data and by the predictive methods available to complete a more rigorous assessment. Following DMRB guidance, the assessment was carried out only for the main indicator metals (copper and zinc) and accidental spillage risk using a simple calculation model to predict respectively the annual pollution build up concentrations and the return periods. Although these are 'conservative' methods, the predicted values are sensitive to potential changes in input concentrations and receiving flows. Additionally, new research (Patel & Drieu, 2005) indicates that more determinants may be considered in the future, particularly total suspended solids (TSS), nutrients and BOD. Where possible this report and the geomorphology (Appendix A9.3) report assess the impact to the watercourses of the TSS.

2.4.2 The baseline water quality assessment was conducted using chemical data (for the period 1998 – 2005) and biological data (for the period 2000-2005) data provided by SEPA (SEPA, 2005) and spot sampling measurements conducted by Jacobs in the summer of 2004. The datasets for copper and zinc provided by SEPA refer only to the River Don, covering a period 1998-2004. Spot sampling results provide only a snapshot of the water quality conditions in the watercourse at the time when the sample was obtained. These results do not equate to monitoring data and they do not provide information on the long-term health of the watercourse.

2.4.3 There are a number of assumptions inherent in using DMRB assessment methods. In the absence of upstream concentrations of copper and zinc in the affected watercourses (except for the Don), the concentrations have been assumed to be half the EQS, as recommended in the DMRB guidance. Flows also are generally represented using low flow data (details given in Surface Water Hydrology: Appendix A9.1). These methods, while simple, tend to err on the conservative side and have been used principally in the design of mitigation features as an indicator of the levels of treatment required.

3 Baseline

3.1.1 The Northern Leg of the proposed scheme passes over or within the vicinity of a number of watercourses. Some are open watercourses in rural areas while others are more heavily modified and partially culverted.

3.1.2 The study area is located mainly within River Don catchment, comprising River Don with its tributaries and a number of smaller watercourses catchments. The surface water features of each catchment can be divided into three main types:

- major watercourses;
- minor watercourses; and
- lochs and other waterbodies.

3.1.3 Table 3-1 below details which watercourses would potentially be affected by the proposed scheme.

Table 3-1 – Water Features Potentially Affected by the Proposed Scheme

Water Body	Northern Leg
Major Watercourse	River Don
Minor Watercourse	Kepplehill Burn
	Kepplehill Ditch
	Gough Burn
	Parkhead Burn
	Parkhead Ditch
	Craibstone Burn
	Craibstone Ditch
	Green Burn
	Walton Field Ditch
	Howemoss Burn
	Bogenjoss Burn
	Goval Burn
	Mill Lade
	Corsehill Burn
	Red Moss Burn
	Blackdog Burn
	Blackdog Ditch
	Middlefield Burn
Lochs and Water Bodies	Craibstone Pond
	Corsehill Pond
	Lochgreens Pond
	Corby Loch
	Lily Loch

3.1.4 The baseline study examines 14 watercourses (Figures 9.1a-9.1g) which would potentially be affected during the construction phase or by the operation of the proposed scheme. Kepplehill Ditch, Parkhead Burn, Parkhead Ditch and Walton Field Ditch will be taken into pre-earthworks, and due to their small size they have been scoped out of this water quality assessment (assessed in Surface Water Hydrology: Appendix A9.1).

3.1.5 Craibstone Ditch and all waterbodies within the vicinity of the proposed scheme identified as important habitats are detailed in Chapter 10. Howemoss Springs are included in the groundwater impact assessment (Chapter 8).

3.1.6 In general, the River Don and its tributaries flow in a northwest to southeast direction into the North Sea. In addition to the main catchment, three other minor watercourses flow directly into the North Sea. Blackdog Burn drains the Red Moss area to the west, merging further downstream with Middlefield Burn before discharging into the North Sea. Blackdog Ditch is a tributary of Blackdog Burn. Red Moss Burn drains the eastern part of the moss and flows into Corby Loch forming part of the Burn of Mundurno’s catchment. All watercourses in the Northern Leg study area are relatively small, with the exception of the River Don, and have not been identified as supporting recreational boating amenity activities.

3.1.7 The baseline section of this report describes each watercourse and the catchment area it drains, up to the point of the proposed scheme. It discusses water quality based on the data provided by SEPA (for the period 1998 - 2005), and on spot sampling measurements conducted by Jacobs (summer 2004). A sensitivity value was also assigned to each watercourse in accordance with

Table 2-1. The use of spot measurements provides an indication of the water quality for the burns that are not included in the SEPA monitoring network.

3.1.8 SEPA monitors the water quality in the Don, Goval Burn and Blackdog Burn (Table 3-2). These watercourses together with Gough and Green Burns were identified to receive existing road drainage water from respectively the A947 (for River Don and Goval Burn), the A90 (Blackdog Burn), a class C road (Gough Burn) and A96 (Green Burn). All 14 watercourses identified as potentially directly affected by the proposed scheme are described in Sections 3.2 and 3.3 below.

Table 3-2 – Water Quality Parameters for the River Don, Goval Burn and Blackdog Burn

Parameter (Units)		**River Don at Fintray Bridge (upstream of AWPR crossing)**	**Goval Burn at B977 Bridge**	**Blackdog Burn (upstream of Tarbothill Landfill)**
Category	2004	A2	B	A2
Temperature (^{0}C)	Aver.	8.4	7.5	7.8
	Max.	20	14	12.5
	Min.	1	2.5	2
BOD (mg/l)	Aver.	1.04	0.70	0.70
	Max.	3.2	1.7	2.4
	Min.	0.3	0.2	0.2
Conductivity (µS/cm)	Aver.	207	277	452
	Max.	298	349	968
	Min.	160	160	329
Total Hardness (mg/l)*	Aver.	64	-	-
	Max.	90	-	-
	Min.	30	-	-
	95%	82	-	-
	5%	46	-	-
Dissolved Oxygen (mg/l)	Aver.	11.5	12.1	11.2
	Max.	14.4	15.0	12.0
	Min.	8.6	10.6	9.0
O_2 Saturation (%)	Aver.	98	101	94
	Max.	121	123	109
	Min.	85	86	83
Total Suspended Solids (TSS) (mg/l)	Aver.	9	5	6
	Max.	36	8	25
	Min.	2	2	2
pH	Aver.	7.6	7.4	7.7
	Max.	8.5	7.9	7.3
	Min.	7.2	7.1	8.1
Ammonia (mg/l)	Aver.	0.102	0.040	0.274
	Max.	0.677	0.101	0.685
	Min.	0.011	0.005	0.007
Nitrite (mg/l)	Aver.	0.033	0.020	0.066
	Max.	0.206	0.034	0.146
	Min.	0.04	0.01	0.018
O-phosphates (mg/l)	Aver.	0.06	0.12	0.03
	Max.	0.13	0.36	0.09
	Min.	0.017	0.052	0.012
Dissolved	Aver.	0.006	-	-

Parameter (Units)		River Don at Fintray Bridge (upstream of AWPR crossing)	Goval Burn at B977 Bridge	Blackdog Burn (upstream of Tarbothill Landfill)
Copper (mg/l)**	Max.	0.068	-	-
	Min.	0.005	-	-
	95%	0.013	-	-
Total Zinc (mg/l)**	Aver.	0.026	-	-
	Max.	0.265	-	-
	Min.	0.0002	-	-
	95%	0.029	-	-

* No hardness data for Goval Burn and Blackdog Burn were provided by SEPA
** No copper and zinc data for Goval Burn and Blackdog Burn were provided by SEPA
Source: Analysis of SEPA chemistry water quality data (SEPA, 1998 - 2004)

3.2 Major Watercourses

River Don

3.2.1 The River Don flows in a northwest to southeast direction, draining water from a number of smaller tributaries into the North Sea. The watercourse is characterised by a series of pools and runs draining a catchment of approximately 1,228 km². The River Don is heavily managed, however water quality has improved in recent years.

3.2.2 The area of interest (Figures 9.1d and 9.1e) in relation to the proposed scheme is between the Hatton Bridge and the Dyce area. A number of tributaries join the River Don within the area of study: Red Burn, Bogenjoss Burn, Goval Burn, and further downstream Green Burn and Kepplehill Burn. Within the area of AWPR, the river flows through some peaty arable and agricultural land, passes the industrial and residential area of Dyce. Further downstream, River Don reaches the north part of the Aberdeen City and finally discharges into the North Sea near Seaton. There are several water abstractions for paper and pulp manufacture located on the River Don. All groundwater abstractions located within the study area and identified to be part of the River Don catchment are described in Chapter 8 (Geology, Contaminated Land and Groundwater).

3.2.3 The quality of the Don is reflected in its capacity to provide a viable habitat for native brown trout, migratory salmon and sea trout. SEPA have classified the River Don upstream of Hayton as Category A2 (good) and downstream at Seaton Park as Category B (fair). The measured levels of dissolved oxygen indicate excellent water quality conditions (oxygen saturation above 80%, SEPA class A1). The ammonia (average 0.102mg/l) and BOD (average 1.04mg/l) are below 0.25mg/l and 2.5mg/l respectively, which are concentrations typical for natural unpolluted rivers (SEPA, 2004). The average orthophosphate concentration for the River Don, 0.06mg/l, is within the Urban Waste Water Treatment Directive (UWWT Directive 91/271/EEC) standard for orthophosphate (0.1mg/l).

3.2.4 The measured copper concentration (5.8μg/l) is within the FWFD (40μg/l) and the DSD (10μg/l) environmental quality standards (at water hardness 50-100mg/l $CaCO_3$). The zinc annual concentration (26μg/l) is within the required DSD annual levels (standard annual average 75μg/l) and below the 95% DSD (300μg/l) and the FWFD (300μg/l) concentrations (Table 2-4).

3.2.5 The River Don provides good habitat conditions and water quality (spot sampling and SEPA water quality data indicate Category A2 (good)) for sustainable fish populations of native brown trout, migratory salmon and sea trout. The River Don watercourse is designated as a Fisheries River under the FWFD, a District Wildlife Site (DWS) as an important Atlantic salmon habitat and the Don estuary is Local Nature Reserve (LNR) and Local Plan District Wildlife Site (LPDW). Therefore the sensitivity of the River Don has been classed as high.

3.3 Minor Watercourses

Kepplehill Burn

3.3.1 Kepplehill Burn rises at the foot of Brimmond Hill, flows through the urban area of Bucksburn before discharging into the River Don. Its upper catchment is part of a Brimmond Hill District Wildlife Site (DWS) and Site of Interest to Natural Science (SINS). As such, it is assumed that the water quality is likely to be good (spot sampling indicated Category A2 (good). The burn has a catchment of approximately 0.3 km^2 to the point of crossing with the AWPR. The proposed scheme (Figure 9.1a) crosses the burn at its upstream section near Newton. This part of the watercourse has already been straightened for agricultural purposes and highly modified therefore Kepplehill Burn has been assigned a low sensitivity.

Gough Burn

3.3.2 Gough Burn is located north of Kingswells residential area (Figure 9.1b). It is a tributary of Green Burn, rising at the foot of Brimmond Hill and draining an area of approximately 1.1 km^2 to the point of crossing with the proposed scheme. The burn forms part of a Gough Burn DWS and SINS. Although it was found to receive side road drainage from a minor road, spot sampling results indicated Category A1 (excellent) water quality, and therefore it has been classed as having a high sensitivity.

Craibstone Burn

3.3.3 Craibstone Burn springs in West Woods, draining an area of approximately 0.5 km^2. It is a small natural tributary of Gough Burn (Figure 9.1b) flowing through predominantly woodland area. It is assumed that the water quality is likely to be excellent (spot sampling indicate Category A1 (excellent)). In the location of the proposed crossing it is not thought to receive road drainage. Consequently the burn is considered to be of high sensitivity.

Green Burn

3.3.4 Green Burn drains westwards through agricultural land to the south of Aberdeen Airport and the urban area of Bankhead, with a catchment area of approximately 2.8 km^2 to the point of crossing with the proposed scheme. From its source near Clinterty Woods, it is joined by the Craibstone and Gough Burns (Figure 9.1b) at a confluence (NJ880105) before finally entering the River Don (at NJ897105). The burn receives high anthropogenic pressure crossing the A96 and collecting the A96 road drainage water. Although spot sampling results indicated excellent (Category A1) water quality, to reflect pressures/activities in the catchment the burn has been assigned a medium sensitivity.

Howemoss Burn

3.3.5 Howemoss Burn is a small artificially straightened watercourse that predominantly acts as an agricultural drainage channel. It drains the Howemoss area forming a catchment of approximately 0.4 km^2 to the point of crossing with the proposed scheme. Although the mainline of the proposed scheme does not cross the burn it would be indirectly affected throughout the construction of the side roads of the proposed scheme (Figure 9.1c). The watercourse will be impacted in its very upper reaches where it is heavily modified and therefore it has been assigned a low sensitivity.

Bogenjoss Burn

3.3.6 The Bogenjoss Burn (Figures 9.1c and 9.1d) confluence with the Diver Don is located approximately 1.8 km west of where the proposed scheme would cross the River Don (NK865153). It drains an area of approximately 1.2 km^2 to the point of crossing with the proposed scheme, flowing from its source in the vicinity of Kirkhill Forest in a northeasterly direction before discharging into the River Don. Bogenjoss Burn is expected to provide valuable habitat as spot sampling results indicate good water quality (Category A2) and habitat diversity. Consequently Bogenjoss Burn has been assigned a high sensitivity.

Goval Burn

3.3.7 Located just north of the River Don (Figure 9.1e) and to the east of the proposed A947 junction, the Goval Burn flows in a south-westerly direction and discharges into the River Don roughly 500m west of the Park Hill Bridge (NK885145). The watercourse begins as Elrick Burn and after the confluence with Meadowhead Burn becomes Goval Burn. Elrick/Goval Burn has several tributaries, which are: Pinkie Burn, Meadowhead Burn, Corsehill Burn and the Mill Lade covering a catchment area of approximately 36.6 km² to the point of crossing of the proposed scheme. The Goval Reservoir is situated northwest of the proposed Goval junction, which was originally built for irrigation purposes (refer to Chapter 13: Cultural Heritage).

3.3.8 Elrick Burn water quality has been categorised by SEPA as A2 (good), whereas at Goval Burn, the nutrients and orthophosphates levels exceed the permitted concentrations and water is of fair (Category B) quality (spot sampling indicates Category A2 (good) water quality). Goval Burn is designated Fisheries River under the FWFD. It provides valuable habitats for atlantic salmon, sea and brown trout and has been assigned a high sensitivity.

Mill Lade

3.3.9 The aqueduct begins from the Goval Reservoir which is fed upstream by the Goval Burn and flows in a southwest direction (Figure 9.1e). The watercourse joins Goval Burn downstream from the Corsehill Burn confluence just after the proposed A947 Goval crossing bridge. The aqueduct was built for irrigation purposes (refer to Chapter 13: Cultural Heritage) and therefore has been assigned a low sensitivity.

Corsehill Burn

3.3.10 The Corsehill Burn is a tributary of Goval Burn and flows in an easterly direction until it discharges into the Goval Burn near Little Goval (Figure 9.1e). It is a relatively small stream with a catchment area of approximately 1.8 km² to the point of crossing of the proposed scheme and good (Category A2) water quality (as indicated by spot sampling results). It is assigned a medium sensitivity.

3.3.11 It is understood through landowner consultation undertaken (Chapter 6: Scoping and Consultation) that a single property septic tank and soakaway is located in close proximity to Corsehill Burn, and this had been taken into consideration within the baseline.

Red Moss Burn

3.3.12 The Red Moss Burn is located about 2 km west of the village of Potterton. The burn rises north-west of Potterton, near Moss-side farm (NJ915159). It is heavily modified and drains the southern part of Red Moss, then into Corby Loch (which is part of the Corby Loch SSSI) with a catchment of approximately 1.3 km^2 to the point of crossing of the proposed scheme (Figure 9.1f). The outflow from Corby Loch (Burn of Munduro) is classified by SEPA (2004) as having good (Category A2) water quality. The spot sampling data indicate fair (Category B) water quality most probably as a result of local agricultural runoff. Red Moss Burn has been assigned a medium sensitivity due to the SSSI status of the receiving waterbody, Corby Loch.

Blackdog Burn and Ditch

3.3.13 Blackdog Burn is located near the village of Potterton, rising in a marshy north area of Red Moss (NJ 905175). Blackdog Ditch is a small tributary of Blackdog Burn. Blackdog Burn has a SEPA river classification of good (Category A2) water quality upstream of the Tarbothill Landfill and fair (Category B) water quality downstream from the tip area. The burn drains a catchment area of 5.4km² to the point of crossing with the proposed scheme collecting agricultural, urban (Potterton) and road drainage (the A90) runoff (Figure 9.1g). In some areas, the natural streambed has been straightened for agricultural purposes. They are assigned a medium sensitivity.

Middlefield Burn

3.3.14 The Middlefield Burn is artificially straightened and acts as an agricultural drainage channel (Figure 9.1g). This burn is a tributary of the Blackdog Burn, draining a catchment area of approximately 0.4 km² to the point of crossing with the proposed scheme. The A90 crosses the burn therefore it is likely to currently receive road runoff. Although SEPA water quality results for 2004 indicate good (Category A2) water quality, to reflect pressures/activities in the catchment the watercourse has been assigned a low sensitivity.

3.4 Summary

3.4.1 The sensitivity of the surface watercourses that would be directly impacted in the Northern Leg of AWPR scheme is presented in the table below. Kepplehill Ditch, Parkhead Burn and Ditch and Walton Ditch have been scoped out of this water quality assessment due to their small size. Craibstone Ditch and all waterbodies are assessed ecologically in Chapter 10. Howemoss Springs are included in the groundwater impact assessment (see Chapter 8).

Table 3-3 – Sensitivity of Surface Water Features for the Northern Leg

Watercourse	SEPA category	Spot sampling category	Sensitivity
Keppelhill Burn	-	A2	Low
Gough Burn	-	A1	High
Craibstone Burn	-	A1	High
Green Burn	-	A1	Medium
Howemoss Burn	-	-	Low
Bogenjoss Burn	-	A2	High
River Don	A2	A2	High
Goval Burn	B	A2	High
Mill Lade	-	A2	Low
Corsehill Burn	-	A2	Medium
Red Moss Burn	-	B	Medium
Blackdog Burn	A2	A2	Medium
Blackdog Ditch	-	-	Medium
Middlefield Burn	A2	-	Low

4 Potential Impacts

4.1.1 For the purposes of this assessment, potential impacts are divided into operational impacts and construction impacts. The operation impacts are considered to be those which are long-term and will influence the watercourses after the scheme is complete. The construction impacts are shorter-term and would directly affect the watercourse during the construction phase.

4.1.2 In order to measure the potential impacts of the proposed scheme, the assessment is initially based on studying the direct effects of the untreated road runoff on the water quality of watercourses without applying any form of treatment or mitigation measures. This assessment therefore presents a worst-case scenario of the potential impact of road runoff with no treatment, spillage reduction or attenuation measures. It is emphasised that this scenario does not represent the final scheme design that is being proposed. The sole purpose is to aid the design process, recommend appropriate mitigation measures and demonstrate the effectiveness of the proposed design.

4.1.3 The potential impacts of the proposed scheme on watercourses (without mitigations) for each of the sections are summarised below. The potential impacts have been subdivided into operational impacts, which include routine runoff (soluble and insoluble pollutant assessment), risk of accidental spillage, as well as impacts on water quality during construction.

4.2 Generic Impacts

4.2.1 The construction of the drainage system allows road runoff to be collected and transported from the impermeable surface area to the receiving watercourse. This way the polluted flow enters the receiving watercourse at specific known point, and can be defined as point source pollutant with irregular flow (polluted flow is discharged only during rainfall and snowmelt events). Wherever point source pollution may occur as a result of direct discharge outfall, these impacts are assessed using the methods set out for routine runoff and accidental spillage.

4.2.2 Diffuse pollution from road operation could also occur via sub-surface paths, where runoff is infiltrated and eventually reaches the groundwater table or is deposited directly into a watercourse near river crossings. Although filter drains are proposed as part of the road drainage design, these are not impermeable and therefore any polluted runoff may still infiltrate into the ground. A wide range of organic and inorganic chemicals may occur as diffuse pollutants. The potential impact from diffuse means is expected to be negligible.

Operational Impacts

4.2.3 During operation of the proposed scheme, pollutants contained in road runoff can include:

- total suspended solids;
- hydrocarbons from diesel, petroleum and lubricating oil leakages;
- hydrocarbons from exhaust emissions;
- heavy metals and trace metals (e.g. copper, zinc, cadmium, chromium, iron);
- tyre wear deposits including lead, zinc and hydrocarbons;
- de-icing agents (e.g. rock salt) during winter months;
- total suspended solids resulting from erosion of watercourse banks at outfall locations;
- chemicals used in windscreen washes such as detergents; and
- herbicides (i.e. if used on roadside verges).

4.2.4 Following the DMRB methodology operational impacts were grouped into three categories: soluble, insoluble and those arising from accidental spillage. Overall, the assessment shows that if mitigation measures are not included, the proposed scheme would not conform to SEPA requirements during the operational phase and would result in an increase in:

- soluble pollution to receiving watercourses;
- insoluble pollutants such as hydrocarbons and total suspended solids; and,
- spillage risk due to new road.

Routine Runoff

Soluble Pollutants

4.2.5 Trace metal road runoff contaminants include copper, zinc, lead, nickel, etc which are extremely toxic to aquatic organisms, particularly when they are in the ionic form. In addition, since metals may be precipitated into sediments near the outfalls, much higher concentrations may be built up than in the water above (Hammerton, 1996).

4.2.6 The behaviour of metals in natural waters is a function of the substrate sediment composition, the suspended sediment composition and the water chemistry. Sediment composed of fine sand and silt will generally have higher levels of adsorbed metals than sediment composed of pebbles (Connell et al., 1984). The water chemistry system controls the rate of adsorption and desorption of metals to and from sediment. Adsorption removes the metal from the water column and stores the metal in the substrate. Desorption returns the metal to the water column, where bioassimilation (the accumulation of a substance within a habitat) and bioaccumulation (the process whereby certain chemicals in the environment accumulate in animal tissues) may take place.

4.2.7 Metals may be desorbed from the sediment into the water column under an increase in salinity, a decrease in redox potential. Redox potential is a measure of the potential of the water for oxidation or reduction, or a decrease in pH. Oxidation is a chemical reaction where molecules or ions lose electrons. Reduction is a chemical process where molecules or ions gain electrons. Decreased redox potential, as is often seen under oxygen deficient conditions, will change the composition of metal complexes and release the metal ions into the overlying water. A lower pH increases the competition between metal and hydrogen ions for binding sites. Decrease in pH may also dissolve metal-carbonate complexes, releasing free metal ions into the water column (Connell et al., 1984).

4.2.8 High metal concentrations can cause death or reproductive failure in fish, shellfish and wildlife. In addition, they can accumulate in animal and fish tissue, be absorbed in sediments, or find their way into drinking water supplies, posing long-term health risks to humans.

4.2.9 Dissolved copper and total zinc concentrations are used as indicators to assess the pollution levels from road runoff (The Highways Agency et al, 1993). These were assessed quantitatively in accordance with the methods set out in the DMRB and detailed in Section 2 (Approach and Methods). The predicted values are then compared to the EQS limits set out by the WFD and the DSD. Detailed calculation sheets for the predicted copper and zinc effects are presented in A9.5, Annex 28.

4.2.10 As stated in DMRB, copper in a soluble form is particularly toxic to aquatic organisms. High concentrations (higher than the EQS standards) of dissolved copper could have acute (short-term and lethal) effects on the water environment while low concentrations (below the EQS values) may pose chronic pollution effects as it is known to bioaccumulate. Copper's toxicity to organisms and its sensitivity to changes in water chemistry, particularly hardness, make it a useful measure for potential impacts on water features. Similarly, measurements of total zinc can be used as an indicator to detect possible chronic (long-term, low level) pollution effects on the aquatic environment as it is known to be less soluble but also bioassimilate (persist and accumulate in the environment). Additionally zinc is strongly correlated with other metals of concern and the effects of some hydrocarbons.

4.2.11 The remaining soluble pollutants (nutrients, de-icing agents, herbicides and pesticides) were assessed qualitatively due to the lack of unified quantitative methods developed.

Insoluble Pollutants

4.2.12 Insoluble pollutants include total suspended solids, vehicle oil and other hydrocarbons and some organic materials such as vegetation debris, grass cuttings, etc. These are described below.

(i) Total Suspended Solids

4.2.13 DMRB notes that a significant proportion of the total pollutant load arising from a road is associated with the solid fraction of the runoff. Insoluble and settleable materials may not cause failure of the water quality standards but could, under some circumstances, cause an unacceptable accumulation of solids on the bed of the receiving watercourse. Several researchers have determined that it is the fine sediment fraction (< 63μm), which is the most important source of pollution (Hamilton & Harrison, 1991).

4.2.14 Fine sediments can adversely affect fish, invertebrates and plants by smothering them. Sediment smothering could lead to die back of water organisms and in turn increased organic loading and its associated impacts, including lowered levels of dissolved oxygen. Suspended solids may also contain contaminants, which can cause pollution of the receiving watercourse. Associated pollutants can include: oils, heavy metals, pesticides, phosphorus, nitrogen, and other organic and inorganic pollutants.

4.2.15 The discharge of untreated road drainage to watercourses could potentially result in dramatic deterioration in water quality and the ecological status of the receiving watercourse. Such a change would not conform to the requirements of the WFD.

(ii) Oils and hydrocarbons

4.2.16 Oils and other hydrocarbons are complex organic compounds made essentially of carbon and hydrogen and classified as either aliphatic or aromatic. Aliphatic compounds represent 70-80% of hydrocarbons found in surface runoff.

4.2.17 Oil contamination can have both physical and chemical impacts. The most well-known physical impacts involve the coating of organisms and the water surface which block respiration, photosynthesis and feeding. Biodegradation of oils in aquatic systems can lead to oxygen depletion. Many mineral oils and hydrocarbons are toxic, persistent and bioaccumulate in the environment.

4.2.18 In road runoff oils and hydrocarbons can bind to sediments and be removed through subtraction of the solid runoff fraction. Direct oil pollution can only occur during accidental spills from vehicle engine leaks.

(iii) Biodegradable organic materials

4.2.19 Non-point sources of biodegradable organic materials include debris and grass cuttings. These materials contain high levels of nutrients (carbon, nitrogen, phosphorus and sulphur) and organic matter. They undergo fairly rapid microbiological degradation, consuming oxygen present within the water (measured as BOD), leading to oxygen sags.

4.2.20 The rapid oxygen sag that occurs as biodegradable material is broken down within a water body can lead to fish and invertebrate fatalities. In the short term, the material may smother the river bed, also leading to the death of benthic species.

Accidental Spillage

4.2.21 The high traffic volume could potentially lead to increased occurrence of accidents and possible acute spillage of pollutants, either from the vehicles' engines or lorries' cargo. The assessment was conducted using DMRB method which is described in detail in Section 2 Methodology. Detailed calculation sheets for the accidental spillage risk are presented in Appendix A9.5, Annex 28.

<u>Culverts and Realignments</u>

4.2.22 Construction of the Northern Leg of the proposed scheme would involve 28 watercourse crossings. Culverting and realignment could potentially change the riverbed morphological diversity and the sediment regime of the watercourses which may have an associated impact upon water quality. The number and length of culverts may impact upon water quality due to lack of light and rapid microbiological degradation of biodegradable material leading to oxygen sags.

Changes to Discharge Regime

4.2.23 The proposed construction works would alter the slope of the surrounding land and slightly increase the local amount of impermeable surface through the construction of the road pavement. This has the potential to increase the total discharge via runoff to the watercourses (see detailed assessment in Appendix A9.1 Surface Water Hydrology).

4.2.24 Changes to discharge regimes can result in substantial changes to water quality. Substantial reduction in discharge levels can severely affect dilution leading to increased concentrations of inorganic and organic pollutants, and consequently to a decrease in dissolved oxygen. Similarly, increased discharge can lead to re-suspension of sediments and trapped contaminants resulting in high turbidity and possible secondary pollution. Increased discharge can also trigger riverbank erosion and affect the geomorphology of the riverbed. Any impacts upon the aquatic ecology are detailed in Chapter 10.

Construction Impacts

4.2.25 Table 4-1 illustrates the potential sources and effects of construction activities on water quality. Construction impacts are likely to be short-term and may have minimal effect on the water quality of a watercourse. However impacts may have a longer term indirect effect on the river ecology.

Table 4-1 – Potential Sources of Impact and Effects on Water Resources from Construction Activities

Source of Impact	Potential Effects
Total Suspended Solids Suspended solids can result from excavations, blasting, runoff from stockpiles, plant and wheel washing, runoff from site roads, runoff during embankment construction, earthworks and landscaping. The risk of release of suspended solids into watercourses or drainage ditches is greatest where the proposed scheme crosses features such as watercourses.	Sediments can cause damage to fish, aquatic invertebrates and plants through deposition resulting in a smothering effect or by interference with feeding and respiratory apparatus. Suspended solids may also contain contaminants, which can cause pollution of the receiving watercourse.
Oils, Fuels and Chemicals Spillage from storage tanks or leakage from mobile or stationary plant.	Oils form a film on the water surface resulting in an adverse effect on water quality. These oils can interfere with the gills of fish and cause loss of buoyancy to water birds as well as toxicity to other organisms. The oils/chemicals may also enter groundwater, reducing the potential for local groundwater utilization and affecting ecological habitats supported by groundwater.
Concrete, Cement and Admixtures Accidental release into watercourses of the materials or from the washings of plant and machinery.	Concrete/cement is highly alkaline and must not be allowed to enter any drain or watercourse or groundwater. Potential for adverse effects on aquatic organisms if pH elevated to / maintained above 8.5.
Watercourse / Drain Crossings and Diversions, Realignment of Watercourses Construction of structures such as culverts is a potential source of pollution and construction debris can block land drains.	Blockage of land drains could result in water-logging of soils. Poorly designed culverts may cause flooding problems upstream. Diversions could cause long term impacts on the watercourse.
Sewerage Accidental / uncontrolled release of sewage from sewers through damage to pipelines during service diversion and uncontrolled release of sewage effluent from workers on site.	Pollution to watercourses / groundwater (refer to Chapter 8).
Contaminated Land and Sediment If not managed properly, disturbance of contaminated materials could lead to pollution of ground and surface waters.	Dependent on types and concentrations of contaminants. Potential loss of aquatic fauna and flora. Derogation of groundwater quality reducing its resource potential and potentially affecting groundwater-supported habitats (refer to Chapter 8).

4.2.26 The construction impact assessment on watercourses was carried out qualitatively. Pollution during the construction phase may be caused by accidental spillage of concrete, cement, oil, chemicals, sewage, excavation or through diffuse runoff. Small burns with limited flows and salmonid rivers were considered to be more sensitive to accidental and diffuse pollution. The scope of the proposed work for each watercourse (i.e. the number of the required culverts and the length of the realignments) was also taken into consideration when conducting the impact assessment. The fine sediment release during the construction phase, and the impacts of culverting and realignment are addressed in detail in Appendix A9.3 (Fluvial Geomorphology) and summarised below. While hydrology and flood risk are touched upon in this section, the impacts are presented in detail in a separate report.

4.3 Specific Impacts

4.3.1 Table 4-4 sets out the proposed modifications and their impacts on the watercourses situated in the Northern Leg study area.

Operational Impacts

4.3.2 There are 10 proposed drainage runs (I to R) within the Northern Leg study area. The designed road drainage outfalls of the proposed scheme are shown on Figures 9.5a to 9.5g. The road drainage from new A96 roundabout would be connected to the existing A96 drainage system.

4.3.3 All ditches and all the following watercourses included in this water quality impact assessment would not be crossed by the proposed scheme (see Table 4-4):

- Kepplehill Ditch;
- Parkhead Burn and Ditch;
- Craibstone Ditch;
- Walton Field Ditch; and
- Howemoss Burn.

4.3.4 Although the proposed scheme would not cross Howemoss Burn, the catchment would still be impacted and this is therefore considered in the impact assessment. Further information regarding catchment impacts is provided in Appendix A9.1 (Surface Water Hydrology).

4.3.5 Kepplehill Burn, Gough Burn, Craibstone Burn and Blackdog Ditch have not been assessed using the DMRB methods, as the design is such that they would not receive any direct road drainage. Pollution impacts may occur through diffuse means and are considered to be of Negligible impact significance through qualitative assessment.

4.3.6 Kepplehill Ditch, Parkhead Burn and Ditch, Craibstone Ditch and Walton Ditch would be taken into pre-earthworks. These are heavily modified watercourses that act as field drains and would be impacted in the very upper reaches of their catchments. These have been identified of being of low sensitivity therefore not included in the detailed impact assessment on water quality.

4.3.7 The existing Mill Lade would be replaced with a new aqueduct and elevated over the proposed scheme. During the operation of the proposed scheme, no road runoff pollution would be expected to enter this watercourse.

Routine Runoff

4.3.8 Due to the limited data available for the watercourses, a number of assumptions have been made in order to quantify the potential impacts based on the DMRB methodology. Details of the calculations are given in the A9.5, Annex 29 and summarised in Table 4-2.

Table 4-2 – Estimated Impact of Total Zinc and Dissolved Copper in Road Runoff (Without Mitigation)

Site	Sensitivity	Parameter	EQS Annual Average (μg/l)	Inferred upstream conc. (μg/l)	Estimated downstream conc. (μg/l)	% increase over baseline levels	Potential Impact	
							Magnitude	Significance
Kepplehill Burn and field ditch	Low	Diffuse	n/a	n/a	n/a	n/a	Negligible	Negligible
Gough Burn	High	Diffuse	n/a	n/a	n/a	n/a	Negligible	Slight/ Negligible
Craibstone Burn	High	Diffuse	n/a	n/a	n/a	n/a	Negligible	Slight/ Negligible
Green Burn	Medium	Copper	10	5	65*	1198	High	Moderate/ Substantial
		Zinc	75	38	286*	662	High	Moderate/ Substantial
Howemoss Burn	Low	Diffuse	n/a	n/a	n/a	n/a	Negligible	Negligible
Bogenjoss Burn	High	Copper	10	5	10*	106	High	Substantial
		Zinc	75	38	64	70	Medium	Moderate/ Substantial
River Don	High	Copper	10	6	6	0	Negligible	Slight/ Negligible
		Zinc	75	26	26	0	Negligible	Slight/ Negligible
Mill Lade	Low	Diffuse	n/a	n/a	n/a	n/a	Negligible	Negligible
Goval Burn	High	Copper	10	5	5	8	Negligible	Slight/ Negligible
		Zinc	75	38	39	5	Negligible	Slight/ Negligible
Corsehill Burn	Medium	Copper	10	5	14*	180	High	Moderate/ Substantial
		Zinc	75	38	82*	119	High	Moderate/ Substantial
Red Moss Burn	Medium	Copper	10	5	13*	166	High	Moderate/ Substantial
		Zinc	75	38	79*	110	High	Moderate/ Substantial
Blackdog Burn	Medium	Copper	10	5	11*	128	High	Moderate/ Substantial
		Zinc	75	38	69	84	Medium	Moderate
Blackdog Ditch	Medium	Diffuse	n/a	n/a	n/a	n/a	Negligible	Negligible
Middlefield Burn	Low	Copper	10	5	8	63	Medium	Slight
		Zinc	75	38	48	27	Low	Negligible

* Exceeds Annual Average EQS

4.3.9 During routine operation of the road without mitigation, the resultant concentrations of dissolved copper and total zinc in Green Burn, Corsehill Burn and Red Moss Burn exceed the annual average EQS (Table 2-4) and the impact of road drainage is considered to be of high magnitude.

This would result in an impact of Moderate/Substantial significance for Green Burn, Corsehill and Red Moss Burn (medium sensitivity).

4.3.10 The resultant concentrations of dissolved copper and total zinc in the River Don and Goval Burn are within the annual average EQS for copper (10µg/l) and zinc (75µg/l) due to greater dilution capacity of the watercourses (Table 2-4). Consequently the impact on road drainage is considered to be of negligible magnitude for the River Don and Goval Burn, which due to their high sensitivity results in an impact of Slight/Negligible significance.

4.3.11 For Bogenjoss Burn the resultant concentrations of dissolved copper exceed the annual average EQS value but total zinc concentrations are within the annual average EQS for zinc (Table 2-4). Consequently, the impact on water quality is considered to be of high magnitude for copper and medium magnitude for zinc. Due to the high sensitivity of Bogenjoss Burn, this would result in an impact of Moderate/Substantial significance for zinc and Substantial significance for copper. Blackdog Burn would have an impact significance of Moderate/Substantial for copper and Moderate for zinc. For Middlefield Burn, the impact significance on copper would be Slight and Negligible for zinc.

4.3.12 Kepplehill Burn, Gough Burn, Craibstone Burn, Howemoss Burn, Mill Lade and Blackdog Ditch would be impacted only through diffuse runoff which would have impacts on the water quality of negligible magnitude, and therefore of Negligible to Slight/Negligible significance.

Suspended Solids

4.3.13 Given the range of sensitivities of the watercourses, the suspended solids impact is considered to be of Moderate significance for Green, Corsehill, Goval, Red Moss, Blackdog and Middlefield Burns, and Moderate/Substantial significance for Bogenjoss Burn (see Table 4-4). For the River Don the impact would be of Slight/Negligible significance (see Table 4-4). Due to further geomorphological assessment conducted for the River Don (Appendix A9.3: Fluvial Geomorphology), the suspended solids impact was considered to be of high magnitude resulting in Substantial significance.

Risk of Accidental Spillage

4.3.14 The assessment indicates that the risk of accidental spillage for Green Burn is below the threshold of acceptability and the impact magnitude is high. This results in Moderate/Substantial impact significance. The level of risk for all other watercourses in the Northern Leg is considered to be of Slight/Negligible to Moderate significance.

4.3.15 Table 4-3 presents a summary of the spillage risk assessment (without mitigation) for the proposed scheme (detailed calculations provided in A9.5; Annex 28).

Table 4-3 – Summary of Spillage Risk Assessment (Without Mitigation)

Watercourse	Sensitivity	Threshold of Acceptability	Spillage Risk in design year – Without Mitigation	Within Acceptable Limits	Potential Impact	
					Magnitude	Significance
Green Burn	Medium	1:100	1:64	No	High	Moderate/Substantial
Bogenjoss Burn	High	1:100	1:1075	Yes	Negligible	Slight/Negligible
River Don	High	1:100	1:479	Yes	Low	Moderate
Goval Burn	High	1:100	1:659	Yes	Low	Moderate
Corsehill Burn	Medium	1:100	1:592	Yes	Low	Slight
Red Moss Burn	Medium	1:100	1:765	Yes	Low	Slight
Blackdog Burn	Medium	1:100	1:104	Yes	Medium	Moderate
Middlefield Burn	Low	1:100	1:378	Yes	Low	Negligible

Construction Impacts

4.3.16 Green, Bogenjoss, Corsehill and Middlefield Burns would undergo a high magnitude of potential impact due to the construction of 3 culverts at Green Burn, Corsehill Burn and Middlefield Burn and extensive realignments and 6 culverts construction on Bogenjoss Burn (see Table 4-4). This could result in Moderate significance impacts for Middlefield Burn, Moderate/Substantial for Green Burn and Corsehill Burn and Substantial for Bogenjoss Burn.

4.3.17 The assessment indicates potential impacts of Substantial significance on the River Don during the construction of the road bridge. Bridging would involve earthworks, possibly resulting in high sediment release, concrete or cement spillage into the watercourse. Goval Burn would be also bridged but due to the limited earthworks (relatively smaller size of the burn) the resulting potential impact is assessed as of Moderate significance. Potential impacts of Slight significance could also arise from concrete or cement spillage when constructing the Mill Lade crossings (A947 bridge crossing and an aqueduct over AWPR mainline).

4.3.18 During the realignment and construction of the culverts, Gough, Craibstone and Bogenjoss Burns and River Don could experience potential impacts of Substantial significance. However, for Green, Corsehill Burns and Blackdog Ditch the impact may be of Moderate/Substantial significance. For the Kepplehill, Howemoss, Goval, Red Moss, Blackdog and Middlefield Burns culverts construction activities could pose adverse impact of Moderate significance (see Table 4-4).

Summary

4.3.19 The potential impacts to receiving watercourses in the Northern Leg of the proposed scheme are summarised in Table 4-4.

Table 4-4 – Impact Assessment of Key Watercourses

Watercourse	Sensitivity	Crossing	Realignment	Road Outfall	Impact Description	Impact Magnitude	Impact Significance
Kepplehill Burn	Low	1 No. culvert ch315200	Realignment associated with culvert construction.	No road drainage discharge to burn	Construction: High impact from the potential risk of accidental spillage of pollutants during construction. Culverting of existing straightened channel would involve some earthworks, possibly resulting in sediment and pollutants release leading to short-term increased turbidity.	High	Moderate
					General Operation: Change in water quality is likely to be negligible due to diffuse pollution. Length of culvert likely to slightly impact upon water quality due to lack of light. Routine Runoff: no outfall planned. Accidental Spillage: no outfall planned. Suspended Solids: no outfall planned.	Negligible	Negligible
Gough Burn	High	2 No. culvert over mainline ch316390 ch 316430	Realignment associated with culvert construction	No road drainage discharge to burn	Construction: High impact from the potential risk of accidental spillage of pollutants during construction due to proximity of works to watercourse. Culverting would involve some earthworks, possibly resulting in sediment and pollutants release and short-medium term increased turbidity in the water column.	High	Substantial
					General Operation: Change in water quality is likely to be negligible due to diffuse pollution. Length of culvert likely to slightly impact upon water quality due to lack of light. Routine Runoff: no outfall planned. Accidental Spillage: no outfall planned. Suspended Solids: no outfall planned.	Negligible	Slight / Negligible
Craibstone Burn	High	1 No. culvert over mainline ch316990	Realignment associated with culvert construction	No road drainage discharge to burn	Construction: High impact from the potential risk of accidental spillage of pollutants during construction due to proximity of works to watercourse. Culverting would involve some earthworks, possibly resulting in sediment and pollutants release and short-medium term increased turbidity in the water column.	High	Substantial
					General Operation: Change in water quality is likely to be negligible due to diffuse pollution. Length of culvert likely to slightly impact upon water quality due to lack of light. Routine Runoff: no outfall planned. Accidental Spillage: no outfall planned. Suspended Solids: no outfall planned.	Negligible	Slight / Negligible
Green Burn	Medium	3 No. culverts ch317330 A96 Dyce Drive	Major realignment resulting in lengthening of burn	2 Proposed outfalls. Total of 12.6Ha draining to A96 Link Road and	Construction: Extensive culverting and realignment would involve major earthworks, possibly resulting in increased suspended solid loads in the short-term. Possible high impact from the potential risk of accidental spillage of pollutants during construction due to proximity of works to watercourse.	High	Moderate/ Substantial

Watercourse	Sensitivity	Crossing	Realignment	Road Outfall	Impact Description	Impact Magnitude	Impact Significance
		Link		ch317470	General Operation: A major shift from baseline conditions due to discharge of road runoff. Long-term adverse impact on water quality and ecology. Routine Runoff: High impact from routine runoff due increase of over 100% over baseline for copper (1198%) and zinc (662%) resulting of failure of EQS. Accidental Spillage: High impact from accidental spillage (1:64) as spillage risk is below the probability threshold of 1 in 100 years. Suspended solids: Q_{mean} for Green Burn is 0.037m^3/s which indicates a medium dilution capacity, therefore suspended solids would pose a medium impact magnitude.	High	Moderate/ Substantial
Bogenjoss Burn	High	6 No. culverts: (offline side roads) ch320100 ch320215 ch320260 ch320475 ch320500 (main line) ch320870	Major realignment resulting in substantial straightening of the channel and shortening of burn	1 Proposed outfall. Total of 1.8Ha draining to ch320710.	Construction: High impact from the construction of 6 culverts. This may increase the risk of pollution from concreting and fuel and oil spills due to amount of construction activity near watercourse. Extensive realignment and culverting in the upstream reach would involve extensive earthworks and could result in the release of sediment, temporarily increasing the suspended sediment load.	High	Substantial
					General Operation: A major shift from baseline conditions due to discharge of road runoff. Length of culverts likely to impact upon water quality due to lack of light. Temporary to long-term adverse impact on water quality and ecology. Routine Runoff: High impact from routine runoff due increase of over 106% over baseline for copper and medium impact regarding zinc concentrations – 70% increase over baseline. Accidental Spillage: Negligible impact from accidental spillage as spillage risk is above the probability threshold of 1 in 1000 years (1:1075 years). Suspended solids: Q_{mean} for Bogenjoss Burn is 0.021 m^3/s which indicates a medium dilution capacity, therefore suspended solids would pose a medium impact magnitude.	High	Substantial
River Don	High	Bridge spanning River and floodplain	No realignment planned	1 Proposed outfall. Total of 4.1Ha draining to ch322500, ch322650 and	Construction: Bridging would involve up to 36 months major earthworks, possibly resulting in high sediment and pollutants release leading to increase in turbidity and water quality deterioration. High potential impact of cement, concrete and oils spills during construction due to proximity and duration of construction activities.	High	Substantial

Watercourse	Sensitivity	Crossing	Realignment	Road Outfall	Impact Description	Impact Magnitude	Impact Significance
				ch322930 and collected into a ditch.	General Operation: A slight shift from baseline conditions due to discharge of road runoff. Temporary to long-term adverse impact on water quality and ecology. River Don is designated fisheries river therefore medium impact. Routine Runoff: Negligible impact from routine runoff due to great dilution capacity of the watercourse (0% increase over the copper and zinc baseline concentrations). Accidental Spillage: Low impact from accidental spillage as spillage risk is above the probability threshold of 1 in 200 years and below 1 in 1000 years (1:479 years). Suspended solids: Q_{mean} for River Don is 19.5 m^3/s which indicates a high dilution capacity; therefore suspended solids would pose a negligible impact magnitude.	Low	Moderate
Goval Burn	High	3 No. Bridges Three bridges across burn: on the mainline, the B977 and the A947	No realignment is proposed	1 Proposed outfall. Total of 3.5Ha draining to ch323900.	Construction: Low potential for spillage of pollutants due to proximity, duration and amount of works proposed. Bridging at three locations would involve limited earthworks, possibly resulting in sediment and pollutants release leading to short-term increased turbidity in the water column. High dilution capacity of the watercourse.	Low	Moderate
					General Operation: A slight shift from baseline conditions due to discharge of road runoff. Temporary to long-term adverse impact on water quality and ecology. Routine Runoff: Negligible impact from routine runoff due increase of 8% over baseline for copper and 5% for zinc. Accidental Spillage: Low impact from accidental spillage as spillage risk is above the probability threshold of 1 in 200 years and below 1 in 1000 years (1:659 years). Suspended solids: Q_{mean} for Goval Burn is 0.6 m^3/s which indicates a high dilution capacity, therefore suspended solids would pose a low impact magnitude.	Low	Moderate
Mill Lade	Low	1 No. Bridge on A947 Aqueduct	No realignment is proposed	No outfall planned	Construction: Construction activities close to watercourse may result in medium impact due to accidental spillage of concrete, oils etc. Bridging would involve limited earthworks, possibly resulting in sediment and pollutants release leading to short term increase turbidity in the water column.	Medium	Slight
					Operation: n/a	N/A	N/A
Corsehill Burn	Medium	3 No Culverts ch325085 Link 1	Major realignment resulting in substantial	1 Proposed outfall. Total of 3.9Ha	Construction: High potential impact to water quality as a result of accidental spillage of pollutants from construction activities. Culverting and realignment would involve major earthworks, possibly resulting in high sediment and pollutants release within the water column.	High	Moderate/ Substantial

Watercourse	Sensitivity	Crossing	Realignment	Road Outfall	Impact Description	Impact Magnitude	Impact Significance
		Link 2	straightening of the channel and lengthening of burn.	draining to Goval Roundabout South.	General Operation: A major shift from baseline conditions due to discharge of road runoff. Long-term adverse impact on water quality and ecology. Routine Runoff: High impact from routine runoff due increase of 180% over baseline for copper and 119% for zinc resulting in failure of EQS. Accidental Spillage: Low impact from accidental spillage as spillage risk is above the probability threshold of 1 in 200 years and below 1 in 1000 years (1:592 years). Suspended solids: Q_{mean} for Corsehill Burn is 0.026 m^3/s which indicates a medium dilution capacity, therefore suspended solids would pose a moderate impact magnitude.	High	Moderate/ Substantial
Red Moss Burn	Medium	1 No. Culvert ch327500	Realignment associated with culvert construction	1 Proposed outfall. Total of 2.3Ha draining to ch327240.	Construction: Proximity of construction works to watercourse poses a medium increase to the risk of pollution from accidental spillage i.e. concrete, oil etc. However, the works would only involve the construction of one culvert. Possible leakage from contaminated land (see Chapter 8 Geology, Contaminated Land and Groundwater, Table 8.7, Quarry – Leuchlands and Joss). Culverting and realignment would involve earthworks, possibly resulting in sediment and pollutants release and increased turbidity. Medium dilution capacity of the watercourse.	Medium	Moderate
					General Operation: A major shift from baseline conditions due to discharge of road runoff. Long-term adverse impact on water quality and ecology. Routine Runoff: High impact from routine runoff due increase of 166% over baseline for copper and 110% for zinc resulting in failure of EQS. Accidental Spillage: Low impact from accidental spillage as spillage risk is above the probability threshold of 1 in 200 years and below 1 in 1000 years (1:765 years). Suspended solids: Q_{mean} for Red Moss Burn is 0.017 m^3/s which indicates a medium dilution capacity, therefore suspended solids would pose a moderate impact magnitude.	High	Moderate/ Substantial
Blackdog Burn	Medium	2 No. Culverts Ch.329950 A90 North	Realignments associated with culvert construction	2 Proposed outfalls. Total of 8Ha draining to ch329940; mainline ch330820 and A90 slip road collected into a ditch.	Construction: Proximity of construction works to watercourse poses a medium increase to the risk of pollution from accidental spillage i.e. concrete, oil etc. as the works would involve the construction of two culverts and realignments would involve major earthworks, possibly resulting in sediment release and short-medium term changes to turbidity in the water column. High dilution capacity of the watercourse.	Medium	Moderate
					General Operation: A major shift from baseline conditions due to discharge of road runoff. Temporary to long-term adverse impact on water quality and ecology.	High	Moderate/Substanti al

Watercourse	Sensitivity	Crossing	Realignment	Road Outfall	Impact Description	Impact Magnitude	Impact Significance
Blackdog Burn [cont'd]	see above	see above	see above	see above	Routine Runoff: High impact from routine runoff due increase of 128% over baseline for copper and medium impact of 84% over baseline concentration for zinc. Accidental Spillage: Medium impact from accidental spillage as spillage risk is above the probability threshold of 1 in 100 years and below 1 in 200 years (1:104). Suspended solids: Q_{mean} for Blackdog Burn is 0.079 m^3/s which indicates a high dilution capacity, therefore suspended solids would pose a medium impact magnitude.		
Blackdog Ditch	Medium	1 No. Culvert ch330065	Realignment associated with culvert construction	No outfall planned	Construction: High impact from the potential risk of accidental spillage of pollutants during construction due to proximity of works to watercourse. Culverting would involve some earthworks, possibly resulting in sediment and pollutants release and short-medium term increased turbidity in the water column.	High	Moderate/ Substantial
					General Operation: Change in water quality is likely to be negligible due to diffuse pollution. Length of culvert likely to slightly impact upon water quality due to lack of light. Routine Runoff: no outfall planned. Accidental Spillage: no outfall planned. Suspended Solids: no outfall planned.	Negligible	Negligible
Middlefield Burn	Low	3 No. Culverts A90 widening Side road 1 Side road 2	Major realignment resulting in shortening of burn	1 Proposed outfall. Total of 0.3 Ha draining to access track east and access track west	Construction: Proximity of construction works to watercourse poses a high increase to the risk of pollution from accidental spillage i.e. concrete oil etc. as the works would involve the construction of three culverts. Culverting and realignment would involve major earthworks, possibly resulting in sediment release and short-medium term increase in turbidity. Low dilution capacity of the watercourse.	High	Moderate
					General Operation: A Medium shift from baseline conditions due to discharge of road runoff. Long-term adverse impact on water quality and ecology. Routine Runoff: Medium impact from routine runoff due increase of 63% over baseline for copper and 27% for zinc resulting in failure of EQS. Accidental Spillage: Low impact from accidental spillage as spillage risk is above the probability of 1 in 200 years and below 1 in 1000 years (1:378). Suspended solids: Q_{mean} for Middlefield Burn is 0.005 m^3/s which indicates a low dilution capacity, therefore suspended solids would pose a medium impact magnitude.	Medium	Slight

5 Mitigation

5.1 Introduction and Guiding Principles

5.1.1 The objective of the mitigation measures outlined in this section of the report is to convey surface water runoff from the road surface to receiving watercourses without detrimental effect on water quality, associated ecosystems and the underlying groundwater.

5.1.2 As set out in the EIA (Scotland) Regulations 1999, mitigation measures are intended 'to prevent, reduce or where possible, offset any significant adverse impacts on the existing drinking and bathing water quality, ecology and nature and conservation value of the surrounding area'.

5.1.3 The WFD has been taken into account in the formulation of mitigation strategies. The requirements of FWFD and DSD have been taken into consideration when choosing the appropriate level of road runoff treatment. Implementation of mitigation measures for all watercourses aims to gain and preserve 'good' water quality and ecological status of any watercourse.

5.1.4 Mitigation measures to prevent adverse impacts typically comprise solutions aimed at the source of the impact. The risk of causing deterioration in water quality can be reduced by 'designing out' any risk. This includes the choice of route location and road alignment to avoid impacts, for example the avoidance of important/sensitive water features where possible. This was taken into consideration throughout the design process for the proposed scheme.

5.1.5 Where potential adverse impacts cannot be prevented, i.e. where there is a need for road runoff to be discharged to local watercourses and drainage ditches, mitigation measures of carefully designed treatment trains will be implemented to reduce the risk. The mitigation measures are described below. Where the scheme intercepts existing field drainage that drains agricultural land, these ditches will be incorporated into the road drainage design and will discharge into the proposed Sustainable Urban Drainage Systems (SUDS).

5.1.6 In addition, SEPA and SNH have been consulted at key design stages to seek guidance on appropriate levels of road drainage, culverting and watercourse realignment.

5.2 Generic Mitigation

Operational Mitigation

5.2.1 Without mitigation in place, operation of the proposed scheme could potentially impact adjacent watercourses through direct discharge of polluted surface runoff from traffic and accidental spills via road drainage outfalls (point source organic and inorganic pollution). The drainage system of the proposed scheme has been designed in accordance with the principles contained in 'Sustainable Urban Drainage Systems: Design Manual for Scotland and Northern Ireland' (Construction Industry Research and Information Association; CIRIA, 2000) and 'Sustainable Urban Drainage Systems: hydraulic, structural and water quality advice' (CIRIA, 2004).

5.2.2 Water quality mitigation measures have been developing continually throughout the design process. In particular major design components such as road drainage, locations of bridges, culverts and watercourse realignment details have been developed through an interactive process involving structural engineers, geomorphologists, ecologists and water quality specialists.

<u>Road Drainage</u>

5.2.3 SUDS techniques that would be implemented to reduce potential impacts during normal road operation (Figures 9.4a to 9.4g) are summarised in Table 5-1 and detailed below. For each outfall a treatment train is proposed which would comprise a series of mitigation measures. For example, this could involve a combination of both wet and dry detention basins and treatment ponds (up to three in series) to maximise pollutant removal efficiency. These drainage design proposals will be presented to SEPA for approval during the CAR licensing process before being finalised.

Table 5-1 – Summary of Mitigation Measures to Address Potential Impacts on Water Quality/Flooding/Groundwater

Type of Measure	Description
Prevent	Consideration of route location and road alignment to avoid impact to sensitive areas.
Reduce	SUDS to be provided to filter out pollutants and reduce the level of pollution from operational runoff entering watercourses. Filter drains and catch-pits must be constructed, where feasible, along the entire length of the proposed scheme. Detention basins and treatment ponds must be provided at appropriate outfalls prior to the discharge of road drainage into the receiving watercourse. This will attenuate peak flows from runoff to pre-development levels and will provide a suitable level of treatment of the road drainage prior to discharge. Regular maintenance of these treatment structures and the filter trains must be undertaken to ensure ongoing mitigation efficiency. Regular maintenance of treatment ponds to ensure efficient operation and the settlement of solids and removal of pollutants (such as hydrocarbons). If herbicides are used, those recommended by SEPA for use near watercourses to be applied in line with manufacturer's instructions to reduce pollution of watercourses. Provision of scour protection at the drainage discharge outfall to protect the banks and bed of the receiving ditch and to limit erosion. Mitigation measures associated with contaminated groundwater are presented in Chapter 8 (Geology, Contaminated Land and Groundwater).

Filter Drains and Catchpits

5.2.4 Filter drains usually consist of a perforated pipe laid in a trench along the road verge and backfilled with gravel. Filter drains can be used to convey highway drainage to the discharge point and also filter out pollutants such as total suspended solids, hydrocarbons, iron. According to the DMRB (The Highways Agency et al*.* 1993) for combined filter drain, copper removal efficiency is 10-30% and zinc removal efficiency is 70-80%. For the purposes of this assessment, the removal efficiencies assumed are 20% for dissolved copper and 75% for total zinc. Where necessary, piped carrier drains may be required to transfer surface water beneath the main carriageway and from the filter drains to designated outfall points.

5.2.5 Where the proposed scheme would be situated in a cutting, there is a greater risk of groundwater contamination. Where this is the case, the filter drain will be designed with an impermeable liner to minimise risk of pollution to groundwater, as described in Chapter 8 (Geology, Contaminated Land and Groundwater).

5.2.6 All filter drains will be designed in accordance with DMRB guidance taking cognisance of guidance contained in the CIRIA SUDS Design Manual C697 (CIRIA, 2007); and C521 (CIRIA, 2000), CIRIA C609 (2004) and CIRIA C648 (2006).

5.2.7 Catchpits consist of a small chamber with a sediment collection sump. These are designed to trap sediments and other debris and retain a proportion of the suspended solids present in the runoff and settle out hydrocarbons and metals. Catchpits will be located at regular spacings (at intervals of no less than 90m) along filter drains and at the junctions of carrier drains.

Detention Basins/Treatment Ponds

5.2.8 Detention basins and treatment ponds will be constructed to discharge to each outfall. These end-of-line treatment systems provide biological treatment and removal of dissolved contaminants and nutrients. Detention basins are principally used to attenuate flows, while treatment ponds are required to treat the more polluted first flush component of road runoff. Further information on this can be found in Appendix A9.1 (Surface Water Hydrology).

5.2.9 A large proportion of pollutants in operational runoff is associated with sediment and therefore it is likely that the majority will accumulate in the filter drains and catchpits. Treatment ponds and detention basin systems provide both biological treatment and the removal, by settlement, of dissolved contaminants and nutrients.

5.2.10 Treatment ponds are reported to remove 50-80% of total zinc and dissolved copper from road drainage (CIRIA, 2004). For the purpose of this assessment, it is assumed that the efficiency removal is 65% for both total zinc and dissolved copper. The provision of detention basins in the treatment train will provide attenuation of peak flows, thereby reducing the risk of flooding in the receiving watercourse and promoting the deposition and removal of suspended solids.

5.2.11 In general, all treatment systems are designed to attenuate flows for between 39 and 192 hours (design dependent) and to release water back into the receiving watercourse at pre-development rates. Treatment times are recommended for between 24-48 hours depending on the number of ponds and level of treatment required. Pollution removal rates decrease in efficiency as detention time in ponds increases, and studies have shown that a detention time beyond 24 hours does not result in a significant improvement in quality (CIRIA, 2004).

5.2.12 The required storage volume to treat road drainage (the treatment volume) is calculated based on the guidance contained in the CIRIA SUDS Design Manual (CIRIA, 2000) and the design guidance given in Treatment of Highway Run-off Using Constructed Wetlands (Environment Agency, 1998). CIRIA guidance states that ponds should be designed with a storage volume equal to the volume generated by a mean annual flood (Vt) or in exceptional circumstances, 4Vt (four times the volume generated by a mean annual flood). In agreement, SEPA recommends that ponds draining particularly sensitive catchments be designed for storage volume 4Vt. Best design practice for pollutant removal, as detailed in CIRIA C609 (2004) and CIRIA C697 (2007), should be adhered to.

5.2.13 In accordance with DMRB, spillage risk removal efficiencies were assumed to be 65% reduction for both total zinc and dissolved copper, irrespective of the treatment method.

Swales

5.2.14 Swales are vegetated surface features that drain water evenly off impermeable areas. The swale channel is broad and shallow and covered by grass or other suitable vegetation to slow down flows and trap pollutants (CIRIA, 2004). Swales can also be designed for a combination of conveyance, infiltration, detention and treatment of runoff (CIRIA, 2004). They are typically located next to highways but can also be constructed in landscaped areas within car parks and elsewhere.

5.2.15 Swales are generally effective at removing pollutants through filtration and sedimentation for frequent small storm events (CIRIA, 2004). For larger, less frequent storms of between a 50% and 10% annual probability (1 in 2 and 1 in 10 year return period), they can act as a storage and conveyance mechanism. For larger storms with an annual probability of less than 10%(return periods greater than 1 in 10 years), providing storage in swales may become impractical as catchment size increases and they are often used in conjunction with other techniques. They are reported to remove 70-90% total zinc and 50-70% dissolved copper from the road drainage (DMRB, 1998). For the purpose of this assessment, the removal efficiencies are assumed to be 70% for total zinc and 50% for dissolved copper (DMRB, 1998).

5.2.16 Swales are often integrated into the surrounding land use, for example public open space or road verges. Local wild grass and flower species can be introduced for visual interest and to provide a wildlife habitat. Care should be taken in the choice of vegetation as tussocks create local eddies, increasing the potential for erosion on slopes. Shrubs and trees can be planted but in this case the vegetated area will need to be wider and have a gentler slope (CIRIA, 2004).

Maintenance of Road Drainage Network

5.2.17 To avoid failure or sub-optimal operation of the road drainage network, the following measures are proposed:

- regular maintenance of treatment structures and filter drains to ensure ongoing mitigation efficiency;
- maintenance of filter drains including monthly inspection and weed control, annual sediment and vegetation build up removal, replacement of clogged filter material (typically once in 10 years or more);
- regular maintenance of attenuation basins and treatment ponds including monthly inspections and site rubbish removal; bank side and pond vegetation clearance at least every 3 years; removal of sediment from forebay when 50% full (at least once in seven years); and removal of sediment from the pool when volume reduced by 25% (25 years or greater);
- regular maintenance of receiving watercourses and culverts to reduce the risk of blockages and thus increased flood risk; and
- provision of scour protection at the drainage discharge outfall to protect the banks and bed of the receiving ditch and to limit erosion.

5.2.18 Further details regarding morphological diversity mitigation requirements, creation and maintenance of a complex riparian zone are provided in Appendix A9.3 (Fluvial Geomorphology) and Appendix A10.16 (Freshwater).

<u>Other Operational Measures</u>

5.2.19 It is preferable that herbicides are not used on highway embankments, cutting or verges as these substances, once in the watercourses, can accumulate in sediments and bio accumulate in a wide range of organisms. However, if the Contractor responsible for verge maintenance considers that the use of herbicides is necessary for the adequate management of vegetation on the highway verge, the Contractor should only use those products recommended by SEPA for use near watercourses. Any herbicides should be used in accordance with the manufacturer's instructions.

5.2.20 At the location of road drainage outfalls, scour protection measures such as revetments and river bed protection may be necessary to minimise erosion of the banks and bed of receiving watercourses.

5.2.21 Water quality/sedimentation/ecological monitoring downstream of key outflows will be undertaken to provide an indication for potential problems.

<u>Adherence to Best Practice near Watercourses</u>

5.2.22 Maintenance is an important factor in pollutant removal efficiency of treatment structures. An appropriate level of ongoing maintenance must be implemented to maximise removal efficiency over the life of the structure. Guidance on the minimum requirements is detailed in SEPA Pollution Prevention Guidelines (PPG 01, PPG 09, PPG 18, PPG 21 and PPG 22), and CIRIA guidance C697 (CIRIA, 2007).

<u>Water Crossings</u>

5.2.23 Bridging high sensitivity watercourses aims at avoiding adverse long-term changes in water quality, morphological diversity and minimising construction impact. The Don River is a protected watercourse therefore it is proposed to be bridged. The river crossing design has been developed by a team including structural engineers, hydraulic modellers, environmental scientists and aesthetic advisors. Details of design features are given in Chapter 4 (The Proposed Scheme) and construction and operation mitigation measures specific to water quality are outlined below.

5.2.24 Watercourses of high sensitivity and identified to support valuable habitats for atlantic salmon are also proposed to be bridged at mainline crossing points, to minimise potential adverse impact on water quality and preserve their excellent water conditions. These comprise all three crossings of Goval Burn.

5.2.25 In all cases, bridges have been designed to entirely span the watercourse at the crossing point, meaning that no piers will be located in the water column and no in channel works at any of these crossing points will be carried out. These measures will reduce the risk of accidental spillage and sediment release within the water channel, prevent river diversion or pumping water away during the bridge construction. In addition, bridges have been designed to minimise damage to the surrounding riparian zone, with piers set back from the water's edge and viaduct options being preferred over the construction of large embankments on floodplains.

5.2.26 The 28 watercourse crossings include:

- one bridge crossing of the River Don and floodplain;
- three bridge crossings of Goval Burn;
- a bridge crossing and an aqueduct at Mill Lade; and
- additional 23 crossings are proposed to be culverted.

5.2.27 Many of the watercourses that would be culverted are very small and of low sensitivity with a large proportion being straightened land drains.

Culvert Design

5.2.28 Culvert design follows SEPA policy (SEPA website, December 2006) and the guidelines set out in Culvert Design Manual, Report 168 (CIRIA, 1997). In addition, the culvert will be designed to facilitate fish passage following guidance from River Crossings and Migratory Fish: Design Guidance: A Consultation Paper for the Scottish Executive (SEERAD, 2000).

5.2.29 Culvert design is aimed at avoiding deterioration in water quality and morphological diversity and the associated suspended solids release. Culverts will be sized to allow debris and sediment material to pass through the culvert unhindered. The proposed crossing design will also reduce disruption to the existing flow regime of the affected watercourse and be designed to pass the 1:200 year return period flow.

5.2.30 Depressed invert box culvert designs will be used for the majority of the watercourses that would be crossed by the proposed scheme. The culverts will be designed to follow Scottish Executive guidance on culverts and migratory fish (SEERAD, 2000). These culverts are proposed at most crossing points except for those watercourses (predominantly small land drains) that would be taken into pre-earthworks.

5.2.31 Culvert bases will be set at below streambed level to allow natural substrate to be used within the culvert. Substrate in the culvert will be new material of a similar size to that of the original channel which will be specified to ensure that the sediment does not wash out at times of high flow or silt up in times of low flow.

5.2.32 All culverts have been designed to allow flows through during a 1:200 year flood and ensure that gradients do not differ markedly from existing conditions to avoid excessive siltation or erosion. In addition most culverts have mammal ledges installed to allow mammal passage through the culverts during most typical flow conditions.

<u>Watercourse Realignments</u>

5.2.33 Realignments are generally used where necessary to reduce crossing (culvert) lengths and associated potential long term adverse water quality impact. Realignments are designed to cause minimal disturbance to flow patterns and adverse changes on water quality, mirroring where possible the original alignment with minimal change to hydraulic gradient.

5.2.34 During the design of the watercourse crossings, several workshops were conducted with engineers, ecologists and geomorphologists at key design stages to ensure that watercourse realignments were limited to essential works and minimised adverse impacts. Geomorphological features present in the original watercourse will be recreated and features such as pool and riffle sequences introduced where possible.

Monitoring of Realigned and Culverted Watercourses

5.2.35 Although river realignments and culverts have been designed to minimise the risk of sedimentation and erosion, a monitoring programme will be undertaken to identify any potential geomorphological, ecological or water quality problems. This approach is aimed at reducing the risk of dramatic changes to the geomorphological diversity and water quality of watercourses. Details of monitoring approach will be agreed with SEPA prior to commencement of the construction works.

Construction Mitigation

5.2.36 Measures to avoid minimise or control pollution of surface water and groundwater are required during the construction of the scheme. These will incorporate SEPA's requirements for pollution control including Pollution Prevention Guidelines (PPGs).

5.2.37 As mentioned above, for all aspects of work that might impact upon the water environment, detailed Method Statements are expected to be provided as part of the CAR licensing process. A detailed method statement is also likely to be required as part of the CAR licensing process, setting out the techniques to minimise sediment release into watercourses.

5.2.38 Treatment ponds included as part of scheme design (Figures 9.4 a-g) will be constructed early during the construction period to allow settlement and treatment of any pollutants contained in the runoff and control the rate of flow before water is discharged into the receiving watercourses. Additional temporary settlement ponds may also be required during construction (A9.5, Annex 30). The addition of temporary SUDS during construction will be determined by the Contractor and agreed with SEPA prior to the start of works on site.

5.2.39 Temporary SUDS are also likely to be used, where required, to control surface water runoff during construction to control erosion, sedimentation or discolourisation of controlled waters. This is part of the Employer's Requirements and the Contractor will provide monitoring proposals and contingency plans prior to commencement of operations on site.

5.2.40 The Employer's Requirements will also require the Contractor to monitor water quality prior to and during construction, assessing chemical (temperature, pH, conductivity, suspended solids, heavy metals, organic components, etc.) and biological parameters (macroinvertebrate communities and macrophytes). Monitoring locations, parameters, frequency of sampling and discharge limits will be agreed with SEPA in advance of construction.

5.2.41 Arrangements for safe storage and disposal of sewage effluent from workers on site, such as chemical toilets or other forms of system with no discharge (PPG 4: Treatment and Disposal of Sewage Where No Foul Sewage is Available, July 2006), will also be agreed with SEPA in advance of works on site.

Adherence to Best Practice near Watercourses

5.2.42 The mitigation measures proposed to reduce potential impacts during construction are summarised in Table 5-2.

Table 5-2 – Mitigation Measures to Reduce Impacts during Construction

Source of Impact	Mitigation
Suspended Solids	Runoff and erosion control measures may include perimeter cut-off ditches; ditches at the base of embankments; settlement lagoons; the installation of silt fences on cut slopes, around drainage inlets, and any drainage path; placement of hay bales; mulching; erosion control blankets; and hydro-seeding. Should chemical flocculants be proposed for settlement, SEPA will be consulted to obtain the necessary approvals. Stockpiles will not be located near watercourses, stockpiles must be covered when not in use and silt fencing must be provided around the perimeter of all stockpiles. Vehicles or vehicle wheels must not be washed near watercourses. Temporary bridges should be used to cross watercourses rather than temporary culverts and fording watercourses must be avoided. A method statement will be provided as part of the CAR licensing process setting out the techniques to minimise sediment release.
Oils, Fuels and Chemicals	Bunded areas with impervious walls and floor lining for the storage of fuel, oil and chemicals must be provided. These bunded areas will have a value of at least 110% that of the storage tanks. In the event of large oil spills that cannot be dealt with at the local level, a detailed contingency plan will be provided to ensure effective mitigation. A method statement will be provided as part of the CAR licensing process setting out the techniques to minimise sediment release.
Concrete, Cement and Admixtures	Storing potential pollutants or undertaking potentially polluting activities (e.g. concrete batching and mixing) away from watercourses, ditches and surface water drains.
Watercourse / Drain Crossings and Diversions	The watercourse will be diverted or pumped away from the construction site during the construction of culverts to minimise potential contamination of the watercourse. Culverts will be sized to ensure adequate passage of water during high flow conditions. Culverts will be designed to ensure fish and mammal passage is facilitated. Ensure minimal disturbance to the banks and beds of watercourses and minimal disturbance to existing land drainage systems. If the new road blocks existing drainage, the existing land drainage will be culverted or diverted as appropriate.
Sewerage	If service diversions need to be carried out, the diversion will be undertaken prior to construction and will be undertaken using good engineering practices to ensure spillage risk is minimised. It is likely that statutory bodies may undertake the diversion works under their own access rights. Arrangements for safe storage and disposal of sewage effluent from workers on site will be agreed with SEPA in advance of construction in accordance with PPG 4.
Contaminated Land and Sediment.	Contaminated land areas have been identified in Chapter 8 Geology, Contaminated Land and Groundwater, Table 8.7. Detailed further ground investigation will be carried out for those areas. Similar methods to those outlined for reducing suspended solids from entering watercourses will be used to prevent disturbed contaminated sediments from entering the watercourses.

5.2.43 One of the key mitigation strategies during construction is to avoid pollution release to watercourses and reducing this impact should it occur. This will be achieved through best practice at site and adherence to the following PPGs published by SEPA:

- PPG01 General Guide to the Prevention of Water Pollution;
- PPG04 Disposal of Sewage Where No Mains Drainage is Available;
- PPG05 Works In, Near or Liable to Affect Watercourses;
- PPG06 Working at Construction and Demolition Sites;
- PPG07 Refuelling Facilities;
- PPG08 Storage and Disposal of Used Oils;
- PPG10 Highway Depots;

- PPG13 High Pressure Water and Steam Cleaners;
- PPG18 Control of Spillages and Fire Fighting Runoff; and
- PPG21 Pollution Incident Response Planning.

Pre-Earthworks

5.2.44 The land drains/watercourses that will be taken into pre-earthworks will require sediment control measures to be applied to reduce the potential impact downstream of the construction area. These may include cut-off ditches and sediment fencing around the perimeter of earth works to minimise sediment release into the watercourse. Additionally, implementation of best practice at site and adherence to the PPGs listed above should be undertaken. The diversion of the watercourse into the pre-earthworks ditches should only be undertaken after the implementation of sediment and pollution control measures (sediment traps/lagoons) at the downstream end of these ditches prior to outfall.

Diversion of Watercourses during Culvert Construction

5.2.45 During installation of culverts, watercourses will be diverted to a temporary channel. This will reduce the potential risk of concrete and chemical spillage, sedimentation and erosion. Temporary channels will be lined with geotextile and new similar sized inert granular material in areas where the ground investigation has indicated that fine particles are present.

Timing of Works

5.2.46 Where possible, works will be avoided during periods of very high and very low flow to minimise potential impacts from construction activities. In salmonid watercourses, in-channel works should be avoided during spawning periods (from Oct-May; see Appendix A10.15: Fish).

5.3 Site-Specific Mitigation

5.3.1 In addition to the above generic mitigation to be applied at all watercourses, site-specific mitigation is proposed where appropriate. Table 5-3 below details proposed site-specific mitigation for both the construction and operational phases.

Table 5-3 – Proposed Site-Specific Water Quality Mitigation during Construction and Operation

Watercourse	Potential Impact	Specification	Mitigation Measures
Keppelhill Burn	Road Drainage	No road drainage discharge to burn	n/a
	Crossing	1 culvert: ch315200 (154m)	• Depressed invert box culverts designed to carry a 1:200 year flow, with mammal ledge. Maintains bed continuity through the structure.
	Realignment	Realigned length 200m (length maintained)	• Regular maintenance and clearance of debris.
	Construction	Increased risk of pollution from concreting and fuel and oil spills. Fine sediment release from earthworks. Possible drain crossings and diversions	Adherence to best practice. Generic mitigation measures apply – Table 5-2. • Batching and mixing off site, using quick setting cement mixes; bunded areas with impervious walls. • Diversion or pumping away during construction of culvert/realignments; Geotextile lining at the temporary realignment to reduce erosion and sedimentation; • Cut-off ditches and sediment fencing; sediment trap (settling lagoons) to reduce sediment release. Use of new similarly sized material to cover the bottom of the culvert. • Detailed method statements to be provided for all aspects of work impacting upon Water Environment during CAR process, including method statement for the release of suspended solids. Detailed contingency plan to be provided for mitigation of large oil spills that cannot be dealt with on a local level. • Early construction of treatment ponds during construction period to allow settlement and treatment of pollutants and control flow rate of run-off before discharge into watercourse. • Contractor to monitor water quality prior to, and during, construction
Gough Burn	Road Drainage	No road drainage discharge to burn	n/a
	Crossing	2 culverts: ch316390 (6.m) and ch316430 (11m)	• Depressed invert box culverts designed to carry a 1:200 year flow, with mammal ledge. Maintains bed continuity through the structure.
	Realignment	Culvert 1: Realignment of 183m length resulting in lengthening of burn by 48m. Culvert 2: Realignment of 25m length (maintained).	• Regular maintenance and clearance of debris.

Watercourse	Potential Impact	Specification	Mitigation Measures
Gough Burn [cont'	Construction	Increased risk of pollution from concreting and fuel and oil spills. Fine sediment release from earthworks. Possible drain crossings and diversions.	Adherence to best practice. Generic mitigation measures apply – Table 5-2. • Batching and mixing off site, using quick setting cement mixes; bunded areas with impervious walls. • Diversion or pumping away during construction of culvert/realignments; Geotextile lining at the temporary realignment to reduce erosion and sedimentation; • Cut-off ditches and sediment fencing; sediment trap (settling lagoons) to reduce sediment release. Use of new similarly sized material to cover the bottom of the culvert. • Detailed method statements to be provided for all aspects of work impacting upon Water Environment during CAR process, including method statement for the release of suspended solids. Detailed contingency plan to be provided for mitigation of large oil spills that cannot be dealt with on a local level. • Early construction of treatment ponds during construction period to allow settlement and treatment of pollutants and control flow rate of run-off before discharge into watercourse. • Contractor to monitor water quality prior to, and during, construction.
Craibstone Burn	Road Drainage	No road drainage discharge to burn	n/a
	Crossing	1 culvert over mainline: ch316990 (106m)	• Depressed invert box culverts designed to carry a 1:200 year flow, with mammal ledge. Maintains bed continuity through the structure.
	Realignment	Realignment of 196m length resulting in shortening of burn by 11m.	• Regular maintenance and clearance of debris.
	Construction	Increased risk of pollution from concreting and fuel and oil spills. Fine sediment release from earthworks. Possible drain crossings and diversions.	Adherence to best practice. Generic mitigation measures apply – Table 5-2. • Batching and mixing off site, using quick setting cement mixes; bunded areas with impervious walls. • Diversion or pumping away during construction of culvert/realignments; Geotextile lining at the temporary realignment to reduce erosion and sedimentation; • Cut-off ditches and sediment fencing; sediment trap (settling lagoons) to reduce sediment release. Use of new similarly sized material to cover the bottom of the culvert. • Detailed method statements to be provided for all aspects of work impacting upon Water Environment during CAR process, including method statement for the release of suspended solids. Detailed contingency plan to be provided for mitigation of large oil spills that cannot be dealt with on a local level. • Early construction of treatment ponds during construction period to allow settlement and treatment of pollutants and control flow rate of run-off before discharge into watercourse. • Contractor to monitor water quality prior to, and during, construction
Green Burn	Road Drainage	2 proposed outfalls. Total of 12.6Ha draining to A96 Link Road and ch317470.	• Filter Drain, Detention Basin, 3 x Treatment ponds (storage volumes, Vt)
	Crossing	3 culverts: ch317330 (113m), A96 (29m), and A96 (23m).	• Depressed invert box culverts designed to carry a 1:200 year flow, with mammal ledge. Maintains bed continuity through the structure.

Watercourse	Potential Impact	Specification	Mitigation Measures
Green Burn [cont'd]	Realignment	Culvert 1: realignment of 160m resulting in shortening of burn by 4m. Culvert 2: realignment of 435m length resulting in shortening of burn by 6m. Culvert 3: part of same realignment as Culvert 2	• With regards to major realignment geomorphological features must be reproduced and hydraulic gradient and length must be maintained. Sensitive realignment design reintroducing meanders, alternating pools and riffle sequences, and morphological diversity where possible to offset straightening of channel and other culverting proposed on the watercourse. Regular maintenance and clearance of debris • Detailed assessment must be completed by a geomorphologist (see Appendix A9.3 Geomorphology).
	Construction	Medium risk of pollution from concreting and fuel and oil spills. Medium risk of fine sediment release during earthworks. Possible drain crossings and diversions. Sewerage. Possible slight impact from land contamination and sediments.	Adherence to best practice. Generic mitigation measures apply – Table 5-2. • Batching and mixing off site, using quick setting cement mixes; bunded areas with impervious walls. • Diversion or pumping away during construction of culvert/realignments; Geotextile lining at the temporary realignment to reduce erosion and sedimentation; • Cut-off ditches and sediment fencing; sediment trap (settling lagoons) to reduce sediment release. Use of new similarly sized material to cover the bottom of the culvert. • Detailed method statements to be provided for all aspects of work impacting upon Water Environment during CAR process, including method statement for the release of suspended solids. Detailed contingency plan to be provided for mitigation of large oil spills that cannot be dealt with on a local level. • Early construction of treatment ponds during construction period to allow settlement and treatment of pollutants and control flow rate of run-off before discharge into watercourse. • Contractor to monitor water quality prior to, and during, construction.
Bogenjoss Burn	Road Drainage	1 proposed outfall. Total of 1.8Ha draining to ch320710.	• Filter Drain, Detention Basin, Treatment pond (storage volume, Vt), swale/grass ditch.
	Crossing	4 offline side road culverts: ch320100 (9m) ch320215 (8m) ch320260 (11m) ch320475 (10m) 2 main line culverts: ch320500 (56m) ch320870 (160m)	• Depressed invert box culverts designed to carry a 1:200 year flow, with mammal ledge. Maintains bed continuity through the structure.
	Realignment	2 realignments of 948m and 261m in length resulting in substantial straightening of the channel and shortening of burn by 156m and 21m, respectively.	• With regards to major realignment geomorphological features must be reproduced and hydraulic gradient and length must be maintained. Sensitive realignment design reintroducing meanders, alternating pools and riffle sequences, and morphological diversity where possible to offset straightening of channel and other culverting proposed on the watercourse. Regular maintenance and clearance of debris. • Detailed assessment must be completed by a geomorphologist.

Watercourse	Potential Impact	Specification	Mitigation Measures
Bogenjoss Burn [cont'd]	Construction	High risk of potential pollution from concreting and fuel and oil spills. High risk of sediment release during earthworks. Possible drain crossings and diversions. Possible slight impact from land contamination and sediments.	Adherence to best practice. Generic mitigation measures apply – Table 5-2. • Batching and mixing off site, using quick setting cement mixes; bunded areas with impervious walls. • Diversion or pumping away during construction of culvert/realignments; Geotextile lining at the temporary realignment to reduce erosion and sedimentation; • Cut-off ditches and sediment fencing; sediment trap (settling lagoons) to reduce sediment release. Use of new similarly sized material to cover the bottom of the culvert. • Detailed method statements to be provided for all aspects of work impacting upon Water Environment during CAR process, including method statement for the release of suspended solids. Detailed contingency plan to be provided for mitigation of large oil spills that cannot be dealt with on a local level. • Early construction of treatment ponds during construction period to allow settlement and treatment of pollutants and control flow rate of run-off before discharge into watercourse. • Contractor to monitor water quality prior to, and during, construction
River Don	Road Drainage	1 proposed outfall. Total of 4.1Ha draining to ch322500, ch322650 and ch322930 collected into a ditch before entering pond	• Filter Drain, Detention Basin , 2 x Treatment pond (storage volumes, Vt)
	Crossing	Bridge spanning River and floodplain	• Bridge with no piers in the river.
	Realignment	No realignment planned	n/a
	Construction	High risk of pollution from concreting and fuel and oil spills. High risk of sediment release during earthworks. Possible drain crossings and diversions. Sewerage.	Adherence to best practice. Generic mitigation measures apply – Table 5-2. • Batching and mixing off site, using quick setting cement mixes; bunded areas with impervious walls. • Geotextile lining to reduce erosion. • Cut-off ditches and sediment fencing; sediment trap (settling lagoons) to reduce sediment release. • Detailed method statements to be provided for all aspects of work impacting upon Water Environment during CAR process, including method statement for the release of suspended solids. Detailed contingency plan to be provided for mitigation of large oil spills that cannot be dealt with on a local level. • Early construction of treatment ponds during construction period to allow settlement and treatment of pollutants and control flow rate of run-off before discharge into watercourse. • Contractor to monitor water quality prior to, and during, construction
Goval Burn	Road Drainage	1 proposed outfall. Total of 3.5Ha draining to ch323900.	• Filter Drain, Detention Basin, Treatment pond (storage volume, Vt).
	Crossing	3 Bridges: on the mainline (ch324600), B977 and the A947	• Bridges with no piers in the river.
	Realignment	No realignment is proposed	n/a

Watercourse	Potential Impact	Specification	Mitigation Measures
Goval Burn [cont'd]	Construction	Increased risk of pollution from concreting and fuel and oil spills. Fine sediment release from earthworks. Possible drain crossings and diversions.	Adherence to best practice. Generic mitigation measures apply – Table 5-2. • Batching and mixing off site, using quick setting cement mixes; bunded areas with impervious walls. • Geotextile lining to reduce erosion. • Cut-off ditches and sediment fencing; sediment trap (settling lagoons) to reduce sediment release. • Detailed method statements to be provided for all aspects of work impacting upon Water Environment during CAR process, including method statement for the release of suspended solids. Detailed contingency plan to be provided for mitigation of large oil spills that cannot be dealt with on a local level. • Early construction of treatment ponds during construction period to allow settlement and treatment of pollutants and control flow rate of run-off before discharge into watercourse. • Contractor to monitor water quality prior to, and during, construction
Mill Lade	Road Drainage	No outfall planned.	n/a
	Crossing	New viaduct crossing to be constructed. 1 Bridge at A947	• Overhead aqueduct crossing replacement of existing • Bridges with no piers in the river
	Realignment	No realignment is proposed.	n/a
	Construction	Increased risk of pollution from concreting and fuel and oil spills. Low impact from fine sediment release during earthworks. Possible drain crossings and diversions.	Adherence to best practice. Generic mitigation measures apply – Table 5-2. • Batching and mixing off site, using quick setting cement mixes; bunded areas with impervious walls. • Diversion or pumping away during construction of viaduct; Geotextile lining at the temporary realignment to reduce erosion and sedimentation. • Detailed method statements to be provided for all aspects of work impacting upon Water Environment during CAR process, including method statement for the release of suspended solids. Detailed contingency plan to be provided for mitigation of large oil spills that cannot be dealt with on a local level. • Early construction of treatment ponds during construction period to allow settlement and treatment of pollutants and control flow rate of run-off before discharge into watercourse. • Contractor to monitor water quality prior to, and during, construction.
Corsehill Burn	Road Drainage	1 proposed outfall. Total of 3.9Ha draining to Goval Roundabout South.	• Filter Drain, Detention Basin, Treatment pond (Storage Volume, Vt)
	Crossing	3 Culverts: ch325085 (77m) Link 1 (32m) Link 2 (55m)	• Depressed invert box culverts designed to carry a 1:200 year flow, with mammal ledge. Maintains bed continuity through the structure.

Watercourse	Potential Impact	Specification	Mitigation Measures
Corsehill Burn [cont'd]	Realignment	Realignment of 585m length resulting in substantial straightening of the channel and lengthening of burn by 15m.	• With regards to major realignment geomorphological features must be reproduced and hydraulic gradient and length must be maintained. Sensitive realignment design reintroducing meanders, alternating pools and riffle sequences, and morphological diversity where possible to offset straightening of channel and other culverting proposed on the watercourse. Regular maintenance and clearance of debris. • Detailed assessment must be completed by a geomorphologist.
	Construction	Increased risk of pollution from concreting and fuel and oil spills. Medium impact from fine sediment release during earthworks. Possible drain crossings and diversions.	Adherence to best practice. Generic mitigation measures apply – Table 5-2. • Batching and mixing off site, using quick setting cement mixes; bunded areas with impervious walls. • Diversion or pumping away during construction of culvert/realignments; Geotextile lining at the temporary realignment to reduce erosion and sedimentation; • Cut-off ditches and sediment fencing; sediment trap (settling lagoons) to reduce sediment release. Use of new similarly sized material to cover the bottom of the culvert. • Detailed method statements to be provided for all aspects of work impacting upon Water Environment during CAR process, including method statement for the release of suspended solids. Detailed contingency plan to be provided for mitigation of large oil spills that cannot be dealt with on a local level. • Early construction of treatment ponds during construction period to allow settlement and treatment of pollutants and control flow rate of run-off before discharge into watercourse. • Contractor to monitor water quality prior to, and during, construction
Red Moss Burn	Road Drainage	1 proposed outfall. Total of 2.3Ha draining to ch327240.	• Filter Drain, Detention Basin, Treatment pond (storage volume, 4Vt)
	Crossing	1 Culvert ch327500 (58m)	• Depressed invert box culverts designed to carry a 1:200 year flow, with mammal ledge. Maintains bed continuity through the structure.
	Realignment	Realignment of 81m (length maintained)	• Regular maintenance and clearance of debris.
	Construction	Increased risk of pollution from concreting and fuel and oil spills. Fine sediment releasing from earthworks. Possible drain crossings and diversions. Possible slight impact from contaminated land & sediments.	Adherence to best practice. Generic mitigation measures apply – Table 5-2. • Batching and mixing off site, using quick setting cement mixes; bunded areas with impervious walls. • Diversion or pumping away during construction of culvert/realignments; Geotextile lining at the temporary realignment to reduce erosion and sedimentation; • Cut-off ditches and sediment fencing; sediment trap (settling lagoons) to reduce sediment release. Use of new similarly sized material to cover the bottom of the culvert. • Detailed method statements to be provided for all aspects of work impacting upon Water Environment during CAR process, including method statement for the release of suspended solids. Detailed contingency plan to be provided for mitigation of large oil spills that cannot be dealt with on a local level. • Early construction of treatment ponds during construction period to allow settlement and treatment of pollutants and control flow rate of run-off before discharge into watercourse. • Contractor to monitor water quality prior to, and during, construction

Watercourse	Potential Impact	Specification	Mitigation Measures
Blackdog Burn	Road Drainage	2 proposed outfalls. Total of 8Ha 7.2Ha draining to ch329940. 0.8Ha of mainline draining to ch.330820 and A90 side road all collected into a ditch.	• Filter Drain, Detention Basin, Treatment pond (storage volume, Vt)
	Crossing	2 Culverts: ch329950 (61m), A90 North (31m)	• Depressed invert box culverts designed to carry a 1:200 year flow, with mammal ledge. Maintains bed continuity through the structure.
	Realignment	2 proposed realignments: 164m (length maintained) 69m (length maintained)	• Regular maintenance and clearance of debris.
	Construction	Increased risk of pollution from concreting and fuel and oil spills. Medium impact from fine sediment release during earthworks. Possible drain crossings and diversions.	• Batching and mixing off site, using quick setting cement mixes; bunded areas with impervious walls. • Diversion or pumping away during construction of culvert/realignments; Geotextile lining at the temporary realignment to reduce erosion and sedimentation; • Cut-off ditches and sediment fencing; sediment trap (settling lagoons) to reduce sediment release. Use of new similarly sized material to cover the bottom of the culvert. • Detailed method statements to be provided for all aspects of work impacting upon Water Environment during CAR process, including method statement for the release of suspended solids. Detailed contingency plan to be provided for mitigation of large oil spills that cannot be dealt with on a local level. • Early construction of treatment ponds during construction period to allow settlement and treatment of pollutants and control flow rate of run-off before discharge into watercourse. • Contractor to monitor water quality prior to, and during, construction.
Blackdog Ditch	Road Drainage	No outfall planned.	n/a
	Crossing	1 Culverts ch330065 (47m)	• Depressed invert box culverts designed to carry a 1:200 year flow, with mammal ledge. Maintains bed continuity through the structure.
	Realignment	Realignment of 96m length resulting in shortening of burn by 2m.	• Regular maintenance and clearance of debris.

Watercourse	Potential Impact	Specification	Mitigation Measures
Blackdog Ditch [cont'd]	Construction	Increased risk of pollution from concreting and fuel and oil spills. Medium impact from fine sediment release during earthworks. Possible drain crossings and diversions.	Adherence to best practice. Generic mitigation measures apply – Table 5-2. • Batching and mixing off site, using quick setting cement mixes; bunded areas with impervious walls. • Diversion or pumping away during construction of culvert/realignments; Geotextile lining at the temporary realignment to reduce erosion and sedimentation; • Cut-off ditches and sediment fencing; sediment trap (settling lagoons) to reduce sediment release. Use of new similarly sized material to cover the bottom of the culvert. • Detailed method statements to be provided for all aspects of work impacting upon Water Environment during CAR process, including method statement for the release of suspended solids. Detailed contingency plan to be provided for mitigation of large oil spills that cannot be dealt with on a local level. • Early construction of treatment ponds during construction period to allow settlement and treatment of pollutants and control flow rate of run-off before discharge into watercourse. • Contractor to monitor water quality prior to, and during, construction
Middlefield Burn	Road Drainage	1 Proposed outfall. Total of 0.3 Ha draining to access track east of A90 and access track west of A90	• Filter Drain, Detention Basin, Treatment pond (storage volume Vt).
	Crossing	3 Culverts: A90 North (47m) , A90 North (93m), and A90 North (54m)	• Depressed invert box culverts designed to carry a 1:200 year flow, with mammal ledge. Maintains bed continuity through the structure.
	Realignment	Realignment of 460m length resulting in the shortening of burn by 65m.	• With regards to major realignment geomorphological features must be reproduced and hydraulic gradient and length must be maintained. Sensitive realignment design reintroducing meanders, alternating pools and riffle sequences, and morphological diversity where possible to offset straightening of channel and other culverting proposed on the watercourse. Regular maintenance and clearance of debris. • Detailed assessment must be completed by a geomorphologist.
	Construction	Increased risk of pollution from concreting and fuel and oil spills. Medium impact from fine sediment release during earthworks. Possible drain crossings and diversions.	Adherence to best practice. Generic mitigation measures apply – Table 5-2. • Batching and mixing off site, using quick setting cement mixes; bunded areas with impervious walls. • Diversion or pumping away during construction of culvert/realignments; Geotextile lining at the temporary realignment to reduce erosion and sedimentation; • Cut-off ditches and sediment fencing; sediment trap (settling lagoons) to reduce sediment release. Use of new similarly sized material to cover the bottom of the culvert. • Detailed method statements to be provided for all aspects of work impacting upon Water Environment during CAR process, including method statement for the release of suspended solids. Detailed contingency plan to be provided for mitigation of large oil spills that cannot be dealt with on a local level. • Early construction of treatment ponds during construction period to allow settlement and treatment of pollutants and control flow rate of run-off before discharge into watercourse. • Contractor to monitor water quality prior to, and during, construction

5.3.2 Mitigation specified in Table 5-3 above should be applied to all watercourses considered as part of this impact assessment. In addition to these measures there are specific measures that must be applied to burns and rivers of high value and these are outlined below.

Bogenjoss Burn

5.3.3 Bogenjoss Burn which flows through a plantation conifer woodland will be extensively realigned at the upstream sites with approximately 1365m of river length realigned and straightened with two culverts at the mainline crossing and four smaller culverted crossings upstream. Due to sedimentation risk it was not considered practical to include meanders in this realignment.

Don Crossing

5.3.4 The Don River supports important populations of Atlantic salmon and otter and as such the mitigation measures proposed for this river are listed below.

5.3.5 During the construction of the Don crossing the following specific mitigation measures will be applied:

- sediment fencing should be applied to reduce the sediment release. This should be installed around the circumference of the working area;
- temporary treatment ponds should be constructed to reduce the runoff pollution from the approach road construction;
- adherence to the relevant PPG's and liaison with SEPA ;
- ecological clerk of works should be present on site during construction, to ensure the implementation of appropriate environmental safeguards;
- concrete mixing and batching outside the flood plain to minimise potential risk of accidental spillage;
- use of plastic sleeve and double falsework/shuttering when working over the watercourse to ensure minimal concrete spillage;
- enclosed spraying when waterproofing preventing from chemicals entering the watercourse;
- no bridging works to be conducted between 14 October and 31 May to avoid migratory and spawning salmon (refer to Chapter 10 Ecology and Nature Conservation for further ecological mitigation measures); and
- long term water quality/ecological monitoring before, during and after construction (to be agreed with SEPA prior to work commencement).

Goval Burn

5.3.6 Goval Burn provides excellent water quality and natural habitat for Atlantic salmon and otters. The following special mitigation measures are proposed to provide better sediment management, less erosion and reduce the adverse impact on the morphological diversity of the watercourse:

- use of bridges rather than culverts;
- mitigations to minimise the risk of sediment release and oil and concrete spillage during construction, e.g. sediment fencing, concrete mixing and batching outside the flood plain, using plastic sleeve, double falsework/shuttering, etc. (similar to the mitigation used during the construction of the River Don bridge)
- temporary treatment ponds should be constructed to reduce the runoff pollution;
- no bridging works to be conducted between 14 October and 31 May to avoid migratory and spawning salmon; and

- presence of environmental/ecological clerk of works required to ensure disturbance to salmon and otters is avoided.

6 Residual Impacts

6.1.1 The residual impacts section presents the likely impacts of the scheme with the implementation of the designed mitigation measures detailed in the previous section. This mitigation will be included, where feasible, through the scheme to conform to SEPA requirements.

Operation

Routine Runoff

6.1.2 Mitigation measures have been used to re-calculate the resulting concentrations assuming removal efficiencies of differing levels of treatment, as set out earlier in the report.

6.1.3 Following treatment and settlement, it is considered that the residual impact of insoluble pollutants entering Bogenjoss Burn, River Don Goval Burn and Middlefield Burn will be of negligible magnitude, which will result in an impact of negligible or slight/negligible significance. Green, Corsehill, Red Moss and Blackdog Burn will be subjected to impacts of negligible to slight significance regarding the zinc and copper concentration in routine runoff. Kepplehill Burn, Gough Burn, Craibstone Burn, Mill Lade and Blackdog Ditch may be impacted through diffuse means (the AWPR will cross these watercourses), however these impacts are considered to be of negligible to slight/negligible significance.

6.1.4 Details of the calculations are provided in A9.5, Annex 29 and the results summarised in Table 6-1. All watercourses which are potentially impacted by crossing or outfall are considered in Table 6-1, those that are proposed to be taken into pre-earthworks drainage are omitted from the table.

6.1.5 Additionally, with the inclusion of scour protection at outfalls the residual impact of erosion on watercourse banks is considered to be of Negligible significance.

Table 6-1 – Estimated Residual Impact of Total Zinc and Dissolved Copper

Site	Sensitivity	Parameter	EQS Annual Average (µg/l)	Estimated downstream concentration			Residual Impact	
				without mitigation (µg/l)	with mitigation (µg/l)	% incr. over baseline conc.	Magnitude	Significance
Kepplehill Burn	Low	Diffuse	n/a	n/a	n/a	n/a	Negligible	Negligible
Gough Burn	High	Diffuse	n/a	n/a	n/a	n/a	Negligible	Slight/Negligible
Craibstone Burn	High	Diffuse	n/a	n/a	n/a	n/a	Negligible	Slight/Negligible
Green Burn	Medium	Copper	10	65*	7	34	Low	Slight
		Zinc	75	286*	37	0	Negligible	Negligible
Bogenjoss Burn	High	Copper	10	10*	6	22	Negligible	Slight/Negligible
		Zinc	75	64	38	2	Negligible	Slight/Negligible
River Don	High	Copper	10	6	6	0	Negligible	Slight/Negligible
		Zinc	75	26	26	0	Negligible	Slight/Negligible
Goval Burn	High	Copper	10	5	5	2	Negligible	Slight/Negligible
		Zinc	75	39	38	0	Negligible	Slight/Negligible

Site	Sensitivity	Parameter	EQS Annual Average (µg/l)	Estimated downstream concentration			Residual Impact	
				without mitigation (µg/l)	with mitigation (µg/l)	% incr. over baseline conc.	Magnitude	Significance
Mill Lade	Low	Diffuse	n/a	n/a	n/a	n/a	Negligible	Negligible
Corsehill Burn	Medium	Copper	10	14*	7	48	Low	Slight
		Zinc	75	82*	40	7	Negligible	Negligible
Red Moss Burn	Medium	Copper	10	13*	7	44	Low	Slight
		Zinc	75	79*	40	7	Negligible	Negligible
Blackdog Burn	Medium	Copper	10	11*	7	34	Low	Slight
		Zinc	75	69	39	5	Negligible	Negligible
Blackdog Ditch	Medium	Diffuse	n/a	n/a	n/a	n/a	Negligible	Negligible
Middlefield Burn	Low	Copper	10	8	6	16	Negligible	Negligible
		Zinc	75	48	38	1	Negligible	Negligible

* Exceeds Annual Average EQS

Risk of Accidental Spillage

6.1.6 The residual risk of accidental spillage with mitigation measures in place are summarised in Table 6-2 below (refer to A9.5, Annex 26 for details of the calculations). All watercourses which are potentially impacted by outfall are considered in Table 6-1, those that are proposed to be taken into pre-earthworks drainage or culverted are omitted from the table.

Table 6-2 – Summary of Spillage Risk Assessment – Residual Impacts (i.e. with Mitigation)

Watercourse	Threshold of Acceptability	Spillage Risk in Design Year		Within Acceptable Limits	Residual Impact	
		Without Mitigation	With Mitigation		Magnitude	Significance
Green Burn	1:100	1:64	1:4298	Yes	Negligible	Negligible
Bogenjoss Burn	1:100	1:1075	1:25062	Yes	Negligible	Slight/Negligible
River Don	1:100	1:479	1:11164	Yes	Negligible	Slight/Negligible
Goval Burn	1:100	1:659	1:5380	Yes	Negligible	Slight/Negligible
Corsehill Burn	1:100	1:592	1:4833	Yes	Negligible	Negligible
Red Moss Burn	1:100	1:765	1:6243	Yes	Negligible	Negligible
Blackdog Burn	1:100	1:104	1:852	Yes	Low	Slight
Middlefield Burn	1:100	1:378	1:3082	Yes	Negligible	Negligible

6.1.7 With mitigation, the residual impact on all watercourses as a result of accidental spillage is considered to be of Negligible to Slight/Negligible significance with the exception of Blackdog Burn where the residual impact is of Slight significance.

6.1.8 The results of the sensitivity tests on the assumed hardness values indicated that the levels of mitigation proposed would be sufficient even if the water hardness is reduced.

Construction

6.1.9 Residual impacts are of Slight/Negligible significance on the high sensitive watercourses (Gough Burn, Craibstone Burn, Bogenjoss Burn, River Don and Goval Burn), and of Negligible significance on Kepplehill Burn, Green Burn, Mill Lade, Corsehill Burn, Red Moss Burn, Blackdog Burn and Ditch and Middlefield Burn (Table 6-3). The watercourses that will be taken into pre-earthworks will be impacted downstream upon by construction activities with Negligible residual impact significance.

Summary

6.1.10 The residual impacts to receiving watercourses for the Northern Leg of the proposed scheme are summarised in Table 6-3 below.

Table 6-3– Residual Impact Assessment of Key Watercourses (residual impact of pollutant release included in overall assessment)

Watercourse	Sensitivity	Potential Impact Description	Potential Impact Significance	Residual Impact Description	Residual Impact Significance
Kepplehill Burn	Low	Construction: High impact from the potential risk of accidental spillage of pollutants during construction. Culverting of existing straightened channel will involve some earthworks, possibly resulting in sediment and pollutants release leading to short-term increased turbidity.	Moderate	Construction: Risk of sediment release or pollutant spillage will be minimised through best practice. Ongoing monitoring during the construction phase will identify any impact upon the water column at an early stage. Negligible residual impact magnitude.	Negligible
		General Operation: Change in water quality is likely to be negligible due to diffuse pollution. Length of culvert likely to slightly impact upon water quality due to lack of light. Routine Runoff: no outfall planned. Accidental Spillage: no outfall planned. Suspended Solids: no outfall planned.	Negligible	Operation: No outfall planned therefore negligible impact due to diffuse pollution. Change to discharge regime will be minimised through careful design of realignment and culverts. Culverts will be designed to carry a 1:200 year flow. Length of culvert likely to impact upon water quality due to lack of light.	Negligible
Gough Burn	High	Construction: High impact from the potential risk of accidental spillage of pollutants during construction due to proximity of works to watercourse. Culverting will involve some earthworks, possibly resulting in sediment and pollutants release and short-medium term increased turbidity in the water column.	Substantial	Construction: Risk of sediment release or pollutant spillage will be minimised through best practice. Ongoing monitoring during the construction phase will identify any impact upon the water column at an early stage. Negligible residual impact magnitude.	Slight/ Negligible
		General Operation: Change in water quality is likely to be negligible due to diffuse pollution. Length of culvert likely to slightly impact upon water quality due to lack of light. Routine Runoff: no outfall planned. Accidental Spillage: no outfall planned. Suspended Solids: no outfall planned.	Slight / Negligible	Operation: No outfall planned therefore negligible impact due to diffuse pollution. Change to discharge regime will be minimised through careful design of realignment and culverts. Culverts will be designed to carry a 1:200 year flow. Length of culvert likely to impact upon water quality due to lack of light.	Slight/ Negligible
Craibstone Burn	High	Construction: High impact from the potential risk of accidental spillage of pollutants during construction due to proximity of works to watercourse. Culverting will involve some earthworks, possibly resulting in sediment and pollutants release and short-medium term increased turbidity in the water column.	Substantial	Construction: Risk of sediment release or pollutant spillage will be minimised through best practice. Ongoing monitoring during the construction phase will identify any impact upon the water column at an early stage. Negligible residual impact magnitude.	Slight/ Negligible
		General Operation: Change in water quality is likely to be negligible due to diffuse pollution. Length of culvert likely to slightly impact upon water quality due to lack of light. Routine Runoff: no outfall planned. Accidental Spillage: no outfall planned. Suspended Solids: no outfall planned.	Slight / Negligible	Operation: No outfall planned therefore negligible impact due to diffuse pollution. Change to discharge regime will be minimised through careful design of realignment and culverts. Culverts will be designed to carry a 1:200 year flow. Length of culvert likely to impact upon water quality due to lack of light.	Slight/ Negligible

Watercourse	Sensitivity	Potential Impact Description	Potential Impact Significance	Residual Impact Description	Residual Impact Significance
Green Burn	Medium	Construction: Extensive culverting and realignment will involve major earthworks, possibly resulting in increased suspended solid loads in the short-term. Possible high impact from the potential risk of accidental spillage of pollutants during construction due to proximity of works to watercourse.	Moderate/ Substantial	Construction: Risk of sediment release or pollutant spillage will be minimised through best practice Ongoing monitoring during the construction phase will identify any impact upon the water column at an early stage. Negligible residual impact magnitude.	Negligible
		General Operation: A major shift form baseline conditions due to discharge of road runoff. Long-term adverse impact on water quality and ecology. Routine Runoff: High impact from routine runoff due increase of over 100% over baseline for copper (1198%) and zinc (662%) resulting of failure of EQS. Accidental Spillage: High impact from accidental spillage (1:64) as spillage risk is below the probability threshold of 1 in 100 years. Suspended solids: Q_{mean} for Green Burn is 0.037m^3/s which indicates a medium dilution capacity, therefore suspended solids will pose a medium impact magnitude.	Moderate/ Substantial	Operation: Road runoff will be treated through SUDS to ensure compliance with EQS and that the pollution risk from accidental spillage is within acceptable limits. Routine Runoff: Low impact from routine runoff - increase of 34% over baseline for copper. Accidental Spillage: Negligible impact from accidental spillage as spillage risk is 1 in 4298 years which is above the probability threshold of 1 in 1000 years. Suspended solids: SUDS will remove up to 90% of suspended solids therefore negligible impact.	Slight
Bogenjoss Burn	High	Construction: High impact from the construction of 6 culverts. This may increase the risk of pollution from concreting and fuel and oil spills due to amount of construction activity near watercourse. Extensive realignment and culverting in the upstream reach will involve extensive earthworks and could result in the release of sediment to the burn increasing temporarily the suspended sediment load.	Substantial	Construction: Risk of sediment release or pollutant spillage will be minimised through best practice. Ongoing monitoring during the construction phase will identify any impact upon the water column at an early stage. Negligible residual impact magnitude.	Slight/ Negligible
		General Operation: A major shift from baseline conditions due to discharge of road runoff. Length of culverts likely to impact upon water quality due to lack of light. Temporary to long-term adverse impact on water quality and ecology. Routine Runoff: High impact from routine runoff due increase of over 106% over baseline for copper and medium impact regarding zinc concentrations – 70% increase over baseline. Accidental Spillage: Negligible impact from accidental spillage as spillage risk is above the probability threshold of 1 in 1000 years (1:1075years). Suspended solids: Q_{mean} for Bogenjoss Burn is 0.021 m^3/s which indicates a medium dilution capacity, therefore suspended solids will pose a medium impact magnitude.	Substantial	Operation: Road runoff will be treated through SUDS to ensure compliance with EQS and that the pollution risk from accidental spillage is within acceptable limits. Routine Runoff: Negligible impact from routine runoff - increase of 22% over baseline for copper and 2% for zinc. Accidental Spillage: Negligible impact from accidental spillage as spillage risk is 1 in 25062 years, which is above the probability threshold of 1 in 1000 years. Suspended solids: SUDS will remove up to 90% of suspended solids therefore negligible impact.	Slight/ Negligible

Watercourse	Sensitivity	Potential Impact Description	Potential Impact Significance	Residual Impact Description	Residual Impact Significance
River Don	High	Construction: Bridging will involve up to 36 months major earthworks, possibly resulting in high sediment and pollutants release leading to increase in turbidity and water quality deterioration. High potential impact of cement, concrete and oils spills during construction due to proximity and duration of construction activities.	Substantial	Construction: Risk of sediment release or pollutant spillage will be minimised through best practice. Ongoing monitoring during the construction phase will identify any impact upon the water column at an early stage. Negligible residual impact magnitude.	Slight/ Negligible
		General Operation: A slight shift form baseline conditions due to discharge of road runoff. Temporary to long-term adverse impact on water quality and ecology. River Don is designated fisheries river therefore medium impact. Routine Runoff: Negligible impact from routine runoff due to great dilution capacity of the watercourse (0% increase over the copper and zinc baseline concentrations). Accidental Spillage: Low impact from accidental spillage as spillage risk is above the probability threshold of 1 in 200 years and below 1 in 1000 years (1:479 years). Suspended solids: Q_{mean} for River Don is 19.5 m^3/s which indicates a high dilution capacity, therefore suspended solids will pose a negligible impact magnitude.	Moderate	Operation: Road runoff will be treated through SUDS to ensure compliance with EQS and that the pollution risk from accidental spillage is within acceptable limits. Routine Runoff: Negligible impact from routine runoff (0% increase of copper and zinc). Accidental Spillage: Negligible impact from accidental spillage as spillage risk is 1 in 11164 years, which is above the probability threshold of 1 in 1000 years. Suspended solids: SUDS will remove up to 90% of suspended solids therefore negligible impact.	Slight/ Negligible
Goval Burn	High	Construction: Low potential for spillage of pollutants due to proximity, duration and amount of works proposed. Bridging at three locations will involve limited earthworks, possibly resulting in sediment and pollutants release leading to short-term increased turbidity in the water column. High dilution capacity of the watercourse.	Moderate	Construction: Risk of sediment release or pollutant spillage will be minimised through best practice. Ongoing monitoring during the construction phase will identify any impact upon the water column at an early stage. Negligible residual impact magnitude.	Slight/ Negligible
		General Operation: A slight shift form baseline conditions due to discharge of road runoff. Temporary to long-term adverse impact on water quality and ecology. Routine Runoff: Negligible impact from routine runoff due increase of 8% over baseline for copper and 5% for zinc. Accidental Spillage: Low impact from accidental spillage as spillage risk is above the probability threshold of 1 in 200 years and below 1 in 1000 years (1:659 years). Suspended solids: Q_{mean} for Goval Burn is 0.6 m^3/s which indicates a high dilution capacity, therefore suspended solids will pose a low impact magnitude.	Moderate	Operation: Road runoff will be treated through SUDS to ensure compliance with EQS and that the pollution risk from accidental spillage is within acceptable limits. Routine Runoff: Negligible impact from routine runoff - increase of 2% over baseline for copper. Accidental Spillage: Negligible impact from accidental spillage as spillage risk is 1 in 5380 years, which is above the probability threshold of 1 in 1000 years. Suspended solids: SUDS will remove up to 90% of suspended solids therefore negligible impact.	Slight/ Negligible
Mill Lade	Low	Construction: Construction activities close to watercourse may result in medium impact due to accidental spillage of concrete, oils etc. Bridging will involve limited earthworks, possibly resulting in sediment and pollutants release leading to short term increase turbidity in the water column.	Slight	Construction: Risk of sediment release or pollutant spillage will be minimised through best practice. Ongoing monitoring during the construction phase will identify any impact upon the water column at an early stage. Negligible residual impact magnitude.	Negligible

Watercourse	Sensitivity	Potential Impact Description	Potential Impact Significance	Residual Impact Description	Residual Impact Significance
		Operation: N/A	N/A	Operation: N/A	N/A
Corsehill Burn	Medium	Construction: High potential impact to water quality as a result of accidental spillage of pollutants from construction activities. Culverting and realignment will involve major earthworks, possibly resulting in high sediment and pollutants release within the water column.	Moderate/ Substantial	Construction: Risk of sediment release or pollutant spillage will be minimised through best practice. Ongoing monitoring during the construction phase will identify any impact upon the water column at an early stage. Negligible residual impact magnitude.	Negligible
		General Operation: A major shift form baseline conditions due to discharge of road runoff. Long-term adverse impact on water quality and ecology. Routine Runoff: High impact from routine runoff due increase of 180% over baseline for copper and 119% for zinc resulting in failure of EQS. Accidental Spillage: Low impact from accidental spillage as spillage risk is above the probability threshold of 1 in 200 years and below 1 in 1000 years (1:592 years). Suspended solids: Q_{mean} for Corsehill Burn is 0.026 m^3/s which indicates a medium dilution capacity, therefore suspended solids will pose a moderate impact magnitude.	Moderate/ Substantial	Operation: Road runoff will be treated through SUDS to ensure compliance with EQS and that the pollution risk from accidental spillage is within acceptable limits. Routine Runoff: Low impact from increase of 48% over baseline for copper and negligible impact from zinc-increase of 7% over baseline concentration. Accidental Spillage: Negligible impact from accidental spillage as spillage risk is 1 in 4833 years, which is above the probability threshold of 1 in 1000 years. Suspended solids: SUDS will remove up to 90% of suspended solids therefore negligible impact.	Slight
Red Moss Burn	Medium	Construction: Proximity of construction works to watercourse poses a medium increase to the risk of pollution from accidental spillage i.e. concrete, oil etc. However the works will only involve the construction of one culvert. Possible leakage from contaminated land (see Chapter 8 Geology, Contaminated Land and Groundwater, Table 8.7, Quarry – Leuchlands and Joss). Culverting and realignment will involve earthworks, possibly resulting in sediment and pollutants release and increased turbidity. Medium dilution capacity of the watercourse.	Moderate	Construction: Risk of sediment release or pollutant spillage will be minimised through best practice. Ongoing monitoring during the construction phase will identify any impact upon the water column at an early stage. Negligible residual impact magnitude.	Negligible
		General Operation: A major shift from baseline conditions due to discharge of road runoff. Long-term adverse impact on water quality and ecology. Routine Runoff: High impact from routine runoff due increase of 166% over baseline for copper and 110% for zinc resulting in failure of EQS. Accidental Spillage: Low impact from accidental spillage as spillage risk is above the probability threshold of 1 in 200 years and below 1 in 1000 years (1:765 years). Suspended solids: Q_{mean} for Red Moss Burn is 0.017 m^3/s which indicates a medium dilution capacity, therefore suspended solids will pose a moderate impact magnitude.	Moderate/ Substantial	Operation: Road runoff will be treated through SUDS to ensure compliance with EQS and that the pollution risk from accidental spillage is within acceptable limits. Routine Runoff: Low impact from increase of 44% over baseline for copper. Negligible impact from zinc - increase of 7% over baseline concentration. Accidental Spillage: Negligible impact from accidental spillage as spillage risk is 1 in 6243 years, which is above the probability threshold of 1 in 1000 years. Suspended solids: SUDS will remove up to 90% of suspended solids therefore negligible impact.	Slight

Watercourse	Sensitivity	Potential Impact Description	Potential Impact Significance	Residual Impact Description	Residual Impact Significance
Blackdog Burn	Medium	Construction: Proximity of construction works to watercourse poses a medium increase to the risk of pollution from accidental spillage i.e. concrete, oil etc. as the works will involve the construction of two culverts and realignments will involve major earthworks, possibly resulting in sediment release and short-medium term changes to turbidity in the water column. High dilution capacity of the watercourse.	Moderate	Construction: Risk of sediment release or pollutant spillage will be minimised through best practice. Ongoing monitoring during the construction phase will identify any impact upon the water column at an early stage. Negligible residual impact magnitude.	Negligible
		General Operation: A major shift from baseline conditions due to discharge of road runoff. Temporary to long-term adverse impact on water quality and ecology. Routine Runoff: High impact from routine runoff due increase of 128% over baseline for copper and medium impact of 84% over baseline concentration for zinc. Accidental Spillage: Medium impact from accidental spillage as spillage risk is below 1 in 200 years (1:104). Suspended solids: Q_{mean} for Blackdog Burn is 0.079 m^3/s which indicates a high dilution capacity, therefore suspended solids will pose a medium impact magnitude.	Moderate/Substantial	Operation: Road runoff will be treated through SUDS to ensure compliance with EQS and that the pollution risk from accidental spillage is within acceptable limits. Routine Runoff: Low impact from routine runoff - increase of 34% over baseline for copper and 5% for zinc. Accidental Spillage: Low impact from accidental spillage as spillage risk is 1 in 852 years, which is above the probability threshold of 1 in 200 and below 1 in 1000 years years. Suspended solids: SUDS will remove up to 90% of suspended solids therefore negligible impact.	Slight
Blackdog Ditch	Medium	Construction: High impact from the potential risk of accidental spillage of pollutants during construction due to proximity of works to watercourse. Culverting will involve some earthworks, possibly resulting in sediment and pollutants release and short-medium term increased turbidity in the water column.	Moderate/ Substantial	Construction: Risk of sediment release or pollutant spillage will be minimised through best practice. Ongoing monitoring during the construction phase will identify any impact upon the water column at an early stage. Negligible residual impact magnitude.	Negligible
		General Operation: Change in water quality is likely to be negligible due to diffuse pollution. Length of culvert likely to slightly impact upon water quality due to lack of light. Routine Runoff: no outfall planned. Accidental Spillage: no outfall planned. Suspended Solids: no outfall planned.	Negligible	Operation: No outfall planned therefore negligible impact due to diffuse pollution. Change to discharge regime will be minimised through careful design of realignment and culverts. Culverts will be designed to carry a 1:200 year flow. Length of culvert likely to impact upon water quality due to lack of light.	Negligible
Middlefield Burn	Low	Construction: Proximity of construction works to watercourse poses a high increase to the risk of pollution from accidental spillage i.e. concrete oil etc. as the works will involve the construction of three culverts. Culverting and realignment will involve major earthworks, possibly resulting in sediment release and short-medium term increase in turbidity. Low dilution capacity of the watercourse.	Moderate	Construction: Risk of sediment release or pollutant spillage will be minimised through best practice. Ongoing monitoring during the construction phase will identify any impact upon the water column at an early stage. Negligible residual impact magnitude.	Negligible

Watercourse	Sensitivity	Potential Impact Description	Potential Impact Significance	Residual Impact Description	Residual Impact Significance
		General Operation: A medium shift from baseline conditions due to discharge of road runoff. Long-term adverse impact on water quality and ecology. Routine Runoff: Medium impact from routine runoff due increase of 63% over baseline for copper and 27% for zinc resulting in failure of EQS. Accidental Spillage: Low impact from accidental spillage as spillage risk is above the probability threshold of 1 in 200 years and below 1 in 1000 years (1:378). Suspended solids: Q_{mean} for Middlefield Burn is 0.005 m^3/s which indicates a low dilution capacity, therefore suspended solids will pose a high impact magnitude.	Slight	Operation: Road runoff will be treated through SUDS to ensure compliance with EQS and that the pollution risk from accidental spillage is within acceptable limits. Routine Runoff: Negligible impact from routine runoff - increase of 16% over baseline for copper. Negligible impact for zinc – increase of 1% over the baseline concentration. Accidental Spillage: Negligible impact from accidental spillage as spillage risk is 1 in 3082 years, which is above the probability threshold of 1 in 1000 years. Suspended solids: SUDS will remove up to 90% of suspended solids therefore negligible impact.	Negligible

7 References

Alabaster, J.S. and Lloyd, R. (1980). Water Quality Criteria for Freshwater Fish. London, Butterworth: 297 pp.

Connell, D.W and G.J. Miller., 1984. Chemistry and Ecotoxicology of Pollution. John Wiley & Sons, NY.

CIRIA (1994) Control of pollution from highway drainage discharges, CIRIA Report 142 Construction Industry Research and Information Association, Luker M & Montague K.

CIRIA (1997) Culvert Design Manual, R168

CIRIA (2000) Sustainable urban drainage systems: design manual for Scotland and Northern Ireland. CIRIA C521, Construction Industry Research and Information Association.

CIRIA (2004) Sustainable Drainage Systems – Hydraulic, Structural and Water Quality Advice CIRIA C609 Wilson, S. Bray, R. and Cooper, P ISBN 0-86017-609-6

CIRIA (2006) Control of water pollution from linear construction projects: Technical guidance CIRIA C648 Murnane, E. Heap, A. and Swain, A ISBN 0-86017-648-7

CIRIA (2007) The SUDS manual CIRIA C697 Woods-Ballard, B. Kellagher, R. Martin, P. Jefferies, C. Bray, R. and Shaffer, P. ISBN 0-86017-697-5

Dangerous Substance Directive (76/464/EEC)

DFO (2000). Effects of sediment on fish and their habitat. DFO Pacific Region Habitat Status Report 2000/01. [http://www.pac.dfo-mpo.gc.ca/sci/psarc/HSRs/hab1.pdf]

DFO (2000). Effects of sediment on fish and their habitat. DFO Pacific Region Habitat Status Report 2000/01. [http://www.pac.dfo-mpo.gc.ca/sci/psarc/HSRs/hab1.pdf]

EA (1998) Treatment of Highway Runoff Using Constructed Wetlands

Freshwater Fisheries Directive (78/659/EEC)

Hamilton, RS & Harrison, RM (1991) Highway Pollution Elsevier Science Publications (London)

Hammerton, D (1996) An Introduction to Water Quality in Rivers, Coastal Waters and Estuaries, Chartered Institution of Water and Environmental Management Booklet 5 ISBN 1-870752-27-9

The Highways Agency *et al*. (1993) Design Manual for Roads and Bridges Volume 11 Section 3 Part 10.

The Highways Agency *et al*. (2006) Design Manual for Roads and Bridges Volume 11 Section 3 Part 10.

Institute of Hydrology, (1999). Flood Estimation Handbook. Vol.1-5. Institute of Hydrology, Wallingford. (now Centre of Ecology and Hydrology, Wallingford)

Jefferies, C (2004) SUDS in Scotland – The Monitoring Programme of the Scottish Universities March 2004 ISBN 1844321797

Maidment (1993) Handbook of Hydrology, McGraw Hill (New York) ISBN 0-07-039732-5

Mance, G & Yates, J (1984) Technical Report TR209 Technical Report: Proposed Environmental Quality Standards for List II Substances in Water: Zinc, Water Research Centre (WRc)

Mance, G, Brown, V & Yates, J (1984) Technical Report TR210 Technical Report: Proposed Environmental Quality Standards for List II Substances in Water: Copper, Water Research Centre (WRc)

Mouchel, November (2002), Western Peripheral Route (Northern Leg) Stage 2 Environmental Assessment Volume 1 – Written Report

Moy, F. Crabtree, RW, & Simms T. (2002) Long Term Monitoring of Pollution from Highway Run-off: Final Report December 2002 WRc Ref: UC 6037

Patel, J & Drieu, O (2005) Technical Note: Pollutant Build up and Run off on Highways; Expanding the Current Methodology for Additional Determinants. Journal of the Chartered Institution of Water and Environmental Management. Volume 19. September 2005 No. 3

SEDD (2000) River Crossings and Migratory Fish: Design Guidance: A Consultation Paper for the Scottish Executive

SEERAD (2000) Scottish Executive Guidance on Culverts and Migratory Fish

SEPA (2002) The Future for Scotland's Water: Guiding principles on the technical requirements of the Water Framework Directive.

SEPA (2004) Personal communication Deidre Caffrey

SEPA (2004) Personal communication D Clark

SEPA (2005) Personal communication Deidre Caffrey

SEPA (2005) Personal communication N Abrams

SEPA (2005) Water Quality Monitoring Data

SEPA website (Dec 2006) SEPA Position Statement to Support the Implementation of the Water Environment (Controlled Activities) (Scotland) Regulations 2005: Culverting of Watercourses

SEPA (2007) The Water Environment (Controlled Activities) (Scotland) Regulations 2005: A Practical Guide, Version 3. May 2007.

SEPA PPG01 General guide to the prevention of water pollution;

SEPA PPG04 Disposal of sewage where no foul sewer is available;

SEPA PPG05 Works in near or liable to affect watercourses;

SEPA PPG06 Working at construction and demolition;

SEPA PPG07 Refuelling Facilities;

SEPA PPG08 Storage and disposal of used oils;

SEPA PPG09 Prevention of Pollution by Pesticides;

SEPA PPG10 Highways depots;

SEPA PPG13 High pressure water and steam cleaners;

SEPA PPG18 Control of spillages and fire fighting run-off;

SEPA PPG21 Pollution Incident Response Planning

SEPA PPG22 Dealing with spillages on highways

Skinner, Young and Hastie (2003) Ecology of the Freshwater Pearl Mussel. Conserving Natura 2000 Rivers, Ecology Series No. 2

Scottish Development Department (Nov 1985) SDD Circular No. 34/1985 Guidance on the Implementation of the Directive 76/464/EEC on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community.

Urban Waste Water Treatment Directive (91/271/EEC)

Water Framework Directive (2000/60/EC)

Water Environment and Water Services (Scotland) Bill (2003)

World Health Organisation Website http://www.who.int/en/

8 Glossary

95-percentile concentration	value below which statistically 95% of the measured concentrations will lie.
Acute	pollution occurs as a result of a severe, usually transient, impact.
Adjustment	modification of river channel shape through erosion and deposition.
Adsorption	process of removal of heavy metals from the water column
Annual Average Concentration.	the average of the measured concentration for a period of one year
Bioaccumulation	process whereby certain chemicals in the environment accumulate in animal tissues.
Bioassimilation	process of accumulation of a substance within a habitat.
BOD	biological oxygen demand mg/l.
Boulder	particle of diameter > 256 mm ‘human head’ size and above.
Buffer Strip.	an area of land between the river channel and cultivated land that is uncultivated and often fenced off
Catchment	the total area of land that drains into any given river.
Channel	Capacity the volume of water that can be contained within a given section of river channel.
Channel	the course of a river including the bed and banks.
Chronic pollution	the result of ongoing low levels of pollution which may result in the accumulation of pollutants over a longer period of time (months/years).
Clay particle	of diameter < 0.002mm.
Coarse sediment.	sediment of grain diameter greater than 2 mm
Cobble	particle of diameter 64mm to 256mm, approximately “fist” sized.
Continuity	how continuous the flow or sediment transfer is within a particular watercourse. Culverts often break the continuity through promoting deposition.
Conveyance	how water is transported downstream (e.g. volume, speed).
Culvert	artificial structure, often concrete, for carrying water underground or under bridges
Desorption	process of reintroduction of heavy metals to the water column.

Discharge	the volume of water flow per unit time usually expressed in cubic metres per second ($m^3 s^{-1}$).
Embankment	artificial flood bank built for flood defence purposes, which can be flush with the channel or set back on the floodplain.
EQS	Environmental Quality Standards.
Erosion	the process by which sediments are mobilised and transported by rivers.
EU Water Framework Directive	Under this Directive, Member States must achieve “good ecological potential” in modified systems and prevent deterioration in the status of surface waters. Ecological status is to be assessed using a number of parameters, including hydromorphological (or fluvial geomorphological and hydrological) quality elements.
Fine sediment	sediment of grain diameter finer than 2 mm.
Flood	a high river flow following rainfall or snowmelt where a river flows out of its channel, sometimes affecting human activity.
Floodplain	area of the valley bottom inundated by water when a river floods.
Flow	regime description of how the flow in a river varies over time and how frequently and for how long high flows (floods) and low flows (during droughts) occur.
Fluvial geomorphology	the branch of geomorphology that describes the characteristics of river systems and examines the processes sustaining them.
Geomorphology	the study of features and processes operating upon the surface of the Earth.
Geotextile	fabric membrane used for bank stabilisation, usually to aid re-vegetation.
Gravel	particle of diameter between 2 mm and 64 mm.
Hydraulic	the force exerted by flowing water.
Hydrological	referring to the flow of water, specifically its routing and speed.
Hydrological regime	the quality and connection to groundwater reflect totally or neat totally undisturbed conditions.
In-stream	the part of the channel covered by water in normal flow conditions.
Load	the amount of sediment that is being carried by the river.
Meander	a bend in the river formed by natural river processes e.g erosion and deposition.
Modification	channel features that have been created by management interventions and often involve river engineering.
Morphological conditions	channel patterns and dimensions, flow velocities, substrate conditions and the structure and condition of the riparian zone correspond totally or nearly totally to undisturbed conditions (Source: EU Directive 2000/60/EC – The Water Framework Directive).

Oxidation	chemical reaction which results in the addition of oxygen to a molecule.
Pool	discrete areas of deep water, typically formed on the outside of meanders.
Q95	flow that is expected to be exceeded 95% of the time (m^3/s).
Qmean	mean flow (m^3/s).
QMED	median annual flood flow (m^3/s) (flow with a 2 year return period).
Reach	a length of an individual river which shows broadly similar physical characteristics.
Realignment	alteration of the planform channel (often by straightening) to speed up flows and reduce flood risk.
Redox	potential measure of the potential of the water for oxidation or reduction.
Reduction	chemical process where molecule gain an electron.
Re-naturalising	a formally modified channel that is adjusting to represent a more natural channel in terms of geometry and vegetation.
Reprofiling	reshaping a bank to improve its stability and potential habitat value (usually by reducing the angle of the slope).
Resectioning	alteration of the cross-sectional profile of a channel, often to speed up flows and reduce flood risk.
Riffle	a shallow, fast flowing section of water with a distinctly disturbed surface forming upstream-facing unbroken standing waves, usually over a gravel substrate.
Riparian land	on the side of the river channel.
River continuity	continuity of the river is not disturbed by human activities and allows the undisturbed migration of aquatic organisms and sediment transport.
River corridor	land to either side of the main river channel, including associated floodplain(s).
Rock armour	angular stone placed to protect eroding banks.
Routine Runoff	is the normal runoff from roads that may include the contaminants washed off the surface in a rainfall event and can result in either acute or chronic impacts.
Runoff	surface flow after rain which entrains and transports fine sediment from the slope to the channel.
SAC	special area of conservation.
salmonid	the family of fish species that includes the salmon trout and char.
Scour	erosion caused resulting from hydraulic action.
Sedimentation	the accumulation of sediment (fine or/and coarse) which was formerly being transported.

Side bars	gravel or other shallow deposits along the edges of straight sections of river channels.
Siltation	deposition of fine sediment (comprising mainly silt) on the channel bed often promoting vegetation growth if it is not flushed downstream regularly.
Sink	a deposit of sediment in the channel – the location where sedimentation is occurring.
Sinuous	a channel displaying a meandering course. High sinuosity relates to a channel with many bends over a short distance; low sinuosity is often used to describe a fairly straight channel.
SSSI	site of special scientific interest.
SUDS	sustainable urban drainage systems.
Suspended solids	typically fine sediment which is transported in suspension.
Treatment train	the application of a selection of drainage systems which provides treatment of the surface runoff such that the pollution impact on the receiving waters is minimised
TSS	total suspended solids (mg/l).
Turbidity	a density flow of water and sediment (suspended solids).
Two stage channel	a channel containing a bench like feature or features (berms) which create a low flow channel within a wider high flow channel.
Waterbody	any water feature, i.e. river, lake, burn, loch, pond, moss etc.
Watercourse	any brook, stream, or artificially constructed water channel
Woody Debris	accumulations of woody material derived from trees, usually fragments of the branches, trunk and roots.