11 Road Drainage and the Water Environment

11.1 Introduction

11.1.1 Purpose & Scope of the Assessment

This Chapter addresses the potential effects on the water environment as a result of the A82 Pulpit Rock scheme ("the scheme"). The water environment includes surface waters (e.g. rivers, burns, static water bodies, tidal waters, etc.) and groundwater (e.g. shallow and deep aquifers). The assessment process comprised of characterisation of the existing water environment, identification and prediction of potential effects, and recommendations for any mitigation measures required to offset any significant effects.

11.1.2 Planning Framework

Apart from general statutory and planning requirements for a scheme of this nature, the water environment aspects are regulated by a number of EU, Scottish and Local instruments, including:

- EU Directive 2000/60/EC (Water Framework Directive (WFD)), transposed into the Water Environment and Water Services Act (Scotland) 2003 (the "WEWS" Act),
- The Water Environment (Controlled Activities) (Scotland) Regulations 2005 in respect of discharges to surface or groundwater,
- SPP (Scottish Planning Policy), Flooding and Drainage sections,
- SEPA Policy No. 22 (Flood Risk Assessment Strategy),
- SEPA Policy No. 41 (SEPA – Planning Authority Protocol, Development at Risk of Flooding: Advice and Consultation),
- SEPA Policy No. 19 (Groundwater Protection Policy for Scotland), and
- The National Park Authority's and the Local Authority's Structure Plans and Local Plans.

This legislation and guidance aims to protect and enhance the status of aquatic ecosystems, prevent further deterioration to such ecosystems, promote sustainable use of available water resources, and contribute to the mitigation of floods and droughts.

The resultant influence of this statutory and planning regime is discussed in Section 11.3.5 in deriving a set of key issues and constraints for the water resource aspects of the Scheme.

11.1.3 Study Area

The section of the A82 under consideration is situated approximately 2km to the south of Ardlui on the west shore of Loch Lomond. The general topography is such that relatively steep slopes fall from the hills surrounding Loch Lomond down to the

loch shore. All surrounding surface water features tend to drain at approximately 90 degrees to the A82, and then straight into Loch Lomond after passing through culverts under the A82, which is situated right on the loch shore at this location.

In the context of these proposals, there are nine water resources features that have been identified as part of this assessment. Within the 250m boundary considered around the scheme (refer to Figure 11.1 – Water Resources Study Area) the significant water resources features include:

- Loch Lomond,
- Three small surface watercourses,
- Four areas of surface water run off (Drainage Paths) from highly localised catchments, and
- The Groundwater beneath the Scheme.

11.1.4 Water Resources Related Proposals

A full description of the scheme is included in Chapter 2 - Scheme Description.

11.1.4.1 Existing Road Drainage & Outfalls

To put the new proposals into context, it is necessary to understand the existing road drainage in the vicinity of Pulpit Rock. No formal drainage plans exist for this section of the A82, and the following information has been collected from site visits and discussions with the design team. This existing section of road drains via over the edge run off from the carriageway either directly onto the loch shore or down the adjacent embankment away from the loch depending on the cross fall direction on the existing carriageway (Refer to Figure 11.2 - Existing Drainage for details).

11.1.4.2 Proposed Road Drainage & Outfalls

As is standard for all new roads schemes, SEPA has requested that Sustainable Drainage System principles are applied where possible. The format of the drainage scheme should be in accordance with the technical guidance set out in CIRIA Report C697 “The SUDS manual”. In response to this, but based on the restricted nature of the site, the road drainage design incorporates varying levels of treatment (refer to Figure 11.3 - Drainage Proposals for full details).

The proposals for the southern section of the scheme will remove surface run-off using a combined kerb system along the viaduct structure. Once off the structure to the south a carrier drain will run along the existing road. Further south the flow will pass through a short section of filter drain before discharging into the loch. The drainage for the southern section of the scheme provides 1 level of SUDS treatment.

On the middle section of the Scheme, a combined kerb system, will be utilised along the viaduct structure. Once off the structure to the north a filter drain will direct the flow to a dry swale before draining to Watercourse 2 and hence into the loch. The drainage for the middle section of the scheme provides 2 levels of SUDS treatment.

The northern section of the scheme will drain as per the existing regime (i.e. over the edge drainage).

These measures have been agreed with SEPA (refer to email dated 04/08/10 in Appendix 1A).

11.1.4.3 Existing Watercourses and Watercourse Crossings

Three existing culverts run under the A82 within the scheme extents and these will be maintained under the proposals. The two culverts at the north end of the scheme will be lengthened by up to 10m and potentially replaced to support the widening of the existing carriageway. Culvert 3 at the south end of the scheme will not be altered under the proposals. Around 60m of the channels of the three watercourses at the northern end of the scheme will be realigned as part of the proposals.

11.2 Approach and Methods

The assessment methodology used in this Chapter is based on the generic methodology presented within Chapter 4 - Assessment Methodology. Into this methodology, the guidance and techniques presented within the Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 10 "Road Drainage and the Water Environment" have been incorporated. The following section gives further detail in regard to how the potential effects on the water resources, which may arise from the construction and operation of the Scheme, were assessed.

11.2.1 Baseline Conditions

Water resources features around the development site were identified initially from Ordnance Survey maps, a desktop review of previous reports and other background information, and data collected from a site visit. This initial review was supplemented by consultations with statutory organisations and further consideration of available data. The study area assessed extends 250m around the scheme for surface water features, whilst groundwater features were considered over an area extending 500m around the Scheme.

11.2.1.1 Surface Waters

Geo-morphological and Hydrological Data

Geo-morphological conditions for each water resources feature were evaluated from Ordnance Survey mapping, data collected during the field surveys for this ES, data collected from a review of the Chapter 9 – Ecology and Nature Conservation (E&NC), and information from the ground investigations completed for the engineering design.

No hydrological data was available for any of the small watercourses or drainage paths and therefore assessments of the potential flows in these watercourses and drainage paths were made using standard hydrologic techniques (Institute of Hydrology Report 101 "Low flow estimation in Scotland") where necessary. It is noted that these flows have been derived for the purposes of this assessment only,

and the designers will be responsible for the detailed design of the road drainage system.

Flooding information was gained from the SEPA Indicative River & Coastal Flood Map (Scotland) for the surrounding area and historical loch levels were obtained from SEPA for the gauging station at Ross Priory to enable an assessment of whether the proposals may affect any identified floodplains.

Water Quality Data

SEPA have developed a classification system in line with the requirements of the Water Framework Directive, which is applied to all significant water bodies in Scotland. This system is based on an assessment of key chemical and ecological indicators. The classification system categorizes water bodies into the following bands; High, Good, Moderate, Poor, and Bad (a full description of this system is available on the SEPA website http://www.sepa.org.uk/water/monitoring_and_classification.aspx).

The small watercourses do not possess a formal SEPA classification. Therefore, the evaluation of baseline water quality in this Chapter for the small watercourses has been estimated based on the estimated water quality classification of the loch, larger watercourses in the area with a classification, and the overall setting of the watercourses.

For the purposes of this assessment, the present water quality objectives for all of the surface water features in this area are assumed to be the achievement of Good status in line with the long term objective for Loch Lomond.

11.2.1.2 Groundwater

Groundwater data was sourced from:

- Consultations with SEPA in regard to any areas of known pollution within the study area,
- Details from the Ground Investigations undertaken for the engineering design of the scheme (including borehole and trial pit logs, groundwater level measurements, desk top ground investigation, etc.),
- The following mapping derived by SEPA for the characterisation of groundwater for the WFD – “Groundwater Vulnerability Map”, “Superficial Aquifer Map”, and the “Bedrock Aquifer Map”, and
- The groundwater data sheets published by SEPA showing the current classification of the groundwater for the area,

Based on the absence of properties within or adjacent to the development boundary (the nearest properties are at Stuckendroin more than 500m from the development) no consideration was given to the presence of private water supplies.

11.2.2 Impact Identification

Identification of the possible range and location of potential impacts was based on:

- The guidance within DMRB Volume 11, Section 3, Part 10 "Road Drainage and the Water Environment",
- The professional experience of the assessment team,
- Consultation with relevant statutory and non-statutory organisations,
- Desk and site based research,
- An EIA scoping report and a DMRB Stage 2 report previously prepared, and
- Liaison with other chapter authors, and in particular the authors of Chapter 9 – E &NC

From this work a list of impacts considered to have potential to cause adverse effects on the water resource features was derived (see Section 11.4). It is noted that environmental effects on the water resource features may also lead to other impacts (such as changes to the aquatic ecology), which are addressed separately in the ES (Chapter 9 – E &NC).

11.2.3 Impact Assessment

Impact assessment was based on the generic assessment methodology presented in Chapter 4 – Assessment Methodology and the guidance and techniques presented within DMRB Volume 11, Section 3, Part 10 "Road Drainage and the Water Environment".

11.2.3.1 Sensitivity of Receptor

The sensitivity of a water resources feature is a synthesis of its environmental importance, socio-economic value, recreational value, and also its resilience to cope with change. The sensitivity of a water resources feature was evaluated using the guidance provided in Tables A4.1 "Water Features: Attributes and Indicators of Quality" & A4.3 "Estimating the Importance of Water Environment Attributes" (DMRB). From this guidance the following objective tests have been used in this Chapter to assess sensitivity:

- The environmental importance of the water resources feature; e.g. if it has a designation at an international or national level (e.g. Special Area of Conservation, SSSI, etc.) or if the water body has a high or good status and is therefore a valuable pristine habitat, then this would tend to increase the sensitivity value of the receptor,
- The socio-economic value of the water body e.g. if the water body has notable aquatic ecological resources (e.g. an important local or national fishery) or if the surface water or groundwater is in a drinking water protected area as defined in the SEPA WFD Protected Areas Register, then this would tend to increase the sensitivity value of the receptor,
- The recreational value of the water body e.g. if an area is a SEPA designated bathing area or if a watercourse is an important local fishery this would tend to increase the sensitivity value of the receptor, and

- The size of the water body and its ability to buffer flow and water quality changes e.g. if a water body has high dilution characteristics compared to a small proposed discharge then its sensitivity value would tend to be lower.

In accordance with the generic methodology provided in Chapter 4 – Assessment Methodology, sensitivity has been scaled from Negligible to Low to Medium to High to Very High. In this Chapter a Negligible or Low sensitivity attribute are both considered to be equivalent to the Low Importance stated in Table A4.3 (DMRB). To ensure the transparency of this assessment, the key environmental, socio-economic, recreational, and resilience indicators used to derive the sensitivity of each water body are identified in Section 11.3 "Baseline Conditions".

11.2.3.2 Impact Magnitude

The magnitude of a potential effect on the water resources features was evaluated using the criteria provided in Table A4.4 "Estimating the Magnitude of an Impact on an Attribute" (DMRB), with the addition of the following criteria to cover areas not specifically dealt with in the DMRB criteria. It is noted that impact magnitudes described below are all phrased assuming adverse impacts, but these general classifications have also been used, where appropriate, to describe beneficial impacts from the Scheme:

Severe – (equivalent to "Major Adverse" in DMRB see below for DMRB "typical examples") – results in loss of attribute and / or quality and integrity of attribute.

Surface Water: Failure of both soluble and sediment-bound pollutants in HAWRAT (Method A, Annex I) and compliance failure with EQS values (Method B). Calculated risk of pollution from a spillage >2% annually (Spillage Risk Assessment, Method D, Annex I). Loss or extensive change to a fishery. Loss or extensive change to a designated Nature Conservation Site.

Groundwater: Loss of, or extensive change to an aquifer. Potential high risk of pollution to groundwater from routine runoff – risk score >250 (Groundwater Assessment, Method C, Annex I). Calculated risk of pollution from spillages >2% annually (Spillage Risk Assessment, Method D, Annex I). Loss of, or extensive change to, groundwater supported designated wetlands.

Flood Risk: Increase in peak flood level (1% annual probability) >100 mm (Hydrological Assessment of Design Floods and Hydraulic Assessment, Methods E and F, Annex I).

Additional criteria used in this assessment:

- Degrading of the existing water quality classification,
- Significantly increased risk of flooding to residential or commercial properties (this is in lieu of the DMRB increase in flood level >100mm),
- Loss of or serious effect on the integrity of an internationally or nationally designated aquatic ecological resource,

- Gross changes to geo-morphological or hydraulic characteristics e.g. loss of natural bank and bed over a length of 50m or more, reduction in flow capacity of an existing river channel by 20% or more, and
- Widespread effect on groundwater movement with a gross change to overall groundwater transfer from up gradient to down gradient resources. Widespread and gross effects on groundwater quality.

Moderate – (equivalent to "Moderate Adverse" in DMRB see below for DMRB "typical examples") – results in effect on integrity of attribute or loss of part of attribute.

Surface Water: Failure of both soluble and sediment-bound pollutants in HAWRAT (Method A, Annex I) but compliance with EQS values (Method B). Calculated risk of pollution from spillages >1% annually and <2% annually. Partial loss in productivity of a fishery.

Groundwater: Partial loss or change to an aquifer. Potential medium risk of pollution to groundwater from routine runoff – risk score 150-250. Calculated risk of pollution from spillages >1% annually and <2% annually. Partial loss of the integrity of groundwater supported designated wetlands.

Flood Risk: Increase in peak flood level (1% annual probability) >50 mm

Additional criteria used in this assessment:

- Degrading of either the combined chemical or ecological status indicators (in the case of watercourses) one or more classifications, but no change in overall classification,
- Slight increased risk of flooding to residential or commercial properties (this is in lieu of the DMRB increase in flood level >50mm),
- Slight impact on an internationally or nationally designated aquatic ecological resource, or a loss or serious effect on the integrity of a nationally or locally important aquatic ecological resource that is not designated,
- Significant, but not gross, changes to geo-morphological or hydraulic characteristics e.g. loss of natural bed and bank over a length of 20m or more, reduction in the area of an existing watercourse channel by less than 20%, and
- Widespread effects on groundwater movement with a measurable, but not gross, effect on overall groundwater transfer from up gradient to down gradient resources. Widespread, but not gross, effects on groundwater quality.

Slight – (equivalent to "Minor Adverse" in DMRB see below for DMRB "typical examples") – results in some measurable changes in attributes quality or vulnerability.

Surface Water: Failure of either soluble or sediment-bound pollutants in HAWRAT Calculated risk of pollution from spillages >0.5% annually and <1% annually.

Groundwater: Potential low risk of pollution to groundwater from routine runoff – risk score <150. Calculated risk of pollution from spillages >0.5% annually and <1% annually. Minor effects on groundwater supported wetlands.

Flood Risk: Increase in peak flood level (1% annual probability) >10mm

Additional criteria used in this assessment:

- Degrading of two or more chemical or ecological status indicators (in the case of watercourses), but with no change in either overall or the individual water or biological quality classifications,
- Some increased risk of flooding in rural areas immediately adjacent to the Scheme, but not affecting property, infrastructure, or ecological resources (this is in lieu of the DMRB increase in flood level >10mm),
- Slight impact on a nationally or locally important aquatic ecological resource, or the loss of a moderate area of an abundant aquatic ecological resource,
- Minor changes to some geo-morphological or hydraulic characteristics e.g. loss of natural bed and bank over a length of less than 20m, reduction in the area of an existing watercourse channel by less than 5%, and
- Localised effect on groundwater movement but no measurable effect on overall groundwater transfer from up gradient to down gradient resources. Localised, measurable but not gross, effects on groundwater quality.

Negligible – (equivalent to "Negligible" in DMRB see below for DMRB "typical examples") – results in effect on attribute, but of insufficient magnitude to affect the use or integrity.

Surface Water: No risk identified by HAWRAT (Pass both soluble and sediment-bound pollutants). Risk of pollution from spillages <0.5%.

Groundwater: No measurable impact upon an aquifer and risk of pollution from spillages <0.5%.

Flood Risk: Negligible change in peak flood level (1% annual probability) <+/- 10 mm

Additional criteria used in this assessment:

- Degrading of one individual chemical or ecological status indicators (in the case of watercourses), but with no change in either the overall or the chemical or ecological quality classifications,
- Minor / no increased risk of flooding in rural areas (this is in lieu of the DMRB increase in flood level <10mm),
- Slight impact on a small area of an abundant aquatic ecological resource,
- Highly localised but not measurable changes in some geo-morphological or hydraulic characteristics, and
- Highly localised effect on groundwater movement but no effect on overall groundwater transfer from up gradient to down gradient resources. Localised, but not measurable, effects on groundwater quality.

11.2.3.3 Impact Significance

Overall Significance is considered to be a product of both the sensitivity of the receptor and the magnitude of the effect. Significance is scaled from Negligible to Minor, and Moderate, to Substantial. In assessing the product of sensitivity and magnitude, the Matrix for Determination of Level of Impact has been adopted and presented in Table 11.1 below. This is in lieu of Table A4.5 Matrix for Estimating the Significance of Potential Effects in the DMRB. This approach provides a transparent assessment for each water resources feature.

Table 11.1 - Matrix for Determination of Level of Impact

MAGNITUDE OF EFFECT	SENSITIVITY OF RECEPTOR				
	Very high	High	Medium	Low	Negligible
SEVERE	Substantial	Substantial	Moderate	Minor	Negligible
MODERATE	Moderate	Moderate	Minor	Minor	Negligible
SLIGHT	Moderate	Minor	Minor	Negligible	Negligible
NEGLIGIBLE	Negligible	Negligible	Negligible	Negligible	Negligible

Only impacts that are “Moderate” or “Substantial” (in grey) are considered to be Significant. The significance of a potential effect on the water resources features has been evaluated using the guidance provided in Table A4.6 “Qualifying Conditions for Overall Assessment Scores” (DMRB).

It is also valuable to attribute a level of confidence to the predicted impact assessment. Unless otherwise stated the impacts described in this Chapter are given at a high confidence level. Where impacts are given at a low confidence level, a reason shall be stated for this e.g. lack of detailed design data.

11.2.3.4 Mitigation

Mitigation measures considered appropriate for the avoidance and minimisation of effects on water resource features will be proposed in accordance with the generic guidance provided in Chapter 4 – Assessment Methodology.

11.2.4 Assessment Years

The baseline established for this assessment has been assumed to remain constant up to the time when the scheme is put in place (2013), and this is because the full implementation of improvement measures identified in the first round of River Basin Management Plans will not have significantly progressed. For the purposes of this assessment the baseline has been assumed to move towards Good status over the next 20 years, based on the objectives set by SEPA for the Loch Lomond North water body (based on 2009 data from SEPA RBMP Water body information sheet for water body 100339 in Clyde).

11.3 Baseline Conditions

11.3.1 Loch Lomond

The principal surface water resources feature within the study area is Loch Lomond, a large loch with a surface area of approximately 70km^2 and a catchment area of some 770km^2. The loch has two distinct morphological areas, with the northern area being long, narrow, and deep, whilst the southern area is broad and shallow. Whilst the catchment contains a number of environmental designations, the loch itself does not possess any specific designations. However, it does provide a valuable habitat for breeding birds and fish, most notably salmon (refer to sections 9.5.15 & 9.5.16 of the E&NC Chapter). It also supports an otter population, and there is evidence of otter activity within the footprint of the scheme (refer to section 9.5.14 of the E&NC Chapter). The loch shoreline in the vicinity of the proposals is steep, rocky, and heavily vegetated with trees and scrub. The SEPA RBMP Water body information sheet for Loch Lomond (North) notes morphological alterations to the shore from multiple sources as a pressure on the water body, and this is one of the reasons it fails to meet good ecological status. Morphology status is currently classed by SEPA as moderate, and the 2009 – 2015 RBMP objectives are to retain this status.

The loch is an important source of drinking water (both south and north basins are "Drinking Water Protected Zones" as defined in the SEPA WFD Interactive Map) and it is also extensively used as a recreational fishery.

The loch is currently classified by SEPA under the Water Framework Directive, with both the north and south basins possessing a "Poor" status with Medium confidence in 2009, downgraded from "Moderate" status in 2006, with all component parameters (i.e. overall chemistry, overall ecology, etc.) testing the same for both the north and south basins. Environmental objectives have been set by SEPA, for both northern and southern Loch Lomond over future River Basin Management Planning cycles in order to sustainably improve its status to "Moderate" in 2021, and gradually to develop to "Good" status in 2027 (based on 2009 data from SEPA Water body Information Sheets).

It is noted that in the assessment of the sensitivity below, only the features relevant to the study area have been considered i.e. only Loch Lomond North basin data has been considered.

Table 11.2 Loch Lomond Sensitivity Assessment

Receptor	Environmental Importance	Socio-Economic Value	Recreational Value	Resilience of Water Body	Overall Sensitivity
Loch Lomond	Water body WFD Status (2009 data) assessed as "Poor" / otters (low / local value) & fish (high / national value) (refer to section 9.6)	Important drinking water supply (Drinking Water Protection Zone) / significant fishery	Extensive use for pleasure craft / water sports / and fishing (refer to section 10.3)	Very large with reasonable ability to buffer discharges, but pressures from farming, recreation, sewage disposal, & multiple morphological	High

Receptor	Environmental Importance	Socio-Economic Value	Recreational Value	Resilience of Water Body	Overall Sensitivity
				pressures on the shoreline	

[1] Effects on recreational water users are not considered within this chapter but are covered in Chapter 10, Section 10.4.

11.3.2 Three Small Watercourses

There are three small watercourses at the northern end of the scheme as shown on Figure 11.2 – Existing Drainage. None of these watercourses are shown on 1:50,000 or 1:25,000 OS mapping, and they appear to drain relatively small catchments, all less than 0.5km^2.

Watercourse 1 drains the mixed rough grazing / woodland area to the west of the Scheme. It is culverted under the railway line to the west and therefore also drains part of the adjacent hillside. A large proportion of the flow in this watercourse passes under the A82 in Culvert 1, however, there is a drainage ditch running along the side of the A82. Consequently, a proportion of the flow continually spills into this ditch, which in turn joins with Watercourses 2 & 3 and passes to Culvert 2. Adjacent to the A82 the watercourse was observed as being generally less than 0.5m wide and is relatively shallow and moderately fast flowing with earthen banks.

Watercourse 2 drains the mixed rough grazing / woodland area to the west of the Scheme. It is culverted under the railway line to the west and therefore also drains part of the adjacent hillside. This watercourse joins with Watercourse 3 and passes under the A82 in Culvert 2. Adjacent to the A82 the watercourse was observed as being generally less than 0.5m wide and is relatively shallow and moderately fast flowing with earthen banks.

Watercourse 3 drains the mixed rough grazing / woodland area to the west of the Scheme. It is culverted under the railway line to the west and therefore also drains part of the adjacent hillside. This watercourse joins with Watercourse 2 and passes under the A82 in Culvert 2. Adjacent to the A82 the watercourse was observed as being generally less than 0.5m wide and is relatively shallow and moderately fast flowing with earthen banks.

Given the small size and similar nature of all of these watercourses and the similar manner in which they will be affected by the scheme they have been generally grouped together for the purposes of this assessment. Given their small size and varied nature of the topography it is difficult to accurately define their catchments. Where necessary for the surface water drainage assessment (Method A in the DMRB HD 45/09) the catchment sizes have been estimated based on a review of the contours on OS mapping and a site visit. The average daily flows in all these watercourses will be relatively small based on the catchment areas noted above.

In terms of water quality, the watercourses are not monitored by SEPA and therefore a classification has had to be derived for the purposes of this assessment based on the water quality classification of the loch, watercourses in the area with a classification, and the overall setting of the watercourses. Given the following: -

- The WFD status of the loch is "Poor", but this partly relates to various point discharges, water abstraction, and recreational use and does not necessarily relate to the quality of the inflowing watercourses,
- Adjacent watercourses have mixed WFD statuses due to various pressures such as hydroelectric flow regulation, etc.
- The catchments of the small watercourses themselves appear to be largely natural with no evidence of major sources of diffuse or point pollution

Therefore the watercourses have been assigned a WFD status of "Moderate" for the purposes of this assessment. No high value fisheries have been noted in the small watercourses (refer to section 9.5.16 of the E&NC Chapter for further details). Otter activity is noted in the area with the possibility of one of the larger burns acting as a dispersal route for otter (refer to section 9.5.13 of the E&NC Chapter for further details).

Table 11.3 Three Small Watercourses Sensitivity Assessment

Receptor	Environmental Importance	Socio-Economic Value	Recreational Value	Resilience of Water Body	Overall Sensitivity
Small water-courses (northern end of the Scheme)	Water body WFD Status assumed "Moderate" / No formal designations / / Limited fisheries interest / some otter activity	Not a fishery or a direct water supply, but is part of the overall catchment which is a Drinking Water Protection Zone	No direct uses but indirectly related to water quality of the loch and fishery of the loch	Low ability to buffer discharges given small catchment and low flows	Low

11.3.3 Four Surface Water Drainage Paths

There are four surface water drainage paths that discharge in the middle section and within the southern section of the scheme as shown on Figure 11.2 – Existing Drainage. None of these drainage paths are shown on 1:50,000 or 1:25,000 OS mapping, and they generally consist of local drainage channels draining small areas in the order of a few hundred to a few thousand square metres.

Drainage Path 1 flows down the steep rock slope in the middle section of the scheme and consists of a continual dripping of water. There is no culvert under the A82 and it is understood this run off either drains across the carriageway or into the verge.

Drainage Path 2 flows down the steep rock slope at the southern end of the Scheme, and this passes under the A82 in Culvert 3. This drainage path has a very narrow channel, which is predominantly on the rock itself. The drainage area for this feature includes the surrounding steep slopes up to the railway retaining wall, and then via a culvert under the railway there is also a drainage area estimated to be in the order of a few thousand square metres to the west of the railway.

Drainage Path 3 is a small rough gully eroded into the soft material overlying the rock and is adjacent to Drainage Path 2. The drainage area for this feature includes the

surrounding steep slopes up to the railway retaining wall, and is estimated to be in the order of a few hundred square metres.

Drainage path 4 is a small rough gully eroded into the soft material overlying the rock and is adjacent to where the southern outfall of the scheme discharges to Culvert 4. The drainage area for this feature appears to include the surrounding steep slopes up to the railway, and is estimated to be in the order of a few hundred square metres.

Given the small size and similar nature of all of these Drainage Paths they have been generally grouped together for the purposes of this assessment.

In terms of water quality, these Drainage Paths are not monitored by SEPA and therefore a classification has had to be derived for the purposes of this assessment. Based on the rationale noted previously for the small watercourses these Drainage Paths have been assigned a WFD status of "Moderate". These Drainage Paths have not been noted as possessing any significant aquatic ecological features in Chapter 9 - E&NC.

Table 11.4 Four Surface Water Drainage Paths Sensitivity Assessment

Receptor	Environmental Importance	Socio-Economic Value	Recreational Value	Resilience of Water Body	Overall Sensitivity
Surface Water Drainage Paths in Middle and Southern Sections of the Scheme	Water body WFD Status assumed "Moderate" / No formal designations / Overall catchment is a Drinking Water Protected Area	Not a fishery or a drinking water supply, but an indirect drinking water supply via the loch	No direct uses but indirectly related to water quality of the loch and fisheries	Low ability to buffer discharges given small catchment and low flows	Low

11.3.4 Groundwater

The following groundwater data has been gathered:

- A desktop geological report (from British Geological Survey) shows that the site is underlain by bedrock which is at or close to the surface and that the superficial deposits are expected to be thin and consist of glacial till. The same report notes that groundwater is likely to occur at a shallow depth within the bedrock near to the loch, and given the bedrock formation it is expected that it will have negligible inter granular permeability and groundwater movement is therefore dominated by fracture flow. This results in a bedrock aquifer of low productivity, which is highly vulnerable to contamination from surface activities. The desktop report identified that there were no records of historical water wells.
- The SEPA "Bedrock Aquifers" map classifies the bedrock as "fracture flow with low productivity", which ties in with the desktop assessment. The SEPA "Superficial Aquifers" map does not show any drift deposits in this area. The SEPA "Vulnerability of Groundwater in the Uppermost Aquifer" map records the area as "Category 4b – 5" i.e. highly vulnerable.

- Based on a review of desktop information and a site visit by a geotechnical engineer the following additional information is noted in regard to the bedrock. The bedrock beneath the study area belongs to the Beinn Behula Schist Formation of Dalradian age and is expected to consist mainly of psammites and pelite (metamorphosed sandstones and siltstones – quartz-mica-schists, grits and gneisses). Both the northern and southern ends of the study area have bands of purple slate. The rock at cut faces is schist with occasional bands of quartz. The rocks at rock head are likely to be hard owing to the removal of weathered and less competent rock by glacial action. A west-southwest to east-northeast trending felsitic dyke, about two to three metres wide, is present at the southern end of the study area. In addition, a northeast to southwest trending fault/lineament traverses the study area leading to the possibility of a zone of fractured and crushed bedrock beneath the study area. There is also inclined foliation directly throughout the study area, in a west to east direction with a dip of 28˚ to 36˚. These features of the bedrock make its composition and properties very variable. It may also contain large quantities of water held within the cracks and fissures of the fault zone.
- Based on a review of the desktop information and a site visit by a geotechnical engineer the following additional information is noted in regard to the drift deposits. There are currently no published geological maps of the drift deposits available for the study area. The desktop geological report indicates that the drift deposits are expected to be generally thin, patchy and likely to consist mostly of glacial till. The glacial till is typically firm to very stiff, sandy and gravelly clay containing rock clasts of cobble to boulder size with irregular bands or lenses of sand and gravel. Evidence of the drift deposits from the site walkover tends to agree with this description as deposits, primarily of silt, clay bands and peat with some sand, were noted. Along the shoreline there are rocky slopes composed of gravel, cobbles and boulders. The depth of the drift deposits can be expected to be very variable though in general should not exceed 5m. Over much of the study area the bedrock is likely to be within 1m to 2m of the surface particularly at the summit of the rock hillside. A bathymetric survey of the loch bed indicates that whilst the bed is sloping, it is generally featureless. There are however possible boulders, rock outcrops and small rock promontories. The depth of the drift deposits beneath the loch range from 1m to 5m.
- The Ground Investigation information collected for the scheme confirms the presence of shallow groundwater (i.e. less than 5m below ground level) in most locations with the presence of numerous fractures within the bedrock.
- The area is a “Drinking Water Protection Zone” and a “Drinking Water (Groundwater)” area, as defined in the SEPA WFD Protected Areas Register. The study area does not possess any further groundwater protected area classifications. There are not considered to be any specific groundwater dependant sensitive habitats within the local study area, however it is noted that Loch Lomond generally is groundwater sensitive given that its quality will to some extent reflect that of the groundwater within the catchment.
- The quality of the groundwater is currently classified as “Good” by SEPA under the Water Framework Directive, with all component parameters (i.e. overall chemistry, overall ecology, etc.) for the area of the scheme (based on 2008 data

from SEPA Water body Data Sheets). The RBMP for this water body is to maintain the current WFD status.

Table 11.5 Groundwater Sensitivity Assessment

Receptor	Environmental Importance	Socio-Economic Value	Recreational Value	Resilience of Water Body	Overall Sensitivity
Ground-water	Overall catchment is a Drinking Water Protection Zone & Drinking Water (Groundwater) Area. Vulnerability is likely to be "highly vulnerable"	Overall catchment is a Drinking Water Protected Area & loch is a major water supply. Though no known direct groundwater abstractions in immediate vicinity of proposals	Not directly applicable to groundwater (but indirectly related to water quality of the loch and fisheries)	Overall groundwater body feeding the loch is relatively large (416km2)	High

It is noted that there is no recorded Scottish Water infrastructure within the study area. Furthermore, based on the absence of properties within or adjacent to the development boundary (the nearest properties are at Stuckendroin more than 500m from the development) no consideration was given to the presence of private water supplies.

11.3.5 Flooding

Review of the published SEPA flood map indicates that the A82 in this location appears to be out with the 1:200 year flood envelope. There are no known reported instances of flooding of the A82 within the development site. However, the SEPA written response to the EIA scoping consultation indicates that they believe parts of the development site potentially lie within the 1:200 year flood envelope. Data provided by SEPA for the Ross Priory Gauging Station (located 3km south of Balmaha) indicates a maximum recorded water level for Loch Lomond of 10.374mAOD, and a mean level of 8.00mAOD. From previous work carried out by Scott Wilson on Loch Lomond, SEPA provided data for this gauge covering the period from 1977 to 2007 (28 complete years). This data was recorded several times per day from 1978 to 1985, at 1-hour intervals from 1985 to 1990, and at 15-minute intervals from 1990 to 2007. For that earlier study a 1:200 year water level was estimated at 11.0mAOD.

The existing A82 within the development site appears to be all above 12mAOD, and this would suggest that it is unlikely to be flood affected. The new viaduct proposed is understood to be no lower than 12m AOD i.e. will tie into the existing road levels and generally follow the existing road profile. Refer to the viaduct cross section provided on Figure 2.2 – The Scheme which shows the general form of the viaduct in relation to the shoreline and loch levels. It is noted that in the SEPA response to the EIA scoping consultation, SEPA do not consider flood risk an issue for the development and have never requested an FRA for the Scheme.

11.3.6 Planning

11.3.6.1 Overarching Legislation

The WFD, enacted in Scotland by the Water Environment & Water Services Act (2003) aims to: protect and enhance the status of aquatic ecosystems; prevent further deterioration to such ecosystems; promote sustainable use of available water resources; and contribute to the mitigation of floods and droughts. A review of the SEPA WFD Interactive Map identified a number of designations for surface and groundwater features, and these have been noted in the Sections 11.3.1 - 11.3.4 and taken into account in the assessment of sensitivity.

11.3.6.2 SPP

SPP provides the current context for planning controls and includes the specific controls in relation to flood risk. SPP states as a general principle that "Development which would have a significant probability of being affected by flooding or would increase the probability of flooding elsewhere should not be permitted".

11.3.6.3 Structure & Local Plans

These documents were reviewed in terms of key policies affecting water resources features and the following policies are highlighted.

Argyll and Bute Structure Plan (2002)

Strategy DC 7 – Nature Conservation and Development Control

a) Development likely to have a significant effect on a Natura site will be subject to an appropriate assessment. The development will only be permitted where the assessment indicates that it will not adversely affect the integrity of the site, or, there are no alternative solutions and there are imperative reasons of overriding public interest.

b) On sites of national importance, SSSI and NNRs, development will only be permitted where it can be demonstrated that the overall objectives of the designation and the overall integrity of the designated area would not be compromised, or where adverse impacts are clearly outweighed by social or economic benefits of national importance

c) Development which impacts on Local Wildlife sites or other nature conservation interests, including sites, habitats or species at risk as identified in the Local Biodiversity Action Plan shall be assessed carefully to determine its acceptability balanced along with national – or local – social or economic considerations

d) Enhancement to nature conservation interests will also be encouraged in association with development and land use proposals

Strategy DC 10 – Flooding and Land Erosion

Proposed development which would be at significant risk of flooding or front erosion, or which would increase the risk to other land and property, or occupy the functional flood plain, will not be in accord with the structure plan. In some places, where it is feasible to manage the threat, suitable mitigation or other measures may be possible.

Loch Lomond and Trossachs National Park Plan (2007 – 2012)

Policy WM1 'Safeguarding and Enhancing the Water Environment' - A strategic approach to safeguarding and enhancing the Park's water environment will be delivered through a coordinated catchment-based approach to management, led by SEPA and delivered by a range of partners.

Loch Lomond and the Trossachs National Park Local Plan (2010)

Policy ENV10 Protecting the Water Environment – New development will be required to:

- Protect and enhance the natural heritage, landscape values and physical characteristics of water bodies (including biodiversity and geodiversity);
- Ensure no adverse impact on the water environment;
- Protect opportunities for public access to ad recreation and enjoyment on and around lochs, rivers, burns, wetlands and the coastal marine area;
- Have regard to any international designated Bathing Waters in the Park;

- Ensure that development has no adverse impact on the quantity of water available for drinking water and other uses; and
- Demonstrate that there would be no significant adverse impact on protected species or their habitats in the water body or its catchment area.

ENV12 Surface Water Drainage – Sustainable Urban Drainage Systems (SUDs) will be required for all new development except for single dwellings or where the surface water discharge is made directly to coastal waters. SUDs will be incorporated into the design of developments. Developments should also consider the impact of discharging surface water from large development to any watercourse by undertaking a Drainage Impact Assessment.

Policy ENV13 River Engineering Works and Culverts – River engineering work in or near water bodies that would have a significant adverse effect on water quality, quantity or flow rate, ecological status, riparian habitat, protected species or floodplains, either up or downstream from the works will not be supported.

There will be a presumption against the culverting of watercourses unless there is no alternative. Proposals for culverting of watercourses for land gain may only be justified if the applicant can demonstrate that:

- No other practical option exists that would allow the watercourse to remain open; and
- The proposed development is of over-riding public interest.

11.3.7 Consultations

The table below provides a summary of the water environment related issues highlighted during the consultation exercise completed for this ES, full details of all responses received can be found in Chapter 3 –Consultation.

Table 11.6 Water Environment Related Consultation Responses

Consultee	Consultee Response Summary
SEPA	Construction phase - environmental impact can be minimised by best practise and implementing mitigation measures particularly in relation to works in and around Loch Lomond. The EIA should refer to PPG notes and a construction method statement should be produced with reference to monitoring proposals. CAR Authorisation should be sought prior to all works either in or adjacent to a water body. Surface Water Drainage - reference to the SUDS manual should be made and any discharge should be in accordance with the Water Environment (Controlled Activities) (Scotland) Regulations 2005 (as amended). Seek to clarify culvert options and request that reference be made to the SEPA Regulatory Method RM08. Request information regarding the 'combined kerbing' on the bridge deck. Flood Risk - Proposed development site lies within the 1 in 200 year flood envelope of the Indicative River and Coastal Flood Map and may be at a medium to high risk of flooding. Does not take

	into consideration flooding arising from surface runoff, surcharged culverts or drainage systems.
SNH (Argyll & Stirling area)	Likely to be otter within the study area (European Protected Species). Fish - species Several fish species in the Loch, and advised that a full fisheries study be carried out and mitigation measures identified. Also highlighted the Loch Lomond Woods Special Area of Conservation (SAC) and cumulative effects on otters, which are both an EPS and qualifying feature of the SAC. Noted the intention to carry out an AA screening to ascertain the impacts on the SAC but also requested the assessment includes the cumulative impacts on otters of the Transerv maintenance schemes scheduled along the A82.
Argyll & Bute Council (Development Services)	No comments on water environment issues.
Loch Lomond Fisheries Trust	No direct response to water environment related issues. Report of the fisheries survey conducted in January 2010 provided.
Loch Lomond & The Trossachs National Park Authority	The Scoping Report identifies five water resources features within the 250m boundary considered around the proposed scheme. Impacts on water quality and potentially the geomorphology of all five features have been identified, mostly relating to surface water run off and increased sediment discharge resulting from construction and operation of the viaduct. Appropriate mitigation should be included in the EIA, such as incorporation of SuDs to reduce and dilute run-off. We note that the addition of a SuDs scheme is like to improve current surface water quality and rates of run-off into the Loch. The extent of, and impacts from, increased sediments are unclear at this stage, and viewing the initial surveys that have been undertaken in coordination with Loch Lomond Fish and Fisheries Trust on fish species would be helpful. In addition to the rates and quality of run off, the EIA should: - Ensure that the amount of sediment discharged is quantified and identify the appropriate mitigation, Identify riparian / loch shore areas which may require restoration and identify appropriate mitigation, Identify specific measures for control of potential oil spills, Identify any additional flood risk and appropriate mitigation. We also note reference to the Finalised Draft Local Plan environmental policies (Chapter 5 – Policies and Plans) which guide decision making on development in and around the water environment. There are specific policies for protecting the integrity of the water environment, SuDs and engineering works which should be considered in the development of the EIA (Policies ENV10 – ENV17). The EIA should also refer to the Water Framework Directive and the need to ensure that the development along Loch Lomond should not compromise its high quality status. We note that SEPA is a consultee on the proposed scheme and clarification of the appropriate authorisations to be sought and any accompanying information would be helpful to determine the extent of work involved. Additional interest groups who may wish to be kept updated on the project include the Loch Lomond Association, Friends of Loch Lomond and the Loch Lomond Fish and Fisheries Trust.

11.4 Predicted Impacts

As a result of the consultations, site visits and desktop studies, the issues requiring consideration in this assessment were identified as being those in the table below. The range of potential effects expected, their magnitude and the overall significance based on the sensitivity of the receptor are set out in the following sections. The effects are split into construction and operation stage effects. The magnitude of effect is stated based on the inclusion of the primary mitigation measures noted.

Table 11.7 Predicted Impacts

General Issue	Specific Issues	Receptor/s
Surface Water Quality	Sediment mobilisation and spillage or discharge of other pollutants into watercourses / drainage paths or the loch (Construction Phase)	Loch Lomond, Small Watercourses, & Drainage Paths
	Discharge of road run off to watercourses / drainage paths and indirectly into the loch (Operational Phase)	Loch Lomond, Small Watercourses, & Drainage Paths
	Other road and infrastructure maintenance (Operational Phase)	Loch Lomond, Small Watercourses, & Drainage Paths
Flooding	Flood risk to surrounding land from development (Construction Phase)	Surrounding land & infrastructure
	Flood Risk to surrounding land from development (Operational Phase)	Surrounding land & infrastructure
Geomorphology and Hydrology	Alteration of the Loch shore and the channels of the small watercourses / drainage paths (Construction Phase)	Loch Lomond, Small Watercourses, & Drainage Paths
	Alteration of the Loch shore and the channels of the small watercourses / drainage paths (Operational Phase)	Loch Lomond, Small Watercourses, & Drainage Paths
	Alteration to land drainage patterns (Construction and Operation Phase)	Small Watercourses & Drainage Paths
	Run off from the scheme into watercourses / drainage paths (Operation Phase)	Small Watercourses & Drainage Paths
Groundwater	Disturbance of groundwater movement (Construction Phase)	Groundwater beneath the site
	Contamination of groundwater (Construction Phase)	Groundwater beneath the site
	Disturbance of groundwater movement from the new road construction (Operational Phase)	Groundwater beneath the site
	Contamination of groundwater (Operational Phase)	Groundwater beneath the site

11.4.1 Construction Stage

Disruption due to Construction is addressed in Chapter 12 but the assessment of construction effects and mitigation within this Chapter will take precedence with regard to water resources features.

11.4.1.1 Surface Water Quality

The following assessment considers the potential for sediment release and spillage / discharge of pollutants (e.g. oils, fuels, chemicals) to surrounding waters during the construction phase, and the potential impacts that such a release may have on surface water quality.

Table 11.8 Surface Water Quality Predicted Impact Assessment (Construction)

Receptor(s)	Loch Lomond, Watercourses 1 – 3 & Drainage Paths 1 - 4
Relevant Scheme Information	The proposals involve significant earth / rock moving activities during construction. This presents a risk of surface water run off eroding bare slopes or material stockpiles, which can lead to increased suspended solids in watercourses. Working over Loch Lomond to construct the viaduct will involve cofferdams and piling (disturbance to sediment and increased turbidity) and working with concrete to form the deck (potential for spills). The proposals also involve minor works in and next to watercourses and drainage paths with potential for sediment disturbance and spillages. The construction phase generally presents the potential for fuels, oils, and other chemicals to be spilled via an accident, improper usage, or poor storage. These could reach the receptors directly via discharge of polluted run off or via seepage into the shallow groundwater. Construction workforce sewage and washing effluent should be contained and taken offsite. Based on the adoption of appropriate storage and pumping to a road tanker the risk of spillage to watercourses is considered to be negligible and this potential impact is therefore not considered further.
Sensitivity of Receptor(s)	High (Loch Lomond), Low (Watercourses 1 – 3) & Low (Drainage Paths 1 - 4)(see “Baseline” section)
Magnitude (and Type) of Effect	Slight Adverse (direct, localised to the area of loch shore around the works and a short length of watercourse channel just upstream and downstream of the A82, temporary) – the proposal includes works over the Loch to create the concrete viaduct and this provides a potential source of sediment disturbance and pollutants. The works also include plant working next to and over Watercourses 1, 2, & 3 and Drainage Path 4 to alter the alignment of the channels over a short length, earthworks to widen the carriageway, extension of the existing culverts, and construction of outfall headwalls. No specific works are undertaken in drainage paths 1 – 3, but there will be plant working in close proximity to these features. (Refer to section 9.7.15 of the E&NC Chapter for predicted impacts on fisheries from surface water quality – predicted at moderate adverse (pre-mitigation))
Overall Significance	Minor Adverse localised to shoreline around works (for Loch Lomond) & Negligible Adverse localised to 20m upstream of road (for Watercourses 1 – 3 & Drainage Paths 1 - 4)

11.4.1.2 Flooding

This part of the assessment considers whether or not the construction activities could affect the level of flood risk to surrounding land and infrastructure.

Table 11.9 Flooding Predicted Impact Assessment (Construction)

Receptor(s)	Surrounding land and infrastructure located adjacent to the identified surface water resources features, including areas upstream and downstream and on adjacent shores of the Loch
Relevant Scheme Information	During construction there will be vessels working adjacent to the loch shore, construction plant working on the loch shore, works required within the small watercourses in the northern section of the scheme to realign the channels of Watercourses 2 & 3 and extend / replace Culverts 1 & 2, and works in the vicinity of Culvert 4 to create a connection from the southern surface water drainage discharge.

	Some parts of the development site are potentially within the 1:200 year flood extents shown on the SEPA Indicative River & Coastal Flood Map. However, SEPA have recognised that the development cannot be located elsewhere and it is not likely to have an adverse effect on flood risk. It is also noted that the deck of the viaduct is generally above the indicative 1:200 year flood level. There are no properties (residential or non-residential) in the vicinity of the scheme (the nearest properties are at Stuckendroin more than 500m from the development).
Sensitivity of Receptor(s)	Rural land is considered as having a Low sensitivity to increased flood risk, but property (both residential and non-residential) is considered as having a High sensitivity to increased flood risk.
Magnitude (and Type) of Effect	Negligible Adverse (direct, highly localised, temporary) – based on no significant change to the loch's bathymetry during the works (i.e. only discrete supports being constructed along the 180m length of the viaduct) and the main viaduct structure being largely above the maximum recorded water level and the indicative 1:200 year flood level (i.e. works will not take up significant volume within the floodplain). Slight Adverse (direct, highly localised, temporary) – based on the potential for the works to realign the watercourse channels and extend the culverts to cause an obstruction to the flows down the watercourses. However, it is noted that these works require only small scale works within the watercourses, and it is considered that these can be completed without obstructing the passage of flows down the watercourses.
Overall Significance	Negligible Adverse (for both rural land and property)

11.4.1.3 Geomorphology & Hydrology

This assessment considers the potential effects of the construction works on the structure of the bed and bank of affected watercourses / drainage paths and the loch, as well as the flow conveyance of each of these features.

Table 11.10 Geomorphology & Hydrology Predicted Impact Assessment (Construction)

Receptor(s)	Loch Lomond, Small Watercourses, & Drainage Paths
Relevant Scheme Information	Geomorphology - during construction there will be works required within and over the loch to erect the 180m long viaduct. These works will cause disturbance to the steep loch shore along the full 180m length of the viaduct due to the temporary works required around each support location (e.g. piling plant, temporary support structures for piling plant, mooring points for floating work platforms, cofferdams, etc.). There will also be disturbance on the loch bed just offshore due to the temporary works required around each support. There will also be disturbance to the channels of the watercourses to extend the existing culverts by up to 10m on the land filled side of the A82 and the realignment of up to 60m of the channels of watercourses 1, 2 & 3. There will also be localised headwall and scour protection works on watercourse 2 to create an outfall from the drainage system. This type of structure is estimated to involve disturbance to the bed and bank for approximately 2 - 4m, although this is likely to be within the section of channel already scheduled for re-alignment. There will also be works required within / adjacent to drainage path 4 to connect the filter drain to the existing culvert, although this is only expected to involve disturbance to the last few metres of this feature. Hydrology – During construction there is potential for affecting the

	passage of flow down the watercourses and drainage paths if temporary works cause any restriction to the channels or the culverts (e.g. during earth moving and channel realignment operations).
Sensitivity of Receptor(s)	Loch Lomond – **High** (see "Baseline" section) Small Watercourses & Drainage Paths – **Low** (see "Baseline" section)
Magnitude (and Type) of Effect	Geomorphology – **Moderate Adverse** (direct, localised, temporary) for the small watercourses and drainage paths as more than 20m of any one feature is likely to be subject to the direct disturbance to the bed and channel. **Slight Adverse** for the loch (in the context of the whole Loch Lomond shoreline) as it is likely that most of the existing bank vegetation will be lost over the 180m viaduct section to gain access for the works (direct, localised to one section of the loch, temporary), and there will also be some disturbance to the form of the bank and the loch bed around each support location from the temporary works required for installation (highly localised to each support and temporary). Given the proximity of the viaduct to the shore (refer to Figure 2.2 – The Scheme) only some of the supports are just within the loch, and therefore it is not expected that the temporary disturbance along the immediate shore would present a significant obstruction to the passage of fish (Refer to section 9.7.15 of the E&NC Chapter for predicted impacts on fisheries from disturbance of loch bed – predicted at moderate adverse (pre-mitigation)). Hydrology – **Negligible Adverse** (direct, localised, temporary) for the loch, as the works will not substantially affect movement of water in the loch. **Slight Adverse** (direct, localised, temporary) for the watercourses and drainage paths, as the construction works have the potential to temporarily affect the passage of flows down the watercourses.
Overall Significance	**Minor Adverse** for geomorphology for the small watercourses / drainage paths & the loch. **Negligible Adverse** for the hydrology of all features.

11.4.1.4 Groundwater

This assessment considers the potential effects of the construction works on the movement of the groundwater.

Table 11.11 Groundwater Movement Predicted Impact Assessment (Construction)

Receptor(s)	Groundwater
Relevant Scheme Information	The main works with a potential impact on the movement of groundwater is the piling to construct the supports for the viaduct over the Loch and the cutting back of the rock face to create the additional road width required over a length just to the north of the viaduct. The piling for the viaduct supports is predominately within the loch or on the steep banks of the Loch. Given that the supports are only at discrete points into the underlying rock at approximately 20m intervals over approximately 180m of shoreline they are not considered to represent a significant disruption to groundwater movement into the loch during the construction phase. The rock cut to the existing near vertical rock face over a length of approximately 100m is likely to encounter groundwater based on the boreholes completed for the Ground Investigation (GI), which recorded groundwater at varying levels within the rock to the west of the A82. Based on the findings of the GI this groundwater is likely to be in the form of encountering flow from fractures within the bedrock. Given the short length of slope intercepted in the context of the whole shoreline and the fact that the rock cut is only taking the slope horizontally back a relatively small amount (a maximum of 6m at any one point), it is considered that the construction stage will have minimal effects on overall groundwater movement in the context of groundwater flows passing into the loch. It is

	noted that the current regime is such that groundwater seeps from fractures in the rock face and onto the A82 and this regime will not be altered during the construction stage.
Sensitivity of Receptor(s)	**High** (see "Baseline" section)
Magnitude (and Type) of Effect	**Negligible Adverse** (direct, highly localised, temporary) – as it is not anticipated that construction work (i.e. rock cut, piling for supports, earthmoving, etc.) will create a significant obstruction to groundwater movement.
Overall Significance	**Negligible Adverse**

This assessment considers the potential effects of the construction works on the **quality** of the groundwater.

Table 11.12 Groundwater Quality Predicted Impact Assessment (Construction)

Receptor(s)	Groundwater
Relevant Scheme Information	The construction work will involve piling plant (probably working from a vessel within the loch), rock breaking plant working from the road, earth moving plant working from the road, and other construction machinery. This presents a risk of spillage of fuels, oils, concrete, and other chemicals, which can seep into the shallow groundwater. The project will also require at least one major construction compound, providing welfare facilities for the Contractor, and these are likely to retain a store of fuels, oils, and other chemicals.
Sensitivity of Receptor(s)	**High** (see "Baseline" section)
Magnitude (and Type) of Effect	**Slight Adverse** (indirect, localised to development site, temporary) – based on the potential for significant quantities of contaminants being released into the shallow groundwater through spillage or poor site controls.
Overall Significance	**Minor Adverse**

11.4.2 Operational Stage

11.4.2.1 Surface Water Quality

Discharge of Road Run Off

As described in Section 11.1.4.3, the surface water drainage from the southern section of the scheme will pass through a short section of filter drain before discharging into the loch, the middle section of the scheme will discharge into Watercourse 2 just upstream of an existing culvert, and the northern section of the scheme will discharge as per the existing regime (i.e. over the edge drainage).

The main contaminants that can be carried into the watercourses from road run-off include suspended solids (including grit, mud, & metal particles), copper and zinc (from deterioration of vehicles), organic materials and hydrocarbons (such as rubber, bitumen, grease, oil and fuel), and salt.

DMRB Volume 11, Section 3, Part 10, HD 45/09 provides a number of assessment methods to gauge the potential impact of run-off from roads on the water environment. HD 45/09 also provides guidance on suitable mitigation measures that can be applied when the above assessments indicate a risk of pollution to the water environment.

Assessment of Potential Impacts of Routine Run Off

With regard to the potential contamination from discharge of routine road run off into a watercourse, HD 45/09 requires that a "Simple Assessment" be made initially to determine whether the watercourse is at risk of pollution and if pollution mitigation measures are needed in specific circumstances. Highways Agency Water Risk Assessment Tool (HAWRAT), a excel worksheet has been developed for this "Simple Assessment". This assessment involves determining toxicity thresholds by first examining the run off quality based on the predicted AADT and the climatic region. The second stage involves entering data on the flow within the watercourse, the permeable area draining to the watercourse, and the impermeable area of road drainage to the outfall. The results are assessed on a pass / fail basis against the soluble toxicity and sediment toxicity content. Step 3 of the assessment includes assessing the effectiveness of pollution control measures to mitigate unacceptable risk (full details of the methodology are within HA 45/09).

If this "Simple Assessment" puts a watercourse in the "pass" category then no further assessment is required.

Based on the road layout and drainage design provided the "Method A" Simple Assessment calculations have been undertaken. The road areas and drainage proposals are noted on Figure 11.3 – Drainage Proposals. Only the catchments for Watercourses 2 & 3 were taken into account for the calculation of the flow in the combined watercourse receiving a discharge at Culvert 2 (i.e. any potential additional flow from Watercourse 1 has been ignored for conservatism). The impermeable area draining to this outfall was taken as the whole of the middle and northern sections of the road drainage area shown on the detailed drainage proposals. The daily volume of flow (at low flow conditions (Q95)) in Culvert 2, which will receive a discharge under the proposals, has been estimated using standard low flow hydrology techniques to be 320m^3/d (the Q95 flow estimate has been calculated using the methodology set out in the Institute of Hydrology Report No.101 "Low flow estimation in Scotland", based on an assessed catchment area of 0.23km^2, a SAAR of 3342mm (from FEH CD), a BFI of 0.44 from BFI Map, and an annual potential evapotranspiration of 400mm estimated from previous work). The annual average daily traffic flow on the A82 in 2009 is estimated to be 3,800 vehicles. This falls into the lowest assessment traffic band of between 10,000 and 50,000. No growth factor has been considered, as it is very unlikely that any traffic growth would move the AADT into the next band (i.e. Two way AADT above 50,000 vehicles).

Using "Method A" calculations showed a "Pass" of soluble toxicity thresholds and flagged a minor amount of sediment deposition from routine run off for Watercourses 2 & 3. According to the guidance in HD 45/09 the minor amount of sediment deposition indicated does not constitute a failure, but merely indicates to the assessor that further consideration of sediment deposition may be required depending on the downstream receptor. Further consideration of this issue is given in the mitigation section. It is noted that these calculations assumed a Q95 for the watercourse of 320m^3/d (i.e. conservative end of the range). Therefore, a detailed assessment using "Method B" was not required. A copy of the Method A calculations are included within Appendix 6A.

De-icing salts will commonly be used on roads between the months of November and March. It is noted that the concurrent flows in watercourses are relatively high during these months, and therefore the salts would be subject to reasonable dilution and dispersion on entering a watercourse. From PPG 10 (Pollution Prevention Guidelines) it is noted that the "…use of salt on highways is unlikely to lead to levels in the water environment that could affect aquatic life or drinking water supplies". There is no specific assessment within the Advice Note for the potential impacts of de-icing salts on watercourses.

Assessment of Potential Impacts from Spillages

With regard to the potential contamination of the watercourses from an accidental spillage on the revised section of the A82, HD45/09 requires an "Assessment of Pollution Impacts from Accidental Spillages" to be undertaken. This involves consideration of the probability of a spillage accident with an associated risk of serious pollution occurring. HD 45/09 states that watercourses should be protected such that the risk of a serious pollution incident has an annual probability less than 1%.

The assessment method was followed based on the proposed surface water drainage arrangements (refer to Section 11.1.4). The annual probability of a spillage incident was calculated to be 0.003%, which is significantly less than 1% and therefore no additional protection measures are required (a copy of the Method D calculations are included within Appendix 6A). It should be noted that the proposed road improvements should have a slight positive impact, in that they reduce the risk of an accidental spillage incident occurring.

Based on the above assessments the following summary of the effects on surface water quality has been derived.

Table 11.13 Surface Water Quality (Road Run-off) Predicted Impact Assessment (Operation)

Receptor(s)	Watercourses 1 – 3, Drainage Path 4, and ultimately Loch Lomond
Relevant Scheme Information	The scheme will formalise the current road drainage arrangements, refer to 11.1.4 and Figure 2.2 – The Scheme for details of the proposed surface water drainage infrastructure.
Sensitivity of Receptor(s)	**High** (Loch Lomond) & **Low** (Watercourses 1 -3 & Drainage Path 4) (see "Baseline" section)
Magnitude (and Type) of Effect	**Negligible Adverse** (direct, local to downstream reach of watercourse, permanent) see Table A4.4 of HA 45/09 - in this case no risk has been identified by HAWRAT (Method A). Predicted Copper and Zinc levels are within the EQS limits, and spillage risk is less than 0.5%. However, the HAWRAT method highlights the risk of a minor accumulation of sediment, although the Deposition Index is 7 which is low and thus of little concern. (Refer to section 9.7.21 of the E&NC Chapter for predicted impacts on fisheries from surface water quality – predicted at slight adverse (pre-mitigation))
Overall Significance	**Negligible Adverse** for both Loch Lomond, Watercourses 1 – 3, & Drainage Path 4

11.4.2.2 Other road and infrastructure maintenance

This assessment considers whether the maintenance of the road, drainage infrastructure, and soft landscaping is likely to have any effect on the water quality of the surrounding water bodies. There is no specific guidance within DMRB HA 45/09 on assessing the potential impacts from this source of pollution.

Table 11.14 Surface Water Quality (Maintenance) Predicted Impact Assessment (Operation)

Receptor(s)	Watercourses 1 – 3 & Drainage Path 4 (i.e. those experiencing surface water run off from the revised road) & ultimately Loch Lomond
Relevant Scheme Information	During the operation of the scheme the principal maintenance activities are likely to be road pavement maintenance (anticipated to be minimal during first 10years), clearing debris from the culverts (possibly annual), cleaning of the filter drains (possibly annual), maintenance of roadside verges (e.g. clearing debris, removing invasive species, etc), etc. There will be a slight increase in the area of carriageway but there is not anticipated to be any net change in the area of embankments to be maintained.
Sensitivity of Receptor(s)	**High** (Loch Lomond) & **Low** (Watercourses 1 - 3 & Drainage Path 4) (see "Baseline" section)
Magnitude (and Type) of Effect	**Slight Adverse** (direct, localised, temporal) – clearing of debris from the culverts is likely to cause only minor disturbance at the entrance and exit of the culvert and the vehicles / plant are assumed to work from the road with the appropriate traffic control measures in place. In terms of the Controlled Activities Regulations such work falls under the General Binding Rules or Registration categories, which are for activities considered to have a low risk to the water environment. Repair of road infrastructure may involve repainting of parapets or use of other potentially polluting materials and this presents a risk of materials entering watercourses through spillages or improper use. It is understood that the landscape design for the road verges is to replant with native grass and therefore there is not expected to be any significant ongoing requirement for the use of herbicides to maintain these areas.
Overall Significance	**Minor Adverse** for Loch Lomond & **Negligible Adverse** for Watercourses 1 – 3, & Drainage Path 4

11.4.2.3 Flooding

This part of the assessment considers whether or not the proposed works would affect the flood risk within any identified floodplains.

Table 11.15 Flooding Predicted Impact Assessment (Operation)

Receptor(s)	Surrounding land and infrastructure located adjacent to the identified surface water resources features, including areas upstream and downstream and on adjacent shores of the loch
Relevant Scheme Information	The completed works will consist of a series of discrete supports in the loch, some lengthened and replaced culverts, some minor realignment of the channels of Watercourses 1, 2 & 3, and the discharge of surface water run off from the road into Culverts 2 & 4. Note – the effects of road drainage on the hydrology of the Watercourses / Drainage Paths is separately considered in the assessment of Geomorphology and Hydrology below. Some parts of the scheme are potentially within the 1:200yr flood envelope shown on the SEPA Indicative River & Coastal Flood Map. However, SEPA have recognised that the development cannot be located elsewhere and it is not likely to have an adverse effect on flood risk. It is

	also noted that the deck of the viaduct is generally above the indicative 1:200yr flood level. There are no properties in the vicinity of the Scheme.
Sensitivity of Receptor(s)	Rural land is considered as having a **Low** sensitivity to increased flood risk, but individual property is considered as having a **High** sensitivity to increased flood risk.
Magnitude (and Type) of Effect	**Negligible Adverse** (direct, local to area immediately upstream of culverts), temporal i.e. during storm events only) – it is anticipated that the presence of the viaduct over the loch (i.e. main viaduct structure being largely above the maximum recorded water level and the indicative 1:200yr flood level) and the supports in the loch will make no difference to water levels within the loch. Assuming standard best practice design, the minor channel realignments and the culvert extensions / replacements should be able to be carried out with no permanent effect on the passage of flows. With regard to the discharge of road run off, the designers should ensure that discharges from the system are in accordance with the guidance provided in CIRIA Report C697 for rates of run off (see further discussion on mitigation measures in section 11.5). The development should therefore be able to comply with the requirements of Policy DC10 of the Argyll & Bute Structure Plan, which requires that a development does not increase flood risk to land or property.
Overall Significance	**Negligible Adverse**

11.4.2.4 Geomorphology & Hydrology

This assessment considers the potential effects of the proposed works on the structure of the bed and bank of affected watercourses / drainage paths and the loch, as well as the flow conveyance of each of these features.

Table 11.16 Geomorphology & Hydrology Predicted Impact Assessment (Operation)

Receptor(s)	Loch Lomond, Small Watercourses, & Drainage Paths
Relevant Scheme Information	Loch Lomond – only permanent intrusion into the loch or onto shoreline is over the length of the viaduct (approx. 180m), which will be sited above and slightly offshore of the existing shoreline. The supports for the viaduct will create permanent features on the shoreline and on the loch bed. It is anticipated that some of the existing shoreline vegetation will grow back after the works, but that due to the presence of the viaduct the balance of the vegetation may be different. (It is noted that assessment of impacts on vegetation loss and the obstruction to the passage of otters from the scheme are considered in section 9.7 of the E&NC Chapter). Small Watercourses – permanent realigning of around 60m of watercourses 1, 2 & 3, up to 10m extensions to culverts 1 & 2, and headwall works on watercourse 3 for drainage discharge. Drainage Paths – permanent headwall works on drainage path 4
Sensitivity of Receptor(s)	Loch Lomond – **High** (see "Baseline" section) Small Watercourses & Drainage Paths – **Low** (see "Baseline" section)
Magnitude (and Type) of Effect	**Slight Adverse** (in the context of the whole Loch Lomond shoreline)(direct, localised, permanent) – as the permanent works will have some impacts on a length of loch shore and the bed, but the main viaduct structure is largely remote from the shoreline and the supports are only in discrete areas on the shoreline or the loch bed. Some vegetation will return, albeit some mature trees will have been lost and the presence of the viaduct will create different light conditions. Given that only discrete supports are envisaged within the loch, it is not anticipated that the complete structure will cause any significant obstruction to the free movement of fish along the loch shore. **Moderate Adverse** (direct,

	localised, permanent) - up to 60m of natural channels are re-aligned but only a short length of these channels is actually lost due to culvert lengthening. The remaining length of these channels should be able to be established in a natural manner re-providing the existing earthen banks & vegetation.
Overall Significance	**Minor Adverse** (Loch Lomond) **& Minor Adverse** (Small Watercourses & Drainage Paths)

This assessment considers the potential effects of the presence of the revised road alignment on the natural surface drainage patterns of the surrounding land. Given the similarities in effects between construction and operational phases, namely potential severance of overland flow between upslope and down slope, both phases have been considered in this assessment.

Table 11.17 Natural Drainage Patterns Predicted Impact Assessment (Operation)

Receptor(s)	Watercourses 1 – 3 and Drainage Paths 1 - 4
Relevant Scheme Information	The scheme broadly retains the alignment of the existing A82 along the shore of the loch, which in turn already influences the natural drainage patterns with surface water drainage being focussed to a series of existing culverts or running over the road. All existing culverts will be retained as part of the scheme and no new obstructions to the flow of surface water down the slopes towards the loch will be introduced.
Sensitivity of Receptor(s)	**Low** (see "Baseline" section)
Magnitude (and Type) of Effect	**Negligible Adverse** (direct, highly localised, permanent) – the scheme is not anticipated to introduce any significant changes to the existing surface water drainage patterns.
Overall Significance	**Negligible Adverse**

This assessment considers the potential effects of the surface water run off from the scheme on the hydrology of the Watercourses / Drainage Paths receiving a surface water drainage discharge. It is noted that the hydrological effects on Loch Lomond have not been considered in detail, as by comparison of the existing (1900m^2) and proposed (3364m^2) road areas the additional run off created by the scheme will be negligible.

Table 11.18 Hydrology Predicted Impact Assessment (Operation)

Receptor(s)	Watercourses 2 & 3 and Drainage Path 4
Relevant Scheme Information	The scheme will increase the volume of surface water captured as it is proposed to install a more formal road drainage arrangement compared to the limited surface water drainage infrastructure currently present.
Sensitivity of Receptor(s)	**Low** (see "Baseline" section)
Magnitude (and Type) of Effect	**Slight Adverse** (direct, highly localised, temporal) - on the basis that more formal road drainage arrangements have the potential to increase the rate at which surface water run off from the road will reach the receiving watercourses.
Overall Significance	**Negligible Adverse** (temporal i.e. during and immediately after rainfall)

11.4.2.5 Groundwater

This assessment considers the potential effects on groundwater **movement** from the presence of the scheme.

Table 11.19 Groundwater (Movement) Predicted Impact Assessment (Operation)

Receptor(s)	Groundwater
Relevant Scheme Information	The main part of the permanent works with potential to impact on the movement of groundwater are the viaduct supports and the cut back rock face just to the north of the viaduct. The supports are predominately within the loch or on the steep banks of the loch, and given that the supports are only at discrete points into the underlying rock at approximately 20m intervals over a length of approximately 180m they are not considered to represent a significant obstruction to groundwater movement over the life of the Scheme. The rock cut to the existing near vertical rock face over a length of approximately 100m is likely to encounter groundwater (refer to Table 11.11 for full details). The intention is to insert weep holes across the cut face and then cover the face with shot applied concrete to stabilise it. The weep holes will allow the groundwater to seep from the cut rock face, and thus maintain the current regime where groundwater seeps from fractures in the rock face and onto the A82. The seepage from the rock face will be captured in a toe drain and piped to the nearest watercourse or straight into the loch, whilst a crest drain will be formed at the top of the rock face to capture run off before it passes down the rock face. Given the short length of slope affected in the context of the whole shoreline and the fact that the current regime of seepage through the rock face will be maintained to a large extent, it is considered that the works will have minimal effects on overall groundwater movement towards the loch and any effects will be highly localised.
Sensitivity of Receptor(s)	**High** (see "Baseline" section)
Magnitude (and Type) of Effect	**Negligible Adverse** (direct, highly localised, permanent) – as it is not anticipated that permanent works (i.e. rock cut, viaduct supports, etc.) will create a significant obstruction to groundwater movement.
Overall Significance	**Negligible Adverse**

This assessment considers the potential effects on groundwater **quality** from the operation of the road.

Table 11.20 Groundwater (Quality) Predicted Impact Assessment (Operation)

Receptor(s)	Groundwater
Relevant Scheme Information	The main operational element of the scheme that has the potential to affect the groundwater quality will be the surface water run off from the widened and realigned road. Therefore there is some potential for surface water run off from the road to percolate into the shallow groundwater. The other potential source for pollution is from vegetation maintenance alongside the road, where herbicides are used to control weeds along linear infrastructure features.
Sensitivity of Receptor(s)	**High** (see "Baseline" section)
Magnitude (and Type) of Effect	**Slight Adverse** (indirect, localised to length of scheme, permanent) – following Method C within HA 45/09 puts the groundwater below the scheme at Medium risk of impact (refer to Appendix 6A for a copy of the Method C assessment). However, this assessment fails to take into account the short length of road and the proximity of the loch. The calculated risk of pollution from accidental spillages is less than 0.5%, which places the groundwater at a negligible risk of impact (Table A4.4 of HD 45/09). Overall magnitude assigned based on the combination of these two assessments.

Overall Significance	**Minor Adverse**

11.5 Mitigation

This section describes the mitigation required to address adverse effects noted in Section 11.4.

11.5.1 Construction Stage

Table 11.21 Construction Stage Mitigation Requirements

Specific Issues	Mitigation Requirements
Sediment mobilisation and spillage or discharge of other pollutants into water-courses / drainage paths or the Loch	The Contractor shall produce a Site Management Plan (SMP), which will describe the specific procedures to be put in place to control sediment mobilisation, surface water discharges, and spillages. The SMP shall be discussed and agreed with SEPA prior to commencement of site works, and all staff on site shall be briefed on and trained in the procedures contained within the SMP. The SMP shall incorporate best practice guidance as detailed in PPG's published by SEPA and CIRIA Reports C532 & C648, as a minimum. In particular, the following measures shall be adopted on site: - ▪ CAR Licences shall be obtained prior to start on site (note this is a separate consenting regime from the approval of the planning application) for work in the loch and the Watercourses, and these shall be displayed prominently on a notice board in the site offices, ▪ Identify and clearly sign all surface water features during site set up and brief personnel on their location during induction, ▪ Site compound and site access routes shall be clearly defined during site set up with the minimum number of watercourse crossing points clearly defined. Formal watercourse crossings shall consist of a piped culvert and vehicle access over the top, ▪ The Contractor shall provide bunds around all fuel, oil, and other chemical stores, and shall centralise and minimise the number of these stores, ▪ A formal wheel wash and concrete wash out area shall be set up on site and this shall drain to a lined sump with the surface water either treated on site or disposed of to a licensed facility off site, ▪ Stripped areas and stockpiles shall have silt fences placed so as to intercept the surface water run off from these areas, ▪ The Contractor shall give consideration to creating the sustainable drainage system infrastructure at the outset of construction work, and this could then be used to treat some of the construction stage site run off prior to discharge. If this is not done the Contractor shall provide some other form of treatment to the surface water run off from the site prior to it reaching the watercourses, ▪ Construction materials and other stockpiles shall be stored away from the surface water features (minimum 10m), ▪ Plant shall be stored and maintained away from surface water features, ▪ The Contractor shall instigate re-vegetation of stripped areas on a sectional basis as early as possible within the programme to reduce the potential for silt laden run off, ▪ Measures to minimise sediment disturbance, increased turbidity, and spread of spillages during works in the Loch shall be implemented to prevent a plume of sediment or other pollutant extending out into the loch. This may involve floating booms and a silt fence around the working area, ▪ Watercourse realignments and culvert extensions shall be undertaken prior to road widening The SMP shall identify a clear monitoring regime to confirm the

Specific Issues	Mitigation Requirements
	application of the above mitigation requirements. It is anticipated that the Contractor's site management personnel would be made responsible for monitoring and in practice many of the measures could be monitored based on a daily or weekly inspection of the site and the completion of a "mitigation requirements" tick sheet. These tick sheets would then be retained as auditable evidence of the monitoring of the mitigation requirements.
Flood risk to surrounding land from development	▪ The Contractor shall ensure that all culverts are inspected on a daily basis and shall keep all culverts clear of construction / non-construction debris for the entire duration of the construction period, ▪ The Contractor shall keep close control of permanent and temporary earthworks operations in the vicinity of Watercourses 1, 2, & 3 and Drainage Paths 1 – 4 to prevent any obstructions of the Watercourse / Drainage Path channels, ▪ The Contractor shall not store materials within or immediately adjacent to watercourse / drainage path channels, ▪ Where works in the watercourse / drainage path channels are required (i.e. for culvert extension / replacement), the Contractor will be required to provide temporary flow bypass facilities (e.g. temporary damming of the watercourses / drainage paths just upstream and the provision of pumps on a duty and stand by arrangement) with sufficient capacity to pass a 1:20yr flow or other such temporary requirement agreed with SEPA in the CAR Licensing process, ▪ All engineering works within the watercourses and drainage paths will need to be carried out in accordance with the Controlled Activities Regulations (i.e. a CAR Licence will be required), ▪ The timescale of such operations would need to be limited to prevent significant effects on the passage of flows (i.e. works to be undertaken during low flow periods only), ▪ All work within watercourses or drainage paths shall be undertaken in accordance with a detailed construction method statement to be produced by the Contractor and discussed and agreed with SEPA in advance of the works The Contractor's site management personnel will ultimately be responsible for monitoring the application of most of these mitigation requirements. Again it is suggested that the monitoring of the application of mitigation requirements is completed via regular inspections of the site and the completion of a tick sheet which summarises the mitigation measures in a readily useable for rapid assessment on site.
Alteration of the Loch shore and the channels of the small water-courses / drainage paths	Geomorphology ▪ Working areas on the loch shore and within the loch, and around and within the Watercourses & Drainage Paths shall be clearly set out prior to commencement of construction works, and these shall be the minimum areas required to safely complete the works, ▪ The Contractor shall not store materials within or immediately adjacent to watercourse / drainage path channels, ▪ Plant movements should be kept to a minimum on the loch shore and on the banks of the Watercourses / Drainage Paths, ▪ A survey to record the form and vegetation along the loch shore and the watercourse / drainage path channels shall be completed by an ecologist or a water engineering specialist covering the area predicted to be disturbed during the works. This information shall provide sufficient detail to allow the alignment, levels, and form of the shore and channels to be reinstated after the works, ▪ Reinstatement shall include re-vegetation with local plant species to

Specific Issues	Mitigation Requirements
	stabilise the structure of the completed shore / banks, ▪ As noted above, all engineering works within the watercourses and drainage paths will need to be carried out in accordance with the Controlled Activities Regulations (i.e. a CAR Licence will be required) Monitoring of the above mitigation measures would be achieved via the Client's Agent inspecting the site during set up to supervise the working areas being set up and ensure they are the minimum practical working areas, and also inspecting the site during the works to confirm the working areas, material storage areas, and reinstatement works are being undertaken satisfactorily. Hydrology ▪ As noted above, the Contractor shall ensure that all culverts are inspected on a daily basis and shall keep all culverts clear of debris, ▪ As noted above, construction materials and other stockpiles shall be stored away from the surface water features (minimum 10m), ▪ As noted above, consideration shall be given to creating the sustainable drainage system infrastructure at the outset of construction work, as this could then be used to attenuate some of the construction stage site run off prior to discharge. If this is not done the Contractor shall provide an alternate means of controlling the surface water run off from the site to ensure the culvert capacities are not exceeded, ▪ The Contractor shall apply for a temporary discharge licence under the Controlled Activity Regulations if required by SEPA for the works. As noted above, these are to be monitored by the Contractor's site personnel and the Client's Agent based on regular inspections using a tick sheet assessment.
Disturbance of groundwater movement	None required at this stage
Contamination of groundwater	As noted above, the Contractor shall produce a Site Management Plan (SMP), which will describe the specific procedures to be put in place to control site discharges and the potential for pollutant spillages. The SMP shall be discussed and agreed with SEPA prior to commencement of site works, and all staff on site shall be briefed on and trained in the procedures contained within the SMP. The SMP shall incorporate best practice guidance as detailed in PPG's published by SEPA and CIRIA Reports C532 & C648, as a minimum. In particular, the following measures shall be adopted on site in relation to mitigating the potential effects on groundwater quality: - ▪ The Contractor shall provide bunds around all fuel, oil, and other chemical stores, and shall centralise and minimise the number of these stores, ▪ The Contractor shall complete all servicing, fuelling, and storage of vehicles at construction compounds, ▪ The Contractor shall provide dedicated wash down areas for concrete and other delivery vehicles, ▪ The Contractor shall implement drainage control measures at the site to prevent areas of standing surface water that could become contaminated and leach into the shallow groundwater. Where collection of water at the site is unavoidable (e.g. within excavations), provision should be made for this water to be collected and passed through some form of treatment before discharge),

Specific Issues	Mitigation Requirements
	▪ The Contractor shall liaise with SEPA regarding any proposed discharge from the site in respect to the Controlled Activities Regulations. As noted above, these are to be monitored by the Contractor's site personnel and the Client's Agent based on regular inspections using a tick sheet assessment.

11.5.2 Operational Stage

Table 11.22 Operational Stage Mitigation Requirements

Specific Issues	Mitigation Requirements
Discharge of road run off to water-courses / drainage paths and indirectly into the Loch	The new sections of road incorporate SUDS principles as far as practical, by providing a mixture of filter drains and a dry swale for the treatment of the road run off. These measures have been agreed with SEPA (refer to email dated 04/08/10 in Appendix 1A). In addition, it is noted that the proposed road alignment and profile has been designed to improve safety and hence reduce the risk of serious accidents and spillages from such accidents in the first place.
Other road and infra-structure maintenance	Works to road infrastructure shall be completed under an approved method statement (approved by route manager within maintenance authority) and shall incorporate best practice measures (including the SEPA Pollution Prevention Guidelines, General Binding Rules, and CIRIA Reports C532 & C632) to reduce the risk of significant of major sediment disturbance and spillages of potential contaminants to the surrounding water resources features. Provisions for monitoring the application of the best practice measures would also need to be noted in the method statement, and in practice this will likely mean that the supervisor of the works will be responsible for ensuring the application of the best practice measures on site.
Flood Risk to surrounding land from development	The realigned channels and extended / replaced culverts shall be designed in accordance with the guidance in CIRIA Report C689 in regard to hydraulic capacity. This would generally be the acceptance of a 1:200yr flow. However, given the rural nature of the area upstream of A82 at this location SEPA may accept design to a lower return period. The designers of the scheme shall confirm the design return period with SEPA for all the culverts. The storm flows shall be calculated for the watercourses / drainage features where works are proposed using FEH or similar accepted hydrological assessment methods.
Alteration of the Loch shore and the channels of the small water-courses / drainage paths	The design of the extended culverts shall ensure that, as a minimum, the existing hydraulic capacity is maintained, but also refer to flood risk mitigation requirements noted above. The design of all new or extended culverts shall be undertaken with due consideration to the guidance contained in "River Crossing and Migratory Fish: Design Guidance", and where fish passage is considered possible then the new or extended culverts shall be designed in accordance with the above guidance. The channel realignment proposals shall include the replication of the form and vegetation of the natural channels. Where bank protection works are considered necessary these shall be "green" bank protection works (refer to "The Water Environment (Controlled Activities) (Scotland) Regulations 2005 - A Practical Guide" for details). Any bank protection works on the watercourses upstream and downstream of the realigned A82 shall be kept to the minimum length required, and shall not extend beyond the extent of the channel realignments (i.e. anticipated to be a maximum of

Specific Issues	Mitigation Requirements
	around 60m across the three watercourses). The advice within CIRIA Report C551 Manual on Scour at Bridges and other Hydraulic Structures shall be taken into account in the design of the culverts.
Alteration to land drainage patterns	None required at this stage.
Run off from the Scheme into water-courses / drainage paths	The surface water drainage proposals for the scheme include an element of SUDS design (including filter drains and a dry swale) fitted within the physical constraints of the site (refer to Figure 11.2 – Existing Draiange for further details). These features will provide some level of attenuation of the run off before discharge to the proposed northern and southern outfalls. It is understood that Argyll & Bute Council have confirmed that no specific surface water drainage attenuation is required for the development, presumably based on the fact that the loch is immediately downstream of the discharge points. However, it is always preferable to adopt best practice where possible, and it is therefore recommended that the designers try (physical restrictions permitting) to ensure that the rates of release of the surface water run off from the road drainage system is in accordance with the guidance provided in CIRIA Report C697 for allowable rates of run off and that the combined flows (watercourse flows and surface water run off flows) do not exceed the capacity of the culverts. It is therefore considered that these proposals be adopted as mitigation requirements to assist in reducing the potential effect on the receiving watercourses.
Disturbance of groundwater movement from the new road construction	None required at this stage.
Contamination of groundwater	The surface water drainage proposals for the scheme include an element of SUDS design (including filter drains and a dry swale), and the use of linear filter drains wherever possible assists in reducing the risk to groundwater (refer to DMRB Method C). It is therefore considered that these proposals be adopted as mitigation requirements to assist in reducing the potential effect on the groundwater.

The monitoring of the operational stage mitigation measures would principally be achieved via a review of the design just prior to finalisation to ensure that the recommended mitigation measures have been incorporated. This would ultimately be the responsibility of the promoter of the Scheme.

11.6 Residual Impacts

This section describes the residual impacts subject to the adoption of the mitigation measures identified in Section 11.5.

11.6.1 Construction Stage

Table 11.23 Construction Stage Residual Impacts

Specific Issues	Receptor	Sensitivity of Receptor(s)	Magnitude (and Type) of Effect (Pre Mitigation)	Mitigation Require-ments	Magnitude (and Type) of Effect (Post Mitigation)	Residual Significance
Sediment mobilisation and spillage or discharge of other pollutants into watercourses / drainage paths or the Loch	Loch Lomond, Watercourses 1 – 3 & Drainage Paths 1 - 4	**High** (Loch Lomond), **Low** (Water-courses 1 – 3) & **Low** (Drainage Paths 1 - 4)(see "Baseline" section)	**Slight Adverse** (direct, localised to an area of loch shore around the works and a short length of watercourse channel just upstream and downstream of the A82, temporary)	See Table 11.21	**Negligible Adverse** (localised to the area of loch shore around the works and a short length of watercourse channel just upstream and downstream of the A82) - based on the adoption of the mitigation measures noted, the risk of a significant discharge of polluting substances into the loch or the Watercourses / Drainage Paths should be able to be reduced to a low level. The effects of any residual construction stage pollution should be temporary in nature, and therefore no long-term impact on the water quality classification should be experienced.	**Negligible Adverse** for Loch Lomond & **Negligible Adverse** for Watercourses & Drainage Paths
Flood risk to surrounding land from development	Surrounding land and infrastructure located adjacent to the surface water resources features, including areas upstream and downstream of the A82, & on adjacent shores of the loch	Rural land is considered as having **Low** sensitivity to increased flood risk, but property is considered as having **High** sensitivity to increased flood risk.	**Negligible Adverse** (direct, highly localised, temporary) for the loch & **Slight Adverse** (direct, highly localised, temporary 0 for the small watercourses	See Table 11.21	**Negligible Adverse** (direct, highly localised, temporary) – based on the adoption of the mitigation measures noted, the Contractor should be able to complete the works without increasing the risk of flooding to rural areas or property. In addition, it is noted that there will be no significant change to the loch's bathymetry during the works (i.e. only discrete supports being constructed along the 180m length of the viaduct) and the main viaduct deck structure being largely above the maximum recorded water level and the indicative 1:200yr flood level.	**Negligible Adverse** (for both rural land and property)

Specific Issues	Receptor	Sensitivity of Receptor(s)	Magnitude (and Type) of Effect (Pre Mitigation)	Mitigation Require-ments	Magnitude (and Type) of Effect (Post Mitigation)	Residual Significance
Alteration of the Loch shore and the channels of the small watercourses / drainage paths	Loch Lomond, Watercourses 1 – 3, & Drainage Paths 1 - 4	Loch Lomond – **High** (see "Baseline" section) Watercourses 1 – 3 & Drainage Paths 1 - 4 – **Low** (see "Baseline" section)	Geomorphology – **Moderate Adverse** (direct, localised, temporary) for the watercourses and drainage paths **Slight Adverse** for the loch (direct, localised to one section of the loch, temporary) Hydrology – **Negligible Adverse** (direct, localised, temporary) for the loch **Slight Adverse** (direct, localised , temporary) for the watercourses & drainage paths	See Table 11.21	Geomorphology – **Moderate Adverse** (direct, localised, temporary) for the watercourses and drainage paths as more than 20m of any one feature is likely to be subject to direct disturbance to the bed and channel. **Slight Adverse** for the loch (in the context of the whole Loch Lomond shoreline) as it is likely that most of the existing bank vegetation will be lost over the 180m viaduct section to gain access for the works (direct, localised to one section of the loch, temporary), and there will also be some disturbance to the form of the bank and the loch bed around each support location from the temporary works required for installation (localised to each support and temporary). (Refer to section 9.9 of the E&NC Chapter for predicted impacts on fisheries from disturbance of loch bed – predicted at slight adverse (post - mitigation)). Hydrology – **Negligible Adverse** (direct, localised, temporary) for the Loch, watercourses, and drainage paths, as the works will not affect the flow of water in the loch, and with the suggested mitigation measures the works should be able to be completed without significantly affecting the passage of flows down the watercourses or drainage paths.	**Minor Adverse** for geomorphology for the watercourses / drainage paths & the Loch. **Negligible Adverse** for the hydrology of all features.
Disturbance of groundwater movement	Groundwater	**High** (see "Baseline" section)	**Negligible Adverse** (direct, highly localised, temporary)	See Table 11.21	**Negligible Adverse** (direct, highly localised, temporary) – as it is not anticipated that construction work will create any significant obstruction to groundwater movement.	**Negligible Adverse**
Contamination of groundwater	Groundwater	**High** (see "Baseline"	**Slight Adverse** (direct, localised,	See Table 11.21	**Negligible Adverse** (indirect, localised, temporary) – based on the adoption of the mitigation measures noted, the likelihood of	**Negligible Adverse**

Specific Issues	Receptor	Sensitivity of Receptor(s)	Magnitude (and Type) of Effect (Pre Mitigation)	Mitigation Require-ments	Magnitude (and Type) of Effect (Post Mitigation)	Residual Significance
		section)	temporary)		significant quantities of contaminants being released into the shallow groundwater should be low. Therefore, it is considered that, although there may be a residual risk of some small spills of oil, fuel, or other chemicals, the effects of these will be highly localised.	

11.6.2 Operational Stage

Table 11.24 Operational Stage Residual Impacts

Specific Issues	Receptor	Sensitivity of Receptor(s)	Magnitude (and Type) of Effect (Pre Mitigation)	Mitigation Require-ments	Magnitude (and Type) of Effect (Post Mitigation)	Residual Significance
Discharge of road run off to watercourses / drainage paths and indirectly into the Loch	Watercourses 1 – 3, Drainage Path 4, and ultimately Loch Lomond	**High** (Loch Lomond), **Low** (Water-courses 1 – 3) & **Low** (Drainage Paths 1 - 4)(see "Baseline" section)	**Negligible Adverse** (direct, localised, permanent)	See Table 11.22	**Negligible Adverse** (direct, localised to downstream reach of watercourse, permanent) see Table A4.4 of HA 45/09 – based on the adoption of the mitigation measures noted, the HAWRAT (Method A) assessment still shows a pass for predicted copper and zinc levels, and the spillage risk remains less than 0.5%. The risk of a minor accumulation of sediment remains, however the mitigation measures added will capture a proportion of this sediment and this has reduced the deposition index further, and this is not considered to be of particular concern. (Refer to section 9.9 of the E&NC Chapter for predicted impacts on fisheries from surface water quality – predicted at minor adverse (post-mitigation))	**Negligible Adverse** for both Loch Lomond, Watercourses 1 – 3, & Drainage Path 4 & complies with Policy ENV12 in the Loch Lomond & the Trossachs National Park Local Plan to include SuDS in all new development
Other road and infrastructure maintenance	Watercourses 1 – 3 & Drainage Path 4 (i.e. those experiencing surface water run off from the revised road) & ultimately Loch Lomond	**High** (Loch Lomond) & **Low** (Watercourses 1 - 3 & Drainage Path 4) (see "Baseline" section)	**Slight Adverse** (direct, localised, temporal)	See Table 11.22	**Negligible Adverse** (direct, localised, temporal) – based on the adoption of the mitigation measures noted, the risk of a significant spillage of a potentially polluting substance should be reduced to a low level. As noted previously, the clearing of debris from the culverts is likely to cause only minor disturbance at the entrance and exit of the culvert. As noted previously it is understood that the landscape design for the road verges is to replant with native grass and therefore there is not expected to be any significant ongoing requirement for the use of herbicides to maintain these areas.	**Negligible Adverse** for Loch Lomond, Watercourses 1 – 3, & Drainage Path 4
Flood risk to surrounding	Surrounding land and	Rural land is considered as	**Negligible Adverse** (direct,	See Table	**Negligible Adverse** (direct, localised to area upstream of culverts, temporal i.e. during storm	**Negligible Adverse** (for

Specific Issues	Receptor	Sensitivity of Receptor(s)	Magnitude (and Type) of Effect (Pre Mitigation)	Mitigation Require-ments	Magnitude (and Type) of Effect (Post Mitigation)	Residual Significance
land from development	infrastructure located adjacent to the surface water resources features, including areas upstream and downstream of the A82, & on adjacent shores of the loch	having **Low** sensitivity to increased flood risk, but property is considered as having **High** sensitivity to increased flood risk.	temporal i.e. during storm events only)	11.22	events only) – based on the adoption of the mitigation measures noted, the culvert works and the surface water drainage system should be able to be designed such that there is no increase in flood risk. The presence of the viaduct over the loch (i.e. main viaduct structure being largely above the maximum recorded water level and the indicative 1:200yr flood level) and the supports in the Loch will make no difference to water levels within the Loch.	both rural land and property)
Alteration of the Loch shore and the channels of the watercourses / drainage paths	Loch Lomond, Watercourses 1 – 3, & Drainage Paths 1 - 4	Loch Lomond – **High** (see "Baseline" section) Watercourses & Drainage Paths – **Low** (see "Baseline" section)	**Slight Adverse** (direct, localised, permanent) for the loch & **Moderate Adverse** (direct, localised, permanent) for the watercourses and drainage paths	See Table 11.22	**Slight Adverse** (in the context of the whole Loch Lomond shoreline)(direct, localised, permanent) for the loch as the permanent works for the viaduct are limited to the discrete supports along the shoreline. **Moderate Adverse** (direct, localised, permanent) based on the adoption of the mitigation measures noted for the watercourses, as only a maximum of 60m of natural channels will be realigned across the three watercourses and only a short length of these channels is actually lost due to culvert lengthening.	**Minor Adverse** (Loch Lomond) **& Minor Adverse** (Small Watercourses & Drainage Paths) & complies with Policy ENV13 in the Loch Lomond & the Trossachs National Park Local Plan to ensure no significant effect on watercourses from engineering works
Alteration to land drainage patterns	Watercourses 1 – 3 and Drainage Paths 1 - 4	**Low** (see "Baseline" section)	**Negligible Adverse** (direct, highly localised, permanent)	See Table 11.22	**Negligible Adverse** (direct, highly localised, permanent) – the scheme is not anticipated to introduce any significant changes to the existing surface water drainage patterns.	**Negligible Adverse**
Run off from	Watercourses 2	**Low** (see	**Negligible**	See Table	**Negligible Adverse** (direct. highly localised,	**Negligible**

Specific Issues	Receptor	Sensitivity of Receptor(s)	Magnitude (and Type) of Effect (Pre Mitigation)	Mitigation Require-ments	Magnitude (and Type) of Effect (Post Mitigation)	Residual Significance
the scheme into watercourses / drainage paths	& 3 and Drainage Path 4	"Baseline" section)	**Adverse** (direct. highly localised, temporal)	11.22	temporal) based on the adoption of the mitigation measures noted to reduce the rate at which surface water run off from the short section of realigned road reaches the receiving waters.	**Adverse** (temporal i.e. during and immediately after rainfall)
Disturbance of groundwater movement from the new road construction	Groundwater	**High** (see "Baseline" section)	**Negligible Adverse** (direct, highly localised, permanent)	See Table 11.22	**Negligible Adverse** (direct, highly localised, permanent) – as it is not anticipated that permanent works will create a significant obstruction to groundwater movement.	**Negligible Adverse**
Contamination of groundwater	Groundwater	**High** (see "Baseline" section)	**Slight Adverse** (indirect, localised to length of scheme, permanent)	See Table 11.22	**Slight Adverse** (indirect, localised to length of scheme, permanent) based on the adoption of the mitigation measures noted this would assist in minimising the potential effects on groundwater quality. The Method C assessment within HA216/06 still puts the groundwater below the scheme at Medium risk of impact (refer to Appendix 6A for a copy of the Method C assessment). However as noted previously, this assessment fails to take into account short length of road and the proximity of the loch. The calculated risk of pollution from accidental spillages is less than 0.5%, which places the groundwater at a negligible risk of impact (Table A4.4 of HD 45/09). Overall magnitude assigned based on the combination of these two assessments.	**Minor Adverse**

11.7 Summary

This chapter addresses the potential effects on water resources as a result of the Scheme. In the context of these proposals the significant water resources are Loch Lomond, three small watercourses, four surface water drainage paths, and the groundwater. The assessment of effects was divided into four main areas, and these were: Surface Water Quality; Flooding; Geomorphology and Hydrology; and Groundwater. The predicted residual impacts ranged from **Negligible to Minor Adverse**, subject to the adoption of a range of mitigation measures identified in Section 11.5. It is noted that there is predicted to be a reduction in spillage risk as a result of the improvement of the road layout and this is an improvement to the current situation in terms of the water environment.

Based on the assessment tools provided in DMRB HD 45/09 and the additional assessments undertaken as part of this Chapter it is considered unlikely that the scheme would lead to any significant residual impacts on water resources features. On this basis it is considered that the scheme complies with Policy ENV10 of the Loch Lomond and the Trossachs National Park Local Plan, in that it is not predicted to have a significant adverse effect on the water environment.

11.8 References

- Argyll & Bute Council, Argyll and Bute Structure Plan (2002)
- British Geological Survey , Geological Assessment – Detailed GR110748_1 (Desktop Study)
- CIRIA, Report C697 – SUDS Manual (2007)
- CIRIA, Report C551 Manual on Scour at Bridges and other Hydraulic Structures (2002)
- CIRIA, Report C532 “Control of water pollution from construction sites” (2001)
- CIRIA, Report C648 “Control of water pollution from linear construction projects” (2006)
- Design Manual for Roads and Bridges, Volume 11, Section 3, Part 10, HD 45/09, Highways Agency / Scottish Executive Development Department (2009)
- Loch Lomond & the Trossachs National Park Authority, Loch Lomond and Trossachs National Park Plan (2007 – 2012)
- Loch Lomond & the Trossachs National Park Authority, Loch Lomond and the Trossachs National Park Local Plan (2010)
- Scottish Environment Protection Agency, Water-body Data Sheets and WFD Interactive Map (2010)