11. Road Drainage and the Water Environment

This chapter considers the impact of the Proposed Scheme upon the water environment of the River Esk (Lothian) catchment, taking into account the potential for adverse and beneficial impacts upon surface waters, drainage network assets, groundwater and flooding during both construction and operation (including maintenance).

The assessment was informed by consultation, desk-based assessments, site walkovers and topographic surveys. The main water features identified include the River North Esk, the Dean Burn, the Esk Valley sand and gravel aquifer, the Dalkeith bedrock and localised sand and gravel aquifers, and the Scottish Water drainage network.

The River North Esk is the main watercourse within the River Esk (Lothian) catchment, of which, the Dean Burn is a minor tributary. With a catchment of approximately 6.2km^2, the Dean Burn flows in a south-west to north-east orientation, running largely parallel to, and to the immediate south of the A720 Edinburgh City Bypass. It is the only watercourse within the study area, though includes a number of features of note within its catchment area, including Lugton Bogs (a small standing waterbody adjacent to the A720) and a functional floodplain. Whilst the Dean Burn is not classified under the Water Framework Directive (WFD), it is within the catchment area for the reach of the River North Esk, which is classified as being of Poor overall status.

No protected areas (identified as those requiring special protection under existing National or European legislation, either to protect their surface water or groundwater, or to conserve habitats or species that directly depend on those waters) would be affected. This includes Groundwater Dependent Terrestrial Ecosystems (GWDTE) which in addition to the above, include non-statutory (UK Biodiversity Action Plan) priority habitats or local nature reserves.

In the absence of mitigation, potential impacts from the Proposed Scheme during construction would include sediment release (i.e. sand, gravel, silt) and accidental spillage (fuel, oils, lubricants) causing a deterioration in surface water quality as a consequence of general site activities, such as stockpiles locations, refuelling, compounds, etc. There is also the risk that mobilisation and discharge of contaminated groundwater, could also result in water quality issues during construction (i.e. during piling and grouting operations) and may also impact upon localised groundwater flow. Appropriate mitigation in line with industry standard guidance (i.e. CIRIA) will be provided during construction, as prescribed within a Construction Environmental Management Plan (CEMP) in order to eliminate and minimise risks to the water environment. Consequently, the potential residual effects will be neutral to slight adverse during construction.

During operation, the Proposed Scheme will provide neutral to slight beneficial effects on the water quality and flow of the Dean Burn due to the inclusion of filter drains and Sustainable Drainage Systems (SuDS), which would provide partial improvement to sediment processes at the reach scale through the introduction of two-tier attenuation of discharges, including reduction in siltation and localised recovery of sediment transport processes. Proposed hydromorphological alterations would provide partial improvement of the Dean Burn, including enhancements to in-channel habitat, riparian zone and morphological diversity of the bed and/or banks. This would provide slight improvement on baseline conditions with potential to improve flow processes at the reach scale.

Compensatory storage is required as part of the design as functional floodplain storage would be lost adjacent to the Dean Burn as a result of SuDS allocation and encroachment of road embankments. Compensatory floodplain would be provided at a level similar to that lost to the Proposed Scheme, thus would not introduce flooding to adjacent land or properties.

11.1 Introduction

11.1.1 This chapter considers the impact of the Proposed Scheme upon the water environment of the River Esk (Lothian) catchment and takes into account surface waters, drainage network assets, groundwater and flooding. Under the provisions of the Water Environment and Water Services (Scotland) Act 2003 [as amended], the water environment is defined as all surface water, groundwater and wetlands, of which:

- ‘surface water’ means inland water (other than groundwater), transitional water and coastal water;
- ‘groundwater’ means water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil; and
- ‘wetland’ means an area of ground where the ecological, chemical and hydrological characteristics are attributable to frequent inundation or saturation by water and which is directly dependent, with regard to its water needs, on a body of groundwater or a body of surface water.

11.1.2 The receptors to be included in the assessment have been identified by review of mapping and site visits. This was to establish the potential construction access routes, working areas and potential for hydrological connection to the Proposed Scheme during construction and operation. The significant water features identified in this assessment are:

- River North Esk;
- Dean Burn;
- Esk Valley Sand and Gravel Aquifer;
- Dalkeith Bedrock and Localised Sand and Gravel Aquifers; and,
- Scottish Water Drainage Network.

11.1.3 The assessment addresses the potential for adverse impacts during construction and operation (including maintenance) and considers the potential for non-conformance with Water Framework Directive (WFD) 2000/60/EC objectives as transposed into national legislation by The Water Environment and Water Services (Scotland) Act 2003 [as amended]. The Proposed Scheme (which includes a sub-section on the drainage design) is detailed within Chapter 5 - The Proposed Scheme of this Environmental Statement (ES).

11.1.4 The aim of this chapter is to make an informed assessment of the impacts of the Proposed Scheme on the water environment and to identify mitigation measures that would reduce and where possible, avoid impacts. With reference to ‘The River Basin Management Plan for the Scotland River Basin District: 2015-2027’ (Natural Scotland, 2015), it is acknowledged that adverse impacts from major development proposals are sometimes unavoidable. In line with the requirements of DMRB LA 113 ‘Road Drainage and the Water Environment’ (formerly HD 45/09) (Highways England, et al., 2019) this chapter addresses the assessment and management of potential environmental impacts on the water environment from highway construction, operation, improvement and maintenance, and aligns with the requirements of the WFD.

11.1.5 In terms of tackling pressures on the water environment, it is critical that adverse impacts are minimised in a balanced manner so to achieve the objective of protecting the water environment with achieving other important goals, such as reducing flood risk. Scottish Environmental Protection Agency (SEPA) and other regulators will continue to ensure developments that would adversely affect the water environment only progress where:

- their benefits outweigh those of protecting the water environment; and,
- all practical steps are taken to minimise adverse impacts.

11.1.6 Historically, roads have not been regarded as a major source of pollution and surface water runoff has been allowed to discharge, often rapidly, with no or minimal treatment. More recently, measures to control and treat runoff have been commonly included as part of road drainage designs where considered necessary. Pollution from road drainage can arise from a variety of sources, including:

- accidents;
- general vehicle and road degradation;

- incomplete fuel combustion;
- small oil or fuel leaks; and,
- atmospheric deposition.

11.1.7 Road runoff may also contain runoff from adjacent properties and brownfield sites in urban areas.

11.1.8 Roads are designed to drain freely to prevent build-up of standing water on the carriageway whilst avoiding exposure to or causing flooding. Contaminants deposited on the road surface are quickly washed off during rainfall. Where traffic levels are high, as is the case with the Sheriffhall Roundabout, the level of contamination increases and therefore, the potential for unacceptable harm being caused to the receiving water environment also increases.

11.1.9 Although there are many circumstances in which runoff from roads is likely to have no discernible effect, a precautionary and best practice approach indicates the need for assessment of the possible impact of discharges from proposed trunk roads and motorways.

11.1.10 As set out in the Water Environment and Water Services (Scotland) Act 2003 [as amended], the Proposed Scheme shall aim to protect of the water environment, including in particular:

- preventing further deterioration of, and protecting and enhancing, the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on those aquatic ecosystems;
- promoting sustainable water use based on the long-term protection of available water resources;
- aiming at enhancing protection and improvement of the aquatic environment through, amongst other things, specific measures for the progressive reduction of discharges, emissions and losses of priority substances and the cessation or phasing out of discharges, emissions and losses of the priority hazardous substances,
- ensuring the progressive reduction of pollution of groundwater and preventing further pollution of it, and
- contributing to mitigating the effects of floods and droughts.

11.1.11 The assessment also provides a consideration of the changes in the baseline water environment that are likely to occur in the absence of the Proposed Scheme and recognises the influence of future climate change.

11.1.12 The assessment is also supported by the following technical appendices, which are referenced as appropriate throughout this chapter:

- Appendix 11.1 – Water Quality Assessment;
- Appendix 11.2 – Dean Burn Diversion Hydromorphology Design Technical Note;
- Appendix 11.3 – Flood Risk Assessment;
- Appendix 11.4 – WFD Water Classification; and
- Appendix 11.5 – Hydrogeological Assessment Technical Note.

11.1.13 The assessment is also supported by the following figures, which are referenced as appropriate throughout this chapter:

- Figure 5.1 - Proposed Scheme Layout;
- Figure 11.1- Road Drainage and the Water Environment – Receptors; and
- Figure 11.2 - Road Drainage and the Water Environment – Proposals.

11.1.14 This chapter of the ES has been prepared by competent experts with relevant and appropriate experience. The technical lead for Road Drainage and the Water Environment has over 15 years of relevant work experience and is a Chartered Water and Environment Manager (C.WEM) with the Chartered Institution of Water and Environmental Management (CIWEM), a Chartered Environmentalist (CEnv) with the Society of the Environment (SocEnv), a Chartered Scientist (CSci) with the Science Council, and a full Member of the Chartered Institution of Water and Environmental Management (MCIWEM). Further details are provided in Appendix 1.2 – Table of Expert Competencies.

11.2 Approach and Methodology

11.2.1 This section describes the approach and methods used to assess potential impacts of the Proposed Scheme on the water environment. The assessment follows the guidance set out in the Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 10 (HD 45/09) 'Road Drainage and the Water Environment' (The Highways Agency, et al., 2009) and LA 113 'Road drainage and the water environment' (which now supersedes HD 45/09). Further guidance was obtained from Chapter 3 'Fluvial Geomorphology' of the Environment Agency's Fluvial Design Guide (Environment Agency, 2009).

11.2.2 The assessment of potential impacts on attributes of the water environment in this chapter include:

- Surface Water and Groundwater Flow & Quality;
- Hydromorphology; and,
- Hydrology and Flood Risk.

11.2.3 The objective is to ensure that the key areas of assessment, as listed above are tailored to the characteristics of the Proposed Scheme and carried out to an appropriate level of detail, related specifically to the degree of environmental risk.

11.2.4 The levels of assessment, where applicable, are consequential and progression is dependent on the type of project, the location of the site and local circumstances, as well as the nature of the potential impact (routine runoff, spillages, flooding, etc.). The process is also cyclical and is only completed when either no adverse impacts are predicted, or other options avoid, treat or mitigate the potential impact, or an adverse impact is deemed to be outweighed by a beneficial impact. Where there is an adverse impact resulting in a change of project, design or mitigation or treatment, there is an obligation to reassess the changed design or efficacy of treatment.

11.2.5 The assessment requires a full appreciation of the proposed works and some knowledge of the landscape, hydrogeology and drainage pattern and process in which the Proposed Scheme is taking place. An assessment is required when there is potential for the scheme to adversely affect the attributes as set out above. As set out in Section 3.2.1 of LA 113 'Road drainage and the water environment', a relevant simple assessment shall be undertaken:

- does the project have the potential to affect an existing watercourse in terms of water quality, hydromorphology or water quantity?;
- does the project have the potential to affect a floodplain?;
- does the project have the potential to cross an existing watercourse where upstream flooding is an existing problem or where there has been significant development in the upstream catchment since the crossing was built?;
- does the project have the potential to change either the road drainage or natural land drainage catchments?;
- does the project have the potential to lead to an increase in traffic flow of more than 20%?;

- does the project have the potential to change the number or type of junctions?;
- is any of the project located within Flood Zone 2, Flood Zone 3 or a source protection zone?;
- can earthworks result in sediment being carried to watercourses?;
- can earthworks alter the groundwater flow regime?;
- does the project have the potential to allow drainage discharges to the ground?

11.2.6 Where these scenarios definitely are not the case, no further assessment will normally be required (after consultation with the relevant statutory bodies).

11.2.7 The water environment is intrinsically linked to ecological receptors, particularly fisheries. As such, reference has been made to Chapter 9 - Nature Conservation of this ES as necessary. Similarly, this chapter considers the potential for impacts to groundwater quality during operation (i.e. direct discharges to ground associated with road runoff and accidental spillage) and construction (i.e. dewatering). Other potential impacts to groundwater resulting from disturbances to groundwater flow including the establishment of preferential pathways for potentially contaminated groundwater to reach surface water are primarily addressed within Chapter 16 - Geology & Soils.

11.2.8 Other chapters with links to the assessment of impacts upon to the water environment include landscape (design of realigned watercourses and SuDS features) and land use (waterway restoration projects, impacts upon field drainage, etc.). These are addressed within Chapter 8 - Landscape & Visual Effects and Chapter 15 – People and Communities - Community & Private Assets, and Human Health respectively.

Study Area

11.2.9 As per the requirements of Chapter 3 'Assessment of Impacts' within LA 113, an assessment has been made of the sensitivity of the water environment by considering the features within a defined study area. The extent of the study area was determined by an offset 0.5km from the Scheme Extents for the Proposed Scheme creating an envelope of interest over 1km in diameter for identifying key features of interest (i.e. surface waters, groundwater body's, functional floodplains, etc.) that may be affected by the scheme or would have a hydrological connection to it.

11.2.10 The Scheme Extent was defined as the area that would encompass the permanent footprint of the Proposed Scheme and the working area required to construct it (not including compounds). In general, it is offset by a minimum of 5m from the scheme footprint.

Baseline Conditions

11.2.11 Consultation with relevant statutory bodies and key stakeholders, desk-top assessment and site walkovers/surveys were utilised to identify baseline conditions within the study area. Information garnered from the consultation process over the course of the assessment process is detailed within Section 11.4 - Consultations.

11.2.12 The following sources were used to gather baseline information on the identified water features within the study area:

- Ordnance Survey (OS) 1:25,000 and 1:10,000 mapping;
- SEPA Water Environment Hub;
- SEPA Water Classification Hub;
- SEPA Flood Risk Management Maps 2014;
- SEPA Superficial and Bedrock Aquifer and Groundwater Vulnerability Maps;
- Scottish Natural Heritage (SNH) Sitelink website;

- Scottish Water Edinburgh ICM Model;
- Flooding information provided by City of Edinburgh Council (CEC) and Midlothian Council (MLC); and
- Private water supply data provided by MLC.

Procedure for Assessing Impacts

11.2.13 As noted above, Chapter 3 ‘Assessment of Impacts’ within LA 113 outlines the procedure for assessing the potential impact of the Proposed Scheme upon attributes or features within the existing water environment. The assessment methodologies are set out in appendices of the updated DMRB guidance documentation, and were reviewed/adopted as appropriate for the following:

- Routine runoff and surface water quality;
- Groundwater level and flow;
- Groundwater dependent terrestrial ecosystems (GWDTE);
- Groundwater quality and routine runoff;
- Spillage and water quality;
- Hydromorphological assessment;
- Flood risk;
- Construction phase impacts;
- Cumulative assessment; and
- WFD assessment.

Water Quality

11.2.14 Potential water quality impacts were assessed utilising the latest available Highways Agency (now Highways England) Water Risk Assessment Tool (HEWRAT), which evaluates the risk of routine road runoff from the road resulting in acute pollution impacts on aquatic ecology (associated with soluble pollutants), and chronic impacts (associated with sediment-bound pollutants).

11.2.15 HEWRAT assesses the effect of potential impacts upon water quality, as well as addressing the effectiveness of mitigation, by predicting road runoff pollutant loading at each step of the assessment and comparing it against runoff specific thresholds (RSTs) (e.g. Environmental Quality Standards (EQSs)) based on annual average concentrations. The relevant EQSs for the protection of freshwater aquatic life have been derived from SEPA’s Supporting Guidance (WAT-SG-53). These are given as 1.0µg/l for copper and 11.9µg/l for zinc.

11.2.16 The DMRB method for assessing potential impacts of routine runoff to groundwater applies when there is direct discharge to groundwater; the methodology is based on a Source-Pathway-Receptor (S-P-R) protocol. Where all proposed road drainage outfalls discharge to surface water bodies (i.e. there are no direct discharges to groundwater), potential groundwater contamination is not generally assessed. However, DMRB Volume 4, Section 2, Part 3, (HD33/16) ‘Design of Highway Drainage Systems’ (The Highways Agency, et al., 2016) recommends that where the treatment system is designed with an element of infiltration (e.g. SuDS basins/dry ponds, swales and grassed channels), the risk to groundwater should be assessed. It should be noted that HD33/16 was updated by CG 501 ‘Design of highway Drainage systems’ in October 2019, however the drainage design was complete by this time and the previous guidance was therefore used to inform the design.

11.2.17 In terms of accidental spillages, HEWRAT evaluates the risk of occurrence of an incident or event on the road network giving rise to toxic materials entering the water environment. It takes account of specific 'higher risk' features, such as slip roads and junctions, as well as traffic volumes using road length and the proportion of Heavy Goods Vehicles (HGVs) derived from traffic modelling. A more detailed description of the procedures for assessing water quality from LA 113 is provided Appendix 11.1 – Water Quality Assessment of this ES.

Hydromorphology

11.2.18 DMRB LA 113 contains a new procedure for assessing hydromorphological impacts as set out in Appendix E: Hydromorphological Assessment of this guidance and states that natural river processes that would have operated before any development had affected the river or catchment should be identified, and then the impacts of the project in terms of deviations from natural conditions assessed. The Water Environment and Water Services (Scotland) Act 2003 ('the WEWS Act') (Scottish Parliament, 2003) also established related targets for restoring and improving the natural water environment.

11.2.19 Assessment of the baseline hydromorphological processes and associated impacts has therefore, been carried out in cognisance of the requirements of LA 113 and utilised procedures developed from the following key reference documents:

- 'Assessing the Significance of Impacts – Social, Economic, Environmental - Supporting Guidance' (WAT-SG-67) (SEPA, 2015);
- 'Review of Impact Assessment Tool and Post Project Monitoring Guideline, Report to SEPA' WAT-SG-30) (SEPA, 2005);
- 'The Fluvial Design Guide' (Environment Agency (EA), 2009); and,
- 'Guidebook of Applied Fluvial Geomorphology', Department of Environment Food and Rural Affairs Technical Report TD1914 (DEFRA, 2003).

11.2.20 In support of this assessment, a hydromorphology technical note was prepared to determine the baseline hydromorphological processes and associated impacts of the Proposed Scheme. This has been included within Appendix 11.2 – Dean Burn Diversion Hydromorphology Design Technical Note.

Hydrology and Flood Risk

11.2.21 The Flood Estimation Handbook (FEH) produced by the Centre for Ecology and Hydrology (1999) gives guidance on rainfall and river flood frequency estimation in the UK and also provides methods for assessing the rarity of notable rainfalls or floods. A number of methods of flood estimation are presented, including the FEH statistical method and the FEH rainfall-runoff method. Subsequent publications have presented the ReFH and ReFH 2 rainfall-runoff method, updating the FEH rainfall-runoff method.

11.2.22 Given the size of the Dean Burn catchment (6.2km^2), hydrological and hydraulic modelling has been carried out for the Proposed Scheme in accordance with both the statistical and ReFH2 methods for comparison before finalising the choice of method. Flow estimates for the Dean Burn catchment were determined for the total catchment at the downstream extent of the study area for input into the hydraulic model.

11.2.23 This allowed for a Flood Risk Assessment (FRA) to be undertaken to assess the current flood risk to the site from the Dean Burn which runs parallel to the A720 Edinburgh City Bypass ('the A720'), assess the impact of the Proposed Scheme (if any), and to develop mitigation options (i.e. compensatory floodplain storage) if required to ensure that flood risk is not adversely affected elsewhere as a result of the development. The FRA has been prepared as a standalone report and is included within Appendix 11.3 – Flood Risk Assessment..

Impact Assessment

11.2.24 It is not sufficient to assess the size and probability of possible impacts; their significance should also be assessed. For example, the impact of a serious spillage event would be more significant if the watercourse it discharges to is a source of potable water, and a flood would be more significant if it affects a residential area.

11.2.25 Firstly, an assessment is made of the sensitivity of the water environment by considering the features within the study area. The environmental sensitivity of a feature such as a river is characterised by identifying and analysing its attributes, for example its use as a source of water (whether for potable or other use), its use for recreation, its function as a drainage channel, or its value to the economy. Guidance on estimating the sensitivity of water environment attributes within the study area are contained within Table 11-1 'Estimating the importance of water environment attributes' (adapted from DMRB Volume 11, Section 3, LA 113 'Road Drainage and the Water Environment' Table 3.70').

Table 11-1 Estimating the importance of water environment attributes

Sensitivity	Criteria	Typical Examples
Very High	Nationally significant attribute of high importance	Surface Water: • Watercourse having a WFD classification shown in a RBMP and Q95 ≥ 1.0 m^3/s. • None or a negligible number of anthropogenic pressures and/or pollutant sources affecting the water feature WFD status, and/or potable water supply serving >10 properties in remote areas where there is no access to alternative supplies; • Site protected/designated under EC or UK habitat legislation (e.g. Special Area of Conservation (SAC), Special Protection Area (SPA), Ramsar site), and/or no existing pressures to biodiversity. • 'High' overall WFD ecology status or for non-classified features, 'High' ecosystem quality, based on site observations and professional judgement. Presence of aquatic species and/or habitats identified as important at an international scale. • A high number of licenced discharges/high daily volume of discharges to or within 50m of water feature (with potential hydraulic connectivity to the water feature) under CAR relative to flow
		Groundwater: • Principal aquifer providing a regionally important resource and/or supporting a site protected under EC and UK legislation • Groundwater locally supports GWDTE • An aquifer constituting a valuable resource because of its high quality and/or or extensive exploitation for public, private domestic (i.e. serving >10 properties) or agricultural/industrial use and/or groundwater is classified as having very high groundwater vulnerability (BGS Vulnerability Class 5).
		Hydromorphology: • Sediment regime provides a diverse mosaic of habitat types suitable for species sensitive to changes in sediment concentration and turbidity, such as migratory salmon, freshwater pearl mussels. Water feature appears in complete equilibrium with natural erosion and deposition occurring. The water feature has sediment processes reflecting the nature of the catchment and fluvial system. • Varied morphological features (e.g. pools, riffles, bars, natural bank profiles) with no sign of channel modification. • Displays natural fluvial processes and natural flow regime, which would be highly vulnerable to change as a result of modification.
		Hydrology & Flood Risk: • Essential infrastructure or highly vulnerable development • Hydrologic importance to internationally designated sensitive ecosystems and/or critical social and economic uses (e.g. water supply, abstraction, recreation, amenity). • Water feature with direct flood risk to > 100 residential properties or critical infrastructure (e.g. trunk road or mainline railway, hospitals, schools, safe shelters) in a 1 in 200-year event (0.5% AEP).
High		Surface Water: • Watercourse having a WFD classification shown in a RBMP and Q95<1.0m^3/s.

Sensitivity	Criteria	Typical Examples
	Locally significant attribute of high importance	• A small number of anthropogenic pressures and/or pollutant sources that do not significantly affect the water feature WFD status and/or potable water supplies serving < 10 properties in remote areas where there is no access to alternative supplies and/or use of water for extensive agricultural purposes • Good' overall WFD ecology status or for non-classified features, 'Good' ecosystem quality, based on site observations and professional judgement. Presence of aquatic species and/or habitats identified as important at a national scale. Protected/designated site under EC or UK legislation (SAC, SPA, Ramsar, SPA) and few existing pressures to biodiversity. • Some existing licenced discharges/moderate daily volume of discharges to or within 50m of water feature under CAR relative to flow.
		Groundwater: • Principal aquifer providing locally important resource or supporting a river ecosystem. • Groundwater supports a GWDTE • An aquifer of limited value either because of quality impairment or because exploitation is not extensive (i.e. private domestic and/or agricultural supply serving < 10 properties) and/or groundwater is classified to have high vulnerability (BGS vulnerability class 4).
		Hydromorphology • Sediment regime provides habitats suitable for species sensitive to changes in sediment concentration and turbidity, such as migratory salmon, freshwater pearl mussels. • Appears largely in natural equilibrium with some localised accelerated erosion and/or deposition caused by land use and/or modifications. Primarily the sediment regime reflects the nature of the natural catchment and fluvial system. • Exhibits a natural range of morphological features (e.g. pools, riffles, bars, varied natural river bank profiles), with limited signs of artificial modifications or morphological pressures • Diverse range of fluvial processes that is highly vulnerable to change as a result of modification
		Hydrology & Flood Risk: • More vulnerable development • Hydrologic importance to nationally designated ecosystems and/or locally important social and economic uses (e.g. water supply, abstraction recreations, and amenity). • Water feature with direct flood risk to 1 -100 residential properties, > 10 industrial premises, and/or other land use of high value or indirect flood risk to critical infrastructure in a 1 in 200-year event (0.5% AEP).
Medium	Of moderate quality and rarity	Surface Water: • Watercourses not having a WFD classification shown in a RBMP and Q95 >0.001m^3/s. • 'Moderate' overall WFD ecology status or for non-classified features, 'Moderate' ecosystem quality, based on site observations and professional judgement. Likely to exhibit a limited number of regional designated ecosystems and/or existing pressures which are likely to be affecting biodiversity. • Few existing licenced discharges/low daily volumes of discharges to or within 50m of water feature under CAR relative to flow.
		Groundwater: • Aquifer providing water for agricultural or industrial use with limited connection to surface water. • Poor groundwater quality and/or low permeability make exploitation of groundwater unlikely and/or groundwater is classed as having moderate vulnerability (BGS vulnerability classes 2-3).
		Hydromorphology • Sediment regime provides some habitat suitable for species sensitive to change in suspended sediment concentrations or turbidity. A water feature with natural processes occurring but modified, which causes notable alteration to the natural sediment transport pathways, sediment sources and areas of deposition. • Exhibits some morphological features (e.g. pools, riffles and depositional bars). The channel cross-section is partially modified in places, with obvious signs of modification to the channel morphology. Natural recovery of channel form may be present (e.g. eroding cliffs, depositional bars). • Some natural fluvial processes, including varied flow types. Modifications and anthropogenic influences having an obvious impact on natural flow regime, flow pathways and fluvial processes.

Sensitivity	Criteria	Typical Examples
		Hydrology & Flood Risk: • Some but limited hydrologic importance to sensitive ecosystems and/or social and economic uses • Water feature with direct flood risk to agricultural or recreational land and/or affecting < 10 industrial premises and high value agriculture (e.g. arable pastures, complex cultivation patterns and agro-forestry) in a 1 in 200-year event (0.5% AEP).
Low	Attribute has a low quality and rarity on local scale	Surface Water: • Watercourses not having a WFD classification shown in a RBMP and Q95 ≤0.001m3/s.. • Highly likely to be affected by anthropogenic pressures and/or pollution sources and/or heavily engineered or artificially modified features (e.g. Road and field drains, and ephemeral features) and/or not used for water supplies. • 'Poor/Bad' ecosystem quality, based on site observations and professional judgement No habitats/species of conservation and/or any existing pressures which are considered to be adversely affecting biodiversity. • No existing licenced discharges to or within 50m of the water feature under CAR
		Groundwater: • Unproductive strata • Very poor groundwater quality and very low permeability make exploitation of groundwater unfeasible. No known past or existing exploitation of this water body and/or groundwater is classed as having low vulnerability (BGS vulnerability classes 0-1).
		Hydromorphology • Sediment regime which provides very limited physical habitat for species sensitive to changes in suspended solids concentration or turbidity. Highly modified sediment regime with limited/no capacity for natural recovery. • Extensively modified (e.g. by culverting, addition of bank protection or impoundments) and exhibits limited-to-no morphological diversity. The water feature is likely to have uniform flow, uniform banks and absence of bars. Insufficient energy for morphological change. • Shows no or limited evidence of active fluvial processes with unnatural flow regime or/and uniform flow types and minimal secondary currents.
		Hydrology & Flood Risk: • Minimal hydrological importance to sensitive ecosystems and/or social and economic uses. • Water feature with little or no flood risk affecting land use or receptors (e.g. rough grazing land) in a 1 in 200-year event (0.5% AEP).

Source: Adapted from DMRB Volume 11, Section 3, LA 113 'Road drainage and the water environment' Table 3.70'

11.2.26 It should be noted that professional judgement is applied when assigning a sensitivity category to all water features. The sensitivity of receptors has been scaled from low, medium, high and very high. 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 11.5 - Baseline Conditions.

11.2.27 Potential impacts should then be assessed in two steps: firstly, estimation of the magnitude of the impact, and then the significance of any potential environmental effects that are identified as part of the assessment process. Table 11-2 'Estimating the Magnitude of an Impact on an Attribute' and Table 11-3 'Estimating the Significance of Potential Effects' (from DMRB Volume 11, Section 3, LA 113 'Road drainage and the water environment' Table 3.71 - with some additional criteria) contain guidance for estimating these.

Table 11-2 Estimating the Magnitude of an Impact on an Attribute

Magnitude	Criteria	Typical Examples
Major Adverse	Results in loss of attribute and/or quality and integrity of the attribute	Surface Water: • Failure of both acute-soluble and chronic-sediment related pollutants in HEWRAT and compliance failure with EQS values. • Calculated risk of pollution from a spillage ≥2% annually (spillage assessment). • Loss or extensive change to a fishery.

Magnitude	Criteria	Typical Examples
		• Loss of regionally important public water supply. • Loss or extensive change to a designated nature conservation site. • Reduction in water body WFD classification.
		Groundwater: • Loss of, or extensive change to, an aquifer. • Loss of regionally important water supply. • Potential high risk of pollution to groundwater from routine runoff - risk score >250 (Groundwater quality and runoff assessment). • Calculated risk of pollution from spillages ≥2% annually (Spillage assessment). • Loss of, or extensive change to GWDTE or baseflow contribution to protected surface water bodies. • Reduction in water body WFD classification. • Loss or significant damage to major structures through subsidence or similar effects.
		Hydromorphology • Significant impacts on the water feature bed, banks and vegetated riparian corridor resulting in changes to sediment characteristics, transport processes, sediment load and turbidity. This includes extensive input of sediment from the wider catchment due to modifications. Impacts would be at the waterbody scale. • Significant/extensive alteration to channel planform and/or cross section, including modification to bank profiles or the replacement of a natural bed. This could include: significant channel realignment (negative); extensive loss of lateral connectivity due to new/extended embankments; and/or, significant modifications to channel morphology due to installation of culverts or outfalls. Impacts would be at the waterbody scale. • Significant shift away from baseline conditions with potential to alter processes at the catchment scale.
		Hydrology & Flood Risk: • Increase in peak flood level for the 0.5% AEP (200-year) plus CC event > 100mm.
Moderate Adverse	Results in effect on integrity of attribute, or loss of part of attribute	Surface Water: • Failure of both acute-soluble and chronic-sediment related pollutants in HEWRAT but compliance with EQS values. • Calculated risk of pollution from spillages ≥1% annually and <2% annually. • Partial loss in productivity of a fishery. • Degradation of regionally important public water supply or loss of major commercial/industrial/agricultural supplies. • Contribution to reduction in water body WFD classification.
		Groundwater: • Partial loss or change to an aquifer. • Degradation of regionally important public water supply or loss of significant commercial/ industrial/ agricultural supplies. • 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 GWDTE. • Contribution to reduction in water body WFD classification. • Damage to major structures through subsidence or similar effects or loss of minor structures.
		Hydromorphology • Some changes and impacts on the water feature bed, banks and vegetated riparian corridor resulting in some changes to sediment characteristics, transport processes, sediment load and turbidity. Impacts would be at the multiple reach scale. • Some alteration to channel planform and/or cross section, including modification to bank profiles or the replacement of a natural bed. Activities could include: channel realignment, new/extended embankments, modified bed and/bank profiles, replacement of bed and/or banks with artificial material and/or installation of culverts. Impacts would be at the multiple reach scale. • A shift away from baseline conditions with potential to alter processes at the reach or multiple reach scale.

Magnitude	Criteria	Typical Examples
		Hydrology & Flood Risk: • Increase in peak flood level for the 0.5% AEP (200-year) plus CC design flood event > 50mm.
Minor Adverse	Results in some measurable change in attribute's quality or vulnerability	Surface Water: • Failure of either acute soluble or chronic sediment related pollutants in HEWRAT. • Calculated risk of pollution from spillages ≥0.5% annually and <1% annually. • Minor effects on water supplies.
		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 an aquifer, • GWDTEs, abstractions and structures
		Hydromorphology • Limited impacts on the water feature bed, banks and vegetated riparian corridor resulting in limited (but notable) changes to sediment characteristics, transport processes, sediment load and turbidity at the reach scale. • A small change or modification in the channel planform and/or cross section. Includes upgrade to and/or extension of existing watercourse crossing and/or structure with associated minor channel realignment with localised impacts. • Minimal shift away from baseline conditions with typically localised impacts up to the reach scale.
		Flood Risk: • Increase in peak flood level for the 0.5% AEP (200-year) plus CC design flood event of > 10mm.
Negligible	Results in effect on attribute, but of insufficient magnitude to affect the use or integrity	Surface Water: • No risk identified by HEWRAT (pass both acute-soluble and chronic-sediment related pollutants). • Risk of pollution from spillages <0.5%.
		Groundwater: • No measurable impact upon an aquifer and/or groundwater receptors and risk of pollution from spillages <0.5%.
		Hydromorphology • Minimal or no measurable change from baseline conditions in terms of sediment transport, channel morphology and natural fluvial processes. Any impacts are likely to be highly localised and not have an effect at the reach scale.
		Hydrology & Flood Risk: • Negligible change in peak flood level for the 0.5% AEP (200-year) plus CC design flood event of up to <+/-10mm.
Minor Beneficial	Results in some beneficial effect on attribute or a reduced risk of negative effect occurring	Surface Water: • HEWRAT assessment of either acute soluble or chronic-sediment related pollutants becomes pass from an existing site where the baseline was a fail condition. • Calculated reduction in existing spillage risk by 50% or more (when existing spillage risk is <1% annually).
		Groundwater: • Calculated reduction in existing spillage risk by 50% or more to an aquifer (when existing spillage risk <1% annually). • Reduction of groundwater hazards to existing structures. • Reductions in waterlogging and groundwater flooding.
		Hydromorphology • Partial improvement to sediment processes at the reach scale, including reduction in siltation and localised recovery of sediment transport processes. • Partial improvements include enhancements to in-channel habitat, riparian zone and morphological diversity of the bed and/or banks. • Slight improvement on baseline conditions with potential to improve flow processes at the reach scale.
		Hydrology & Flood Risk:

Magnitude	Criteria	Typical Examples
		• Minor improvement over baseline conditions involving a reduction in peak flood level (0.5% annual probability) > 10mm
Moderate Beneficial	Results in moderate improvement of attribute quality	Surface Water: • HEWRAT assessment of both acute-soluble and chronic-sediment related pollutants becomes pass from an existing site where the baseline was a fail condition. • Calculated reduction in existing spillage by 50% or more (when existing spillage risk >1% annually). • Contribution to improvement in water body WFD classification.
		Groundwater: • Calculated reduction in existing spillage risk by 50% or more (when existing spillage risk is >1% annually). • Contribution to improvement in water body WFD classification. • Improvement in water body catchment abstraction management Strategy (CAMS) (or equivalent) classification. • Support to significant improvements in damaged GWDTE.
		Hydromorphology • Reduction in siltation and recovery of sediment transport processes at the reach or multiple reach scale. • Partial creation of both in-channel and vegetated riparian habitat. Improvement in morphological diversity of the bed and/or banks at the reach or multiple reach scale. Includes partial or complete removal of structures and/or artificial materials. • Notable improvements on baseline conditions and recovery of fluvial processes at the reach or multiple reach scale.
		Hydrology & Flood Risk: • Reduction in peak flood level for the 0.5% AEP (200-year) plus CC design flood event > 50mm
Major Beneficial	Results in major improvement of attribute quality	Surface Water: • Removal of existing polluting discharge or removing the likelihood of polluting discharges occurring to a watercourse. • Improvement in water body WFD classification.
		Groundwater: • Removal of existing polluting discharge to an aquifer or removing the likelihood of polluting discharges occurring. • Recharge of an aquifer. • Improvement in water body WFD classification.
		Hydromorphology • Improvement to sediment processes at the catchment scale, including recovery of sediment supply and transport processes. • Extensive creation of both in-channel habitat and riparian zone. Morphological diversity of the bed and/or banks is restored, such as natural planform, varied natural cross-sectional profiles, recovery of fluvial features (e.g. cascades, pools, riffles, bars) expected for river type. Removal of modifications, structures, and artificial materials. • Substantial improvement on baseline conditions at catchment scale. Recovery of flow and sediment regime.
		Hydrology & Flood Risk: • Reduction in peak flood level for the 0.5% AEP (200-year) plus CC design flood event > 100mm

Source: Adapted from DMRB Volume 11, Section 3, LA 113 'Road drainage and the water environment' Table 3.71

11.2.28 Table 11-3 'Estimating the Significance of Potential Effects' below shows how the determination of the significance of effect is reached, by considering both the magnitude of impact and sensitivity of the receptor. Effects that are large or very large are considered to represent key factors in the decision-making process. Those that are moderate are considered to be important but not likely to be key decision-making factors. Therefore, significant effects typically comprise residual effects that are within the moderate, large or very large categories. Effects which are slight are unlikely to be critical in the decision-making process but are important in enhancing the subsequent design of the project. Neutral refers to those effects which are beneath levels of perception. Effects are assumed to be adverse unless stated otherwise.

Table 11-3 Estimating the Significance of Potential Effects

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

Limitations

11.2.29 It is likely that the Proposed Scheme will be procured by means of a Design and Build (D&B) type contract. Under the terms of this contract type, the Contractor will undertake both the detailed design and construction of the Proposed Scheme

11.2.30 It is expected that the construction work would take place within the Scheme Extents as shown on Figure 1.2 'The Proposed Scheme'. The Scheme Extents have informed the land take calculations undertaken for assessment purposes in this ES. The land within the Scheme Extents will be purchased under a CPO.

11.2.31 It is possible that the Contractor may require construction compounds to be located out with land identified in the CPO. Should construction compounds be located out with the Scheme Extents it will be the responsibility of the Contractor to assess the environmental impacts of the construction compounds and seek to mitigate these where possible.

11.2.32 The construction assessment is based on the construction information that is currently available, with advice being provided by the Highway Design Team. As with all construction assessments, the exact details of construction activities would not be fully known before a specific contractor is appointed to complete the works who would determine their exact construction methods and programme during the detailed design stage.

11.2.33 As the Proposed Scheme is developed at detailed design any refinements to the design should be subject to environmental review to ensure that the residual effects would not be greater (or significantly different) than those reported in this ES. The findings of any such review should be subject to approval by Transport Scotland (TS) and where necessary opinions should be sought from the statutory bodies.

11.3 Legislative and Policy Context

Legislation

11.3.1 A summary of the relevant legislation and planning policies for the water environment assessment is included in the sections below.

11.3.2 Two key pieces of legislation, namely; the EU Directive 2000/60/EC Water Framework Directive (WFD) (European Parliament, 2000) transposed into the Water Environment and Water Services Act (Scotland) 2003 (Scottish Parliament, 2003) and The Water Environment (Controlled Activities) (Scotland) Regulations 2011 [as amended] (Scottish Parliament, 2011) regulate the water environment aspects for development of this nature. This legislation 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.

11.3.3 A review of the Scottish Natural Heritage (SNH) Sitelink website and the AECOM GIS database identified a number of designations for surface and groundwater features, including several for the Firth of Forth (SSSI, SPA, Ramsar) and these have been noted in the establishment of the baseline conditions and taken into account in the assessment of importance. Listed below is relevant legislation for the assessment of the water environment in relation to the Proposed Scheme:

- EU Directive 2000/60/EC (Water Framework Directive (WFD)), transposed into the Water Environment and Water Services Act (Scotland) 2003 ('the WEWS Act');
- Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR) in respect of discharges to surface or groundwater ('the CAR Regulations'); and,
- Flood Risk Management (Scotland) Act 2009 and the Flood Risk Management (Flood Protection Schemes, Potentially Vulnerable Areas and Local Plan Districts) (Scotland) Regulations 2010 ('the Flood Risk Management Act').

National Policy and Guidance

National Planning Framework 3 (NPF3) (Scottish Government, 2014a)

11.3.4 The National Planning Framework 3 (NPF 3) was published in June 2014 by the Scottish Government and outlines the key principles that guide the wider planning system in Scotland. NPF 3 guides Scotland's spatial development for the next 20 to 30 years, setting out strategic development priorities to support the Scottish Governments central purpose of promoting sustainable economic growth. Plans that are beneath the NPF 3 in the planning policy hierarchy are directly influenced by the goals and themes in the document.

11.3.5 Adaptation to climate change is an important theme, understanding that flood risk will be an increasingly important consideration in future planning decisions.

Scottish Planning Policy (SPP) (Scottish Government, 2014b)

11.3.6 Scottish Planning Policy (SPP) provides the current context for planning controls and includes the specific controls in relation to flood risk. Paragraphs 254 to 268 of the SPP address flood risk issues, which start by stating, "*National Planning Framework 3 supports a catchment-scale approach to sustainable flood risk management. The spatial strategy aims to build the resilience of our cities and towns, encourage sustainable land management in our rural areas, and to address the long-term vulnerability of parts of our coasts and islands. Flooding can impact on people and businesses. Climate change will increase the risk of flooding in some parts of the country. Planning can play an important part in reducing the vulnerability of existing and future development to flooding*." (Clause 254)

11.3.7 In terms of planning policy principles, paragraph 255 stipulates that the planning system should promote:

- "A precautionary approach to flood risk from all sources, including coastal, watercourse (fluvial), surface water (pluvial), groundwater, reservoirs and drainage systems (sewers and culverts), taking account of the predicted effects of climate change;
- Flood avoidance: by safeguarding flood storage and conveying capacity, and locating development away from functional floodplains and medium to high risk areas;
- Flood reduction: assessing flood risk and, where appropriate, undertaking natural and structural flood management measures, including flood protection, restoring natural features and characteristics, enhancing flood storage capacity, avoiding the construction of new culverts and opening existing culverts where possible; and
- Avoidance of increased surface water flooding through requirements for Sustainable Drainage Systems (SuDS) and minimising the area of impermeable surface."

11.3.8 Paragraph 262 states that "*Local development plans should protect land with the potential to contribute to managing flood risk, for instance through natural flood management, managed coastal realignment, washland or green infrastructure creation, or as part of a scheme to manage flood risk*."

11.3.9 Development within the 0.5% Annual Exceedance Probability (AEP) or 1-in-200 year flood boundary may be suitable for "essential infrastructure within built-up areas, designed and constructed to remain operational during floods and not impede water flow" (Paragraph 263).

Planning Advice Notes (PANs) and Other Guidance

11.3.10 PANS provide national guidance on various topics and SEPA has produced a number of guidance documents covering a range of environmental issues. Those documents and others relevant to the water environment are listed below:

- PAN 51 - Planning, Environmental Protection and Regulation;
- PAN 61 - Planning and Sustainable Urban Drainage Systems;
- PAN 79 - Water and Drainage;
- SEPA Policy No. 19 - Groundwater Protection Policy for Scotland;
- SEPA Interim Position Statement on Planning and Flooding;
- SEPA Engineering Activities in the Water Environment: Good Practice Guide – River Crossings;
- SEPA Land Use Planning System SEPA Guidance Note 31, 'Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems;
- SEPA Technical Flood Risk Guidance for Stakeholders;
- SEPA Pollution Prevention Guidelines are currently out of date. A review plan for the PPGs is currently underway, replacing them with a replacement guidance series, Guidance for Pollution Prevention (GPPs). GPPs provide environmental good practice guidance for the whole UK, and environmental regulatory guidance directly to Northern Ireland, Scotland and Wales only.
  - PPG 1 General Guide to the Prevention of Pollution, (SEPA, 2013);
  - GPP 2: Above ground oil storage tanks, (SEPA et al., 2018a);
  - PPG 3 Use and design of oil separators in surface water drainage systems, (SEPA, 2006);
  - GPP 4: Treatment and disposal of wastewater where there is no connection to the public foul sewer, (SEPA et al., 2017a);
  - GPP 5: Works and maintenance in or near water (SEPA et al., 2017b);
  - PPG 6 Working at Construction and Demolition Sites, (SEPA, 2012);
  - PPG 7 Safe storage - The safe operation of refuelling facilities (SEPA, 2011);
  - GPP 8: Safe storage and disposal of used oils (SEPA et al., 2017c);
  - GPP 21: Pollution incident response planning, (SEPA et al., 2017d); and,
  - GPP 22: Dealing with spills, (SEPA et al., 2018b).
- Scottish Natural Heritage (SNH), A Handbook on Environmental Impact Assessment (SNH, 2018);
- CIRIA, C532 Control of Water Pollution from Construction Sites (CIRIA. 2001);

- CIRIA, C648 Guidance on Controlling Water Pollution from Linear Construction Projects (CIRIA, 2006); and,
- CIRIA, C741 Environmental Good Practice on Site Guide (CIRIA, 2016).

Regional Policy

South East Scotland Strategic Development Plan (SDP) (SESplan, 2013)

11.3.11 The Edinburgh and South East Scotland Strategic Development Plan (SESplan), which was approved by Scottish Ministers (with modifications) on 27 June 2013 comprises the City of Edinburgh, East Lothian, Midlothian, Fife, Scottish Borders and West Lothian Councils. Policy 15 within the plan states that Local Development plans "*will consider flood risk at the catchment-scale, identify areas where there is a degree of flood risk, and include policies to reduce that overall risk by avoiding new allocations which are at risk of flooding. Strain on existing water management infrastructure may be exacerbated by new development. The SDP seeks to ensure a high-quality water environment where water quality, quantity and ecology are protected*."

Proposed South East Scotland Strategic Development Plan (SDP2) (SESplan, 2016)

11.3.12 The Proposed Strategic Development Plan (SDP2) sets out the vision for the city region over 20 years from 2018. When approved in 2018 it will replace the current SESplan and will inform the next set of Local Development Plans. One of the Placemaking Principles is to be 'Resource Efficient', indicating that "*Development should be located away from functional flood plains and areas of medium to high flood risk*" and "*Areas important for flood storage and conveying capacity should be safeguarded for a range of compatible uses such as recreation, water quality management, flood attenuation and habitat creation*."

11.3.13 As discussed in Chapter 2 – Need for the Scheme, the Proposed SDP (SDP2) was rejected by the Scottish Ministers on the 16 May 2019; however, SDP2 has still been considered within this ES as a draft plan.

Local Policy

Edinburgh Local Development Plan (City of Edinburgh Council, 2016)

11.3.14 The CEC Adopted Local Development Plan adopted 2016 Policy Env 21 states that "*Planning permission will not be granted for development that would:*

- Increase a flood risk or be at risk of flooding itself;
- *Impede the flow of flood water or deprive a river system of flood water storage within the areas shown on the Proposals Map as areas of importance for flood management; and*
- *Be prejudicial to existing or planned flood defence systems."*
- Policy Env 22 states that *"Planning permission will only be granted for development where:*
- *There will be no significant adverse effects for health, the environment and amenity;*
- *There will be no significant adverse effects on: air, and soil quality; the quality of the water environment; or on ground stability; or,*
- *Appropriate mitigation to minimise any adverse effects can be provided."*

Midlothian Local Development Plan (Midlothian Council, 2017)

11.3.15 The MLC Local Development Plan (LDP) was adopted in November 2017. The LDP focuses on providing for, and managing, future change across the Council area in line with the SESplan requirements. It comprises a development strategy for the period to 2024 and a detailed policy framework to guide future land use in a way which best reflects SESplan's vision, strategic aims and objectives.

11.3.16 The Strategic Objectives of the MLC LDP states that *"sustainable place-making factors and the wider principles of sustainable development provide the basis for the environmental, social and economic objectives underpinning the policies and proposals of this Plan"* (Pg.2). One of the Environmental Objectives listed is *"Safeguard and enhance biodiversity and take full account of development impact on the water environment whilst consideration being taken for its improvement"* (Pg. 3).

11.3.17 Policy DEV 5 – Sustainability in New Development states that *"the Council will expect development proposals to have regard to the principles of sustainability which include:*

- *treating and conserving water on site in line with best practice and guidance on sustainable urban drainage; and,*
- *where flood risk has been identified on a development site or where a development proposal will increase flood risk elsewhere, the layout of the site will be designed to reduce flood risk on or off site, in accordance with ENV9.'"*

11.3.18 Policies ENV 9 and ENV 10 refer to Flooding and Water Environment respectively. These are quoted in full below:

Policy ENV9 – Flooding

"Proposals for development will be assessed in relation to the flood risk framework and flood risk policy as set out in Scottish Planning Policy, using the SEPA flood maps to delineate the zones of little or no risk, low to medium risk, and medium to high risk. Development will not be permitted which would be at unacceptable risk of flooding or would increase the risk of flooding elsewhere. Flood Risk Assessments will be required for most forms of development in areas of medium to high risk but may also be required at other locations depending on the circumstances of the proposed development.*

The functional flood plain will be protected; in undeveloped and sparsely developed areas development may be acceptable in areas at medium to high risk of flooding if the location is essential for operational reasons and an alternative, lower risk location is not available. Where flood protection measures to the appropriate standard already exist or are planned (under the adopted Local Flood Risk Management Plan) in built-up areas, development for residential, institutional, commercial and industrial development may be suitable. Any loss of flood storage capacity should be mitigated to achieve a neutral or better outcome. All proposals should be considered in accordance with the flood risk framework.

Flood protection scheme proposals, or further land for natural flood risk management purposes, as promoted under the adopted LFRMP, will be supported in principle and protected from development which would prejudice their delivery.

Sustainable drainage systems will be required for most forms of development, so that surface water run-off rates are not greater than in the site's pre-developed condition, and to avoid any deterioration of water quality. The Council may seek long-term management agreements with developers to maintain such features in perpetuity.

**Generally, an annual probability of up to 0.5% will be acceptable for most development, but higher standards may apply to essential infrastructure and the most vulnerable uses"* (Pg. 52).

Policy ENV10 – Water Environment

"New development should pass surface water through a sustainable drainage system (SuDS) which ameliorates the water to an acceptable quality prior to release to the wider water environment. The design of the system should meet

best current practice. To ensure that the biodiversity and amenity benefits of SuDS are realised, the Council does not favour the use of underground tanks as a SuDS measure, other than in exceptional circumstances.

There is a presumption against development which changes the natural morphology of a river or other water body. The formation of new culverts is not supported.

Small-scale hydropower installations will only be supported provided that no deterioration of the water body's status occurs.

Proposals that support measures identified in the River Basin Management Plan will be supported in principle, including the retrofitting of SuDS features to the existing surface drainage system, the restoration of watercourses through the opening out of existing culverts, and the removal of redundant structures

There is a presumption against development which may cause a deterioration in water quality. Where development generating a foul drainage, requirement takes place in an area benefiting from a public sewerage system, it should connect to that system.

Where development adjoins a watercourse, buffer strips of a minimum of 6 metres in width from the top of the bank should be provided, to enable access for maintenance, promote biodiversity and improve public amenity" (Pgs. 52-53).

11.4 Consultations

11.4.1 An important element in the assessment process is liaison and data collection, giving opportunity for relevant interested bodies to register concerns, constraints, or requirements during the assessment process. The following table, Table 11-4 'Summary of Consultation Responses in relation to Road Drainage and the Water Environment' outlines the responses from the consultation in relation to Road Drainage and the Water Environment for the Stage 3 assessment only. Please note Chapter 7 – Consultation and Scoping includes a full summary of all consultations undertaken.

Table 11-4 Summary of Consultation Responses in relation to Road Drainage and the Water Environment

Consultee	Consultation Date	Date of Response	Aspect	Comments
Buccleuch Property	21 November 2018	08 January 2019	SuDS and flooding	Request for regular dialogue/review in relation to location of SuDS features (temporary and permanent). SuDs to the south of roundabout are located in 'blue wash' flood zone, compensatory flood storage could potentially be needed due location of SuDS in this area. New SuDS locations or off-site works may be required to provide compensation area?
Scottish Environment Protection Agency (SEPA)	21 November 2018	11 December 2018	SuDS and construction	Proposals for SUDS should be accompanied by the output of the Simple Index Approach. Included standard advice for a Controlled Activities Regulations (CAR) construction site licence which may be required for the managements of surface water run-off from a construction site, including access tracks which: • is more than 4 hectares, • is in excess of 5km, or • includes an area of more than 1 hectare or length of more than 500m on ground with a slope in excess of 25˚. See SEPA's Sector Specific Guidance: Construction Sites (WAT-SG-75) for details. Advised that site design may be affected by pollution prevention requirements and strongly encouraged engagement in pre-CAR application discussions with the regulatory services team in SEPA.

Consultee	Consultation Date	Date of Response	Aspect	Comments
				Must comply with CAR General Binding Rule 10 which requiring all reasonable steps must be taken to ensure that the discharge does not result in pollution of the water environment. Details of regulatory requirements and good practice advice for the applicant can be found on the SEPA website.
		14 March 2019	Grouting	SEPA request information on the likelihood that the grouting of shallow mine workings might affect surface water. SEPA's local team should be notified when these works start, what works are involved, what watercourse /ditches they may affect and what mitigation is in place. SuDS should be in place prior to any soil removal for the construction phase. Specific advice can be provided on receipt of more detail of the nature of the works, the proximity to watercourses, etc. Included Planning Standard Response, outlining guidance document '*Stabilising mine workings with PFA grouts. Environmental Code of Practice. 2nd Ed, BRE Report 509.*' Also recommend consultation with The Coal Authority. Outlined the following Key points in relation to the water environment when undertaking mine workings grouting: An adequate hydrogeological conceptual model is required. Ideally, the conceptual model would be backed up with site specific ground investigation and monitoring data. Recommend that the applicant carries out an appropriate water features survey to identify what might be affected by the grout. Consider and mitigate as necessary risks /potential hazards both within and outwith the development site. It should be noted that even if mine waters are currently low, groundwater levels might rebound into the grouted zone if mine water pumping were to cease. SEPA would recommend considering both scenarios. May be required to demonstrate that dewatering of excavations (if required) will not adversely affect the hydrogeological regime. Any adverse effects will depend on the size and duration of the excavation works.
Scottish Natural Heritage (SNH)	21 November 2018	18 December 2018	SuDS	Recommend that SuDS ponds are functionally linked where possible, and are not simply designed as drainage basins. For example the two ponds between A7 South and A6106 South (Old Dalkeith Road) lie very close together, and the land around them could be planted with wetland species to create a small wetland habitat network that would bring additional benefits to nature.
City of Edinburgh Council (CEC)	09 April 2019	16 May 2019	Contaminated land	The former Gilmerton Colliery and spoil heap which has now been flattened are located approximately 350m to the north west of the broken line delineating the site of interest on the plan provided at coordinates 329799, 667981. There is now a scrap yard located on this area. No land has been identified as contaminated land within the area of interest. It is known that there was a water treatment system (reedbeds) for water arising from mine workings at Gilmerton. The treatment system is located at 329929, 667735.

11.5 Baseline Conditions

11.5.1 This section provides a proportionate effort description of the existing water environment within or hydrologically connected to the predefined study area. This includes the baseline conditions for all water environment attributes (including sensitivity) addressed within this chapter.

11.5.2 The key water environment features located within the study area are shown on Figure 11.1 'Road Drainage and Water Environment – Receptors'. Details for each waterbody were gained from desktop studies and site visits undertaken over the course of the assessment process. The baseline conditions of the water environment receptors relevant to the assessment are outlined in the following sections and Table 11-10 'Sensitivities of Receptors' provides a summary of this baseline information and the sensitivity of each receptor.

Existing Surface Waters

River Esk (Lothian) catchment

11.5.3 The study area is located within the River Esk (Lothian) catchment. The main watercourse is the River Esk, forming after the confluence of the River North Esk and River South Esk on the outskirts of Dalkeith. Other notable watercourses within the catchment include the Dean Burn (as shown on Figure 11.1 'Road Drainage and the Water Environment – Receptors') and the Bilston Burn.

11.5.4 River North Esk flows in a west to northeast orientation, and is aligned largely parallel to the existing A720 City of Edinburgh Bypass (just north of Dalkeith) before its confluence with the River South Esk. From this point, the River Esk makes its way northwards through Musselburgh, where it flows into the Firth of Forth.

River North Esk

11.5.5 The River North Esk rises in the North Esk Reservoir in the Pentland Hills, in Midlothian, a mile (1.6km) north of the village of Carlops. It flows north-eastwards past Penicuik and Auchendinny, where it is joined by the Glencorse Burn, flowing in a south-easterly direction from the Glencorse Reservoir. It continues through Roslin Glen and the Penicuik–Dalkeith Walkway, past Hawthornden Castle, Polton, Lasswade and Melville Castle. It is a mostly upland catchment with the headwaters draining the steep slopes of the Pentland Hills. Land use is mostly rough grazing with some forest and arable areas and significant areas of urban development along its course, particularly in the lower reaches.

Plate 11-1 Downstream View of the River North Esk from the A7 Road Bridge

11.5.6 With a catchment of approximately 137km^2, it is the main watercourse within the study area, located approximately 390m downstream of the redline boundary for the Proposed Scheme (at the A7 South) and is hydrologically connected to the existing road network, via a minor tributary (the Dean Burn). A downstream view of the river from the A7 road bridge is shown on Plate 11.1 (Photograph location P1 on Figure 11.1 'Road Drainage and the Water Environment – Receptors').

South Esk

11.5.7 The South Esk rises at the southernmost extremity of Midlothian, on the western slopes of Blackhope Scar (the highest of the Moorfoot Hills). It flows north through Gladhouse Reservoir and Rosebery Reservoir, and by the village of Temple, before receiving the Redside Burn close to Arniston House. It is joined by the Gore Water and then the Dalhousie Burn, just to the west of Newtongrange, before passing Newbattle Abbey and proceeding through Dalkeith. It is not located within the study area, nor is it hydrologically connected to it.

11.5.8 The North Esk and South Esk converge approximately 1.25 miles (2.01km) north-east of Dalkeith, at the edge of the grounds of Dalkeith Palace. From here the River Esk continues north for approximately 4.3 miles (6.9km), skirting Inveresk, and flowing into the Firth of Forth at Musselburgh, East Lothian.

Dean Burn

11.5.9 The Dean Burn is a minor tributary of the River North Esk and rises as the May Burn in the vicinity of Pentland Industrial Estate, at Loanhead. With a catchment of approximately 6.2km^2 it flows in a south-west to north-east orientation, running largely parallel to, and to the immediate south of the A720. As shown on Figure 11.1 'Road Drainage and the Water Environment – Receptors' and Plate 11. 2 (Photograph location P2 on Figure 11.1), the burn is in very close proximity to the A720 between the A772 Gilmerton Road (where it flows past a Scottish Water Pumping Station) and A7 (south). At several points along this reach, the watercourse is located within 30m of the A720.

Plate 11-2 Dean Burn downstream of a Scottish Water Pumping Station at A772 Gilmerton Road

11.5.10 Downstream of the Scottish Water pumping station, there is a small standing waterbody adjacent to the A720 at Lugton Bogs (as shown on Plate 11.3 (Photograph location P3 on Figure 11.1 'Road Drainage and the Water Environment – Receptors')). Historical mapping indicates that the pond would have been created around the time of construction of the A720 between 1981 and 1989. It is likely that the pond was created for amenity purposes.

Plate 11-3 Lugton Bogs Pond alongside the A720 (view towards east)

11.5.11 The inlet to the pond is piped and takes overflow from the Burn and at high water levels. There appears to be no outfall from road drainage directly to the pond. The outfall to the Burn (as shown on Plate 11.4 (Photograph Location P4 on Figure 11.1 'Road Drainage and the Water Environment – Receptors')) is also piped and from visual inspection does seem to be impacting upon water quality conditions within the burn (i.e. increased turbidity).

11.5.12 A further outflow entered the Dean Burn from a constructed wetland used to treat contaminated mine drainage from Gilmerton Coal Bing to the north of the A720, approximately 1.75km upstream and west of Sheriffhall Roundabout (E.329920 N.667730). Historically, the inflow and outflow to the treatment system has been monitored by SEPA, as well as baseline water quality from an upstream location. Chemical water quality data (as provided by SEPA) was variable and the data indicated that at times the system appeared to provide an improvement for some elements (such as Ammonia, Aluminium, Biological Oxygen Demand, Chemical Oxygen Demand, Electrical Conductivity, Iron and Suspended Solids), however pH samples were very acidic compared to the baseline samples. Therefore, water quality in the Dean Burn has been shown to be impacted to some degree by the outflow from the Gilmerton Coal Bing treatment system.

Plate 11-4 Dean Burn at the Surface Water Outflow

11.5.13 However, information recently received from The City of Edinburgh Council (CEC) has indicated that the former Gilmerton Colliery and spoil heap has now been flattened and replaced with a scrap yard. It was noted in this consultation, that the Council were aware of this water treatment system (reedbeds) and for water arising from mine workings at Gilmerton, however none of this land has now been identified as contaminated.

Plate 11-5 Iron rich deposits on the bed of the Dean Burn

11.5.14 The Dean Burn flows through an area of woodland at Lugton Bogs, before entering agricultural land. The banks of the Burn comprise very soft, erodible sandy material, as the superficial geology in this area is dominated by glacial sand and gravel deposits. Plate 11.5 (Photograph location P5 on Figure 11.1 “Road Drainage and the Water Environment – Receptors’) gives an indication of the iron rich deposits which line the bed of the channel. The woodland is poorly managed; with large volumes of wooded debris in the channel (as shown on Plate 11.6 (Photograph location P6 on Figure 11.1‘Road Drainage and the Water Environment – Receptors’)).

11.5.15 The presence of this material has helped to create a somewhat morphologically diverse channel, with some steps and pools, erosion and deposition processes. However, it is likely that woody debris could be transported downstream during high flows as the majority has been stripped of branches and is unanchored. The woodland is used by Edinburgh Combat Challenge for paintballing and much of the woody material located around the Burn may be related to this. Such woody material can cause downstream blockage and damage to structures.

Plate 11-6 Dean Burn in the Woodland Area

11.5.16 Historical mapping indicates that the Dean Burn has changed little since the OS maps of the 1800s. Where the reach flows through farmland, downstream of the woodland, the watercourse is deeper, wider and straighter than it would be naturally (as shown on Plate 11.7 (Photograph location P7 on Figure 11.1‘Road Drainage and the Water Environment – Receptors’)). These hydromorphological modifications are likely related to agricultural improvements and road construction.

11.5.17 As included in Appendix 11.2 – Dean Burn Diversion Hydromorphology Design Technical Note, a hydromorphological technical note has been prepared which addresses the channel characteristics of the Dean Burn. As detailed within this note, the burn is a low activity, locally sinuous, single thread, riffle-pool-plain bed system. There is a general lack of gravel bedload to the channel and an excessive input of fines. This is related to diffuse inputs linked to the management of the system (agriculture, industrial areas and road runoff), as well as the local erosion of bank material containing a high proportion of fines. Where there is more coarse bed material, this appears to be immobile, and in places has become indurated into the bed (as evidenced by the presence of embedded brick and rubble debris).

11.5.18 Where the channel has been able to begin naturalising, there is evidence of increased local sinuosity and the development of some bed features. Grossly over-wide sections have seen subsequent development of low-level fine sediment berms which have become vegetated. These provide beneficial diversity to the flow and marginal habitat in these reaches.

11.5.19 The burn is more confined in the wooded reach, with some steep banks in sinuous sections, acting as a local source of fine sediment and some smaller gravels. Some deeper pools have formed in these areas, which would normally be indicative of active transport of material, flushing out and maintaining the pools. It is likely in this case that finer material is flushed through the pools in higher flows, but undersupply of the coarser bedload has inhibited infilling.

Plate 11-7 Hydromorphological modification of the Dean Burn

11.5.20 As described previously, along its course, the Burn flows through a number of road culverts including beneath the A772, the A7 and A6106, following which it flows through Dalkeith Country Park, subsequently joining the River North Esk to the north of Dalkeith.

11.5.21 Consequently, from a hydromorphology perspective, the watercourse has been assigned a medium sensitivity value.

Water Quality

11.5.22 With reference to the '*Recommendations on Surface Water Classification Schemes for the purposes of the Water Framework Directive Report*' (UKTAG, 2007), Member States are required to classify the 'status' of surface water bodies. This is determined by whichever is the lower of a water body's 'ecological' or 'chemical' status. To achieve the overall aim of 'Good' surface water status, the Directive requires that surface waters be of at least 'Good' ecological and 'Good' chemical status. 'Good' surface water status is one of the principal objectives for surface water bodies not designated as heavily modified or artificial. The other principal objective is to prevent deterioration of surface water status.

11.5.23 The ecological quality of surface waters is an expression of the quality of the structure and functioning of surface water ecosystems, as indicated by the condition of a number of 'quality elements'. The Directive uses the term 'quality elements' to refer to the different indicators of ecological quality comprising its ecological status classification schemes. The quality elements used to assess ecological status are:

- biological quality elements (invertebrates, plants, fish, phytobenthos and phytoplankton);
- general chemical and physiochemical quality elements (phosphorous in rivers and lakes, nitrogen in transitional and coastal waters, dissolved oxygen and pH);
- specific pollutants (ammonia and other potentially ecologically toxic substances); and,
- hydromorphological quality elements (water flow and physical modifications).

11.5.24 For each waterbody, the ecological quality elements are classified individually, and chemical quality is determined by the levels of certain hazardous and dangerous substances. The ecological and chemical results are then combined to give an overall status in one of five classes:

- High Ecological Status (HES);
- Good Ecological Status (GES);
- Moderate Ecological Status (MES);
- Poor Ecological Status (PES); and,
- Bad Ecological Status (BES).

11.5.25 As noted above, the Directive requires that the overall ecological status of a water body be determined by the results for the biological or physiochemical quality element with the worst class (i.e. the quality element worst affected by human activity). This is called the ‘one out - all out’ principle. If a water body is classified as ‘High’ or ‘Good’ status, then it has a healthy ecology, which deviates only slightly from natural conditions, is an important natural asset, and can support a wide range of uses such as recreation, fishing and drinking supply. If a water body is classified as ‘Moderate’, ‘Poor’ or ‘Bad’, then the ecology is adversely affected and the range of uses that can be supported is reduced.

River North Esk

11.5.26 The 17km reach of the River North Esk from the Glencorse Burn confluence to the South Esk was classified as having an overall WFD status of ‘Poor’ in 2017 (two separate waterbodies; IDs 3807 and 3806). It did not achieve ‘Good’ or ‘High’ status due to water quality issues and obstacles to fish passage. The objective is to improve this status to ‘Good’ by 2027 (Table 11-5 ‘WFD Status of the River North Esk from Glencorse Burn confluence to Elginhaugh (ID3807).’and Table 11-6 ‘WFD Status of the River North Esk from Elginhaugh to confluence with South Esk (ID3806)’).

Table 11-5 WFD Status of the River North Esk from Glencorse Burn confluence to Elginhaugh (ID3807).

	2014	2017	2021	2027	Long Term
Overall	Poor	Poor	Poor	Good	Good
Access for Fish Migration	Poor	-	Good	Good	Good
Water Flows and Levels	High	-	High	High	High
Physical Condition	Good	-	Good	Good	Good
Freedom from Invasive Species	High	-	High	High	High
Water Quality	Moderate	-	Moderate	Good	Good

Source: https://www.sepa.org.uk/data-visualisation/water-environment-hub

Table 11-6 WFD Status of the River North Esk from Elginhaugh to confluence with South Esk (ID3806)

	2014	2017	2021	2027	Long Term
Overall	Poor	Poor	Poor	Good	Good
Access for Fish Migration	Poor	-	Good	Good	Good
Water Flows and Levels	High	-	High	High	High
Physical Condition	Good	-	Good	Good	Good
Freedom from Invasive Species	High	-	High	High	High

	2014	2017	2021	2027	Long Term
Water Quality	Moderate	-	Moderate	Good	Good

Source: https://www.sepa.org.uk/data-visualisation/water-environment-hub

11.5.27 The full water classification data for each of these waterbody's is included in Appendix 11.4 – WFD Water Classification.

11.5.28 Whilst the Dean Burn is not classified under the WFD, it is within the catchment area for the reach of the River North Esk from Elginhaugh to confluence with South Esk (ID3806), which is classified as being of Poor overall status. The main stem of the river in this reach is approximately 4.2km in length.

11.5.29 The main pressures affecting this waterbody are:

- Access for fish migration (barriers); and,
- Water quality (diffuse source and unknown pressures).

11.5.30 From 2014, elevated concentrations of manganese have been monitored by SEPA within the waterbody, however the cause has not been identified. Manganese occurs naturally in the water environment, but elevated concentrations can be toxic to aquatic plants and animals. The concentration which is harmful depends on the type of organism affected and varies with water chemistry. In more acidic waters (lower pH), invertebrates are more sensitive to manganese whilst in more alkaline waters plants are more sensitive. With increasing water hardness, the toxicity of manganese generally decreases. The waterbody also suffers from the effects of nutrient pollution.

11.5.31 The overall ecology of the River North Esk from Elginhaugh to confluence with South Esk (ID3806) is also classified as being Poor.

11.5.32 Utilising the overall and ecological status of the River North Esk from Elginhaugh to the confluence with South Esk (ID3806) as a proxy for the classification of water quality within the Dean Burn, in combination with professional judgement and understanding of existing conditions, the watercourse has been assigned a low sensitivity value.

Protected Areas

11.5.33 The WFD requires that a register of protected areas be identified to help ensure that the management of relevant water bodies is geared towards achieving protected area objectives. Protected areas are identified as those requiring special protection under existing National or European legislation, either to protect their surface water or groundwater, or to conserve habitats or species that directly depend on those waters. The purpose of the protected area register is to bring all EC water-related legislation under one umbrella.

11.5.34 As noted previously, the River Esk flows into the Firth of Forth at Musselburgh, approximately 7km to the north-east of Sheriffhall. The Firth of Forth has a number of environmental designations, which include a Site of Special Scientific Interest (SSSI), a Special Protection Area (SPA) and is designated as a Ramsar site (a wetland designation of international importance under the Ramsar Convention). The designations cover a range of aspects, including unique habitats and geology, bird species and invertebrates, along with archaeological and other landscape assets.

11.5.35 No protected areas (identified as those requiring special protection under existing National or European legislation, either to protect their surface water or groundwater, or to conserve habitats or species that directly depend on those waters) would be affected, as they are all located over 1km from any outfall associated with the Proposed Scheme and thus acute (copper and zinc) or chronic (sediment) pollution impacts from routine runoff would have no effect on these areas. Therefore, the impacts on protected areas will not be assessed for impacts as a result of the Proposed Scheme.

11.5.36 As detailed within Chapter 9 - Nature Conservation, there are no habitats/species of conservation and/or any existing pressures which are considered to be adversely affecting biodiversity in the Dean Burn and as the SSSI is hydrologically over 9km downstream of the study area, it has been assigned a low sensitivity value.

Groundwater

11.5.37 Groundwater occurs everywhere beneath the ground across Scotland. It plays a significant role in supporting surface water flows and levels through natural discharge from the ground to rivers, lakes, streams and wetlands. This contribution to surface waters can also act to dilute pollutant concentrations in the surface water; therefore, helping support the overall ecological and amenity value of these systems.

11.5.38 The WFD requires the status of groundwater management units (groundwater bodies) within each river basin to be determined as 'Good' or 'Poor'.

11.5.39 Groundwater bodies are assessed by examining the main land-use pressures that are likely to affect them; these include chemical (diffuse and point sources) and quantitative (water abstraction and quarry de-watering) pressures. Using the monitoring data, the following is considered:

- the scale, frequency and distribution of the pressures;
- the nature of the link between the pressure and the groundwater;
- trends in groundwater (and surface water) quality and levels; and,
- the relationship between groundwater bodies and the surface water bodies and wetland systems to which they eventually discharge.

11.5.40 In the vicinity of the existing Sheriffhall Roundabout, the underlying bedrock is composed of the moderately productive Scottish Coal Measures Group. The unit is composed of sedimentary cycles including sandstone and coal layers. Fractures and abandoned mine shafts provide a secondary permeability as there are historic coal mine workings abundant throughout the area. Water quality from these sources tends to be poor with elevated iron and fluoride concentrations.

11.5.41 The 'Dalkeith' groundwater body has an overall WFD status of 'Poor', due to the extensive coal mining works, and resultant degraded water quality, see Table 11-7 'WFD Status of Dalkeith Groundwater Body (ID 150552) 75km^2'. The waterbody is approximately 75km^2 in size, and the quantity and flow of groundwater have 'Good' status. Remediation of the water quality is not possible due to the long-term effects of leaching of metals from strata exposed during mining. It is therefore expected that improvement will not be detected for decades to come.

Table 11-7 WFD Status of Dalkeith Groundwater Body (ID 150552) 75km^2

	Current	2021	2027	Long Term
Overall	Poor	Poor	Poor	Good
Water Flows and Levels	Good	Good	Good	Good
Water Quality	Poor	Poor	Poor	Good

Source: https://www.sepa.org.uk/data-visualisation/water-environment-hub

11.5.42 As the Dalkeith Groundwater Body's overall status is poor and based on the characterisation as set out below, it is deemed to be of medium sensitivity.

11.5.43 Overlying the bedrock is the moderately to highly productive 'Esk Valley Sand and Gravel Aquifer', which has an overall WFD status of 'Good' (Table 11-8 'WFD Status of Esk Valley Sand and Gravel Groundwater Body (ID 150723)

22km^2'). Both the quality and quantity of groundwater are assessed to have 'Good' status. The aim is to maintain this status throughout the upcoming cycles. The waterbody is approximately 22km^2 in size.

Table 11-8 WFD Status of Esk Valley Sand and Gravel Groundwater Body (ID 150723) 22km^2

	Current	2021	2027	Long Term
Overall	Good	Good	Good	Good
Water Flows and Levels	Good	Good	Good	Good
Water Quality	Good	Good	Good	Good

Source: https://www.sepa.org.uk/data-visualisation/water-environment-hub

11.5.44 As the Esk Valley Sand and Gravel Groundwater Body's overall status is good, it is deemed to be of high sensitivity.

11.5.45 The full water classification data for each of these waterbody's is included in Appendix 11.4 – WFD Water Classification.

11.5.46 As detailed within Chapter 9 - Nature Conservation, there are no habitats/species of conservation that could be constituted as Groundwater Dependent Terrestrial Ecosystems (GWDTE) within the study area.

Hydrogeology

11.5.47 An aquifer classification system has been developed by British Geological Survey (BGS) in accordance with WFD guidance to assess and manage all waters within Member State boundaries in a unified manner. For the purposes of WFD analysis, the aquifer classification scheme considers the following elements in defining aquifer type/category:

- Strata type (Bedrock or Superficial);
- Relative 'productivity' with respect to exploitation history/well yields (where data is available); and,
- Flow Type (intergranular, fractured, karstic or combination).

11.5.48 Appendix 11.5 – Hydrogeological Assessment Technical Note, provides a hydrogeological characterisation of the study area, as detailed below.

11.5.49 The Coal Measures are classified by the SEPA as the 'Dalkeith Bedrock' groundwater body. The strata are further classified by SEPA as being moderately permeable, with variable permeability and thickness of overlying superficial deposits. The BGS (British Geological Survey) classifies the bedrock in the area as a moderately productive aquifer, in which flow is virtually all through fractures and other discontinuities. Within both the Middle and Lower Coal Measures, it is likely that the sandstone strata are the main water bearing units. The mudstones, siltstones and coals typically act as low permeability barriers to flow, confining the groundwater in underlying sandstone units where the bands are laterally continuous. Groundwater flow also takes place through fractures and fissures within the bedrock, which may have been enhanced following coal mining activities. The Dalkeith Bedrock groundwater body has an overall Water Framework Directive (WFD) status of Poor, due to the effects of extensive coal mining and the resultant degraded water quality. The water quantity and flow of the groundwater have a WFD status of Good. Whilst mine drainage through the former coal workings may be impacting on the hydrogeological conditions in the bedrock, it is understood that there are no active mine drainage schemes currently in operation in the area. Active pumping from the old coal workings ceased at the Monktonhall Colliery, approximately 2.1km north-east of the area in 2009.

11.5.50 Aquifer property data from the joint BGS and SEPA Groundwater Science Programme differentiates between Carboniferous sedimentary rocks that have been extensively mined for coal and those that have not. This is due to unmined coal seams acting as a low permeability layers and restricting flow between sandstone aquifer units, potentially forming a series of hydrogeologically discrete units. In contrast, mine voids, shafts and tunnels can artificially increase aquifer transmissivity and link previously separate flow systems laterally and vertically. Aquifer property data for Carboniferous sedimentary aquifers extensively mined for coal, estimate a wide transmissivity between 10-1000m^2/d and a specific capacity between 48-132m^3/d/m.

11.5.51 Glaciofluvial sand and gravel, and mixed deposits are classified as having a high productivity rating, with borehole supplies in excess of 10l/s, by the BGS. The BGS also assumes flow through all superficial deposits will be granular, though acknowledges that flow may occur in fractures in certain tills. The glaciofluvial deposits in the proposed development area typically have a high intergranular permeability in the sand and gravel units which facilitates groundwater flow. Falling head permeability tests completed in the superficial deposits in March 2019, calculated a permeability of 1.59x10-5m/s for a sand and gravel deposit, and a permeability between 1.4x10-6 m/s and 6.0x10-8 m/s for clay deposits. Due to the variability of the lithology and the presence of low permeability clay-rich units including boulder clay (till) in these deposits, water bearing horizons may be discontinuous and perched aquifers may be encountered.

11.5.52 It is unlikely that there is a significant direct hydrogeological connection between the superficial aquifer and the bedrock due to the presence of low permeability (boulder) clay, siltstone and mudstone strata, all of which limit the vertical hydraulic connectivity through the aquifers. There is no obvious correlation in groundwater level fluctuations between those piezometers measuring the bedrock and those measuring the superficial deposits. There is no hydraulic continuity between groundwater in the superficial deposits and that in the bedrock, with the groundwater level in the Coal Measures being on average approximately 12m lower.

Groundwater Levels and Flow

11.5.53 Based on the results of groundwater level monitoring, it is considered that groundwater flow in the superficial deposits is approximately east/north-east towards local surface water features, which are assumed to be in hydraulic continuity with groundwater in the superficial deposits. Groundwater in the superficial deposits provides baseflow discharge to the watercourses. It is known from the Borders Railway construction that the ground conditions in the vicinity of Sheriffhall comprised sands with a high groundwater level, which resulted in ‘running sands’ in the cutting excavation.

11.5.54 Groundwater flow in the bedrock is likely to be approximately down-dip towards the north-east. Historic mine workings, water treatment and dewatering operations in the former coal workings are likely to have significantly disrupted the bedrock hydrogeological conditions and the natural direction of groundwater flow. Information from the Coal Authority has shown that the groundwater level in the former workings has rebounded in this area from approximately 20mAOD in 2012, to 40m to 46mAOD currently.

11.5.55 Groundwater level monitoring was initially completed in 107 piezometers, installed as part of the ground investigation works at the site between July 2018 and February 2019. Subsequently an additional 15 piezometers were installed, in which groundwater level monitoring was completed between April 2019 and May 2019. Analysis has been undertaken of all the available groundwater level monitoring data. Typically, the maximum groundwater level recorded in each piezometer has been used for assessment.

11.5.56 17 of the piezometers installed as part of the ground investigation phase of works, monitor the groundwater levels in the Coal Measures strata. Water levels were monitored in a number of units in the Coal Measures, and the monitored groundwater level ranges from approximately 18mAOD to 61mAOD. Seven of these piezometers, six of which are located adjacent to the existing roundabout, were recorded as dry on each monitoring occasion, with the lowest levels below 42.1m AOD. The majority of these boreholes are located in the centre of the study area, in line with the existing A720 bypass and roundabout. Groundwater levels in the Coal Measures to the south of the Sheriffhall Fault indicate a maximum groundwater level of approximately 47mAOD. The recorded groundwater level varies between 16.2m and 21.3m below ground. It is likely that previously worked coal seams below this level are flooded. Maximum monitored groundwater levels in the Coal Measures to the north of the Sheriffhall Fault are more variable. This includes the highest recorded water level in the Coal Measures at 56.09mAOD, 3.92m below ground level. This was recorded in the deep piezometer installed in borehole BH17, monitoring a zone of medium strong, grey fine-grained sandstone from 48mAOD to 49mAOD, above the coal seams. BH17 is situated adjacent to the westbound carriageway of the A720, approximately 100m from the centre of the existing roundabout. Water levels in the Coal Measures in boreholes BH28-M and BH26-M, to the north-east of the site and east of the Sheriffhall Fault, were considerably lower at 27.36mAOD and 28.67mAOD respectively. These boreholes however monitor lower strata at approximately 18mAOD and 27mAOD. Information received from the Coal Authority shows that recent groundwater levels in the former coal workings are in the range 40m to 46m AOD.

11.5.57 Across the area groundwater conditions in the bedrock are typically confined, with an average maximum pressure head of 5.38m. Notably borehole BH17 recorded a maximum groundwater level approximately 6.1m above the top of the bedrock, into the superficial deposits. During the eight-month period of monitoring, the average groundwater level fluctuation was 0.96m and the maximum groundwater level fluctuation was 1.81m. Figure 1 within Appendix 11.5 shows the groundwater levels recorded in the bedrock. Based on the groundwater levels in Figure 1 within Appendix 11.5 – Hydrogeological Assessment Technical Note, the groundwater flow direction in the bedrock is inferred to be approximately east/north-east. It is unclear as to whether the Sheriffhall Fault has a major impact on the groundwater flow in the Coal Measures.

11.5.58 94 of the piezometers installed as part of the ground investigation phase of works, monitor the groundwater level in the superficial deposits, of these 27 piezometers were recorded as dry on each monitoring occasion. The majority of the dry boreholes were monitoring clay-rich strata or shallow (<5mbgl) sand and gravel deposits. The highest recorded water level during the period of monitoring was 68.62mAOD. This was recorded in the piezometer installed in borehole BH73. BH73 is situated adjacent to the A7, approximately 450m from the centre of the proposed development and facilitates monitoring of the sand and gravel. During the initial eight-month period of monitoring, the average groundwater level fluctuation was 0.56m and the maximum groundwater level fluctuation was 2.97m. The minimum monitored depth to water table varied between 0.04mbgl (59.95m AOD) in Borehole BH65 (located in the south of the area), and 11.16mbgl (50.35m AOD) in Borehole BH82 (located adjacent to the southern portion of the existing roundabout). Figure 2 within Appendix 11.5 – Hydrogeological Assessment Technical Note shows the groundwater levels recorded in the superficial deposits. Typically, the water levels are highest in the south and west of the area, and lowest in the north-east of the area. This indicates an approximate east/north-east flow direction. However due to the variability of the superficial deposits, groundwater is likely to be present in discrete pockets of granular deposits and may not be vertically or laterally continuous.

11.5.59 Five of the piezometers installed as part of the ground investigation phase of works, monitor the groundwater level in the made ground. The maximum recorded water levels vary between 67.08mAOD (5.30m below ground) to the west of the study area and 51.32mAOD (1.50m below ground) to the north-east of the study area. Figure 3 within Appendix 11.5 – Hydrogeological Assessment Technical Note shows the groundwater levels recorded in the made ground.

11.5.60 The remaining 6 piezometers installed as part of the groundwater investigation phase of the works, are screened against both the bedrock and overlying superficial deposits. One of these piezometers were recorded as dry on each monitoring occasion, with levels below approximately 48mAOD. The remaining six piezometers had a maximum recorded water level between 36.14mAOD and 59.86mAOD. As these boreholes facilitate monitoring of both the bedrock and the superficial deposits, the relevance of these levels is unclear.

11.5.61 The high-water table makes groundwater in the superficial deposits especially susceptible to pollution, as the pathway length for a surface contaminant to reach groundwater generally is very short and hence minimises any potential for attenuation.

Groundwater Quality

11.5.62 Groundwater associated with historic mining activity in the area tends to be poor quality with a low pH and elevated sulphate, iron and fluoride concentrations. The Dalkeith Bedrock groundwater body has an overall WFD status of Poor, due to the extensive former coal mining works and resultant degraded water quality.

11.5.63 In-situ groundwater quality monitoring was completed in June 2018 on samples from Boreholes BH05-M, BH26-M, BH28-M, BH41-M, BH45-M, BH55-M, BH59-M and BH80-M in the bedrock, and Boreholes BH28A, BH29, BH40, BH50, BH62-M, BH70A, BH74, BH76 in the superficial deposits. This included observations for light non-aqueous phase liquid (LNAPL) and dense non-aqueous phase liquid (DNAPL) presence, turbidity, redox potential (ORP), dissolved oxygen, electrical conductivity (EC), temperature and pH. None of the samples indicated the presence of LNAPLs or DNAPLs. The pH ranged from 6.26 to 7.94 in the bedrock and from 6.66 to 7.76 in the superficial deposits. The average EC recorded in the bedrock was 953μs/cm. The average EC recorded in the superficial deposits was 1060μs/cm.

11.5.64 Additional in-situ groundwater quality monitoring was completed in May 2019 on samples from Borehole BH89, BH90, BH91, BH93 and BH110 in the superficial deposits. No LNAPLs or DNAPLS were detected. The pH ranged from 6.39-7.93.

Groundwater Abstractions

11.5.65 There are six BGS registered water wells within 2km of the study area. Three of these exploit the Coal Measures formation and have depths between approximately 103m and 122m. Details for the remaining three boreholes are not available. The presence of a BGS well record is not indicative of an active groundwater abstraction. Information provided by the MLC Environmental Health Officer indicated that there are no private water supplies in the vicinity of the proposed works.

Historic Mine Workings

11.5.66 The Sheriffhall area has been subjected to extensive underground coal mining. Local mining activities have been identified in the vicinity of the area, from data sourced from the Coal Authority’s Coal Mining Report and the BGS Environmental Geology Map. These indicate a total of 40 mine entries within the immediate vicinity of the site, 16 of which are considered to be directly affected by the Proposed Scheme and thus pose a risk to surface stability. There also remains potential for unrecorded mine entries.

11.5.67 Available mine plans relating to the site have been reviewed and confirmed the presence of workings beneath the site in eleven coal seams (from shallowest to deepest): the Diamond, Musselburgh Jewel, Little Splint, Cowpits Five Foot, Salters (Whitehall Great), Nine Foot (Whitehill Splint), Fifteen Foot (combined Pinkie Three Foot and Six Foot), Six Foot (Jewel of Whitehill), Great Seam, Stairhead and Parrot Seam. These dip approximately north-east towards the River Esk. Downstream of the confluence between the River North Esk and River South Esk. It is understood from ground investigation that these workings have largely collapsed. There are no identified adits in the mine working areas proposed for grouting treatment as part of the construction works.

11.5.68 Mine spoil water treatment occurs at the Gilmerton Coal Bing to the north of the A720. There is a mine water treatment scheme at Monktonhall, approximately 2.1km north-east of the study area. Correspondence with the Coal Authority indicates that there are several proposed mine water treatment sites in the vicinity of the study area. Their proposed locations are approximately 0.9km south, 2.0km south-east and 3.1km south-east of the study area. It is not expected that these would affect hydrogeological conditions beneath the site.

11.5.69 There are no current local groundwater control operations reported by the Coal Authority. Groundwater pumping at Monktonhall ceased in 2009.

Groundwater Vulnerability

11.5.70 A methodology for groundwater vulnerability assessment has also been developed by the BGS, in accordance with WFD guidance to help characterise and assess risk to groundwater bodies. In order to carry out risk assessments, knowledge of the vulnerability of groundwater is necessary. Typically, groundwater is of High quality and often requires little treatment prior to use. However, it may be vulnerable to contamination from both diffuse and point source pollutants, from direct discharges into groundwater, and indirect discharges into or onto land.

11.5.71 Groundwater vulnerability is defined as the tendency and likelihood for general contaminants to reach the water table after introduction at the ground surface. All groundwater is to some degree vulnerable, and the groundwater vulnerability screening methodology is designed to reflect the ability of contaminants to reach the water table surface. Groundwater decontamination is difficult, prolonged, and expensive, and therefore the prevention of pollution is important.

11.5.72 The screening methodology applies to the situation where contamination from the land surface leaches vertically downwards to the water table within the uppermost aquifer at a particular locality. The groundwater vulnerability assessment is, therefore, influenced by several factors that relate to the pathway element of a typical Source – Pathway – Receptor risk assessment. In this case, the pathway is characterised by the geological and hydrogeological characteristics of the top soil layer, the underlying superficial deposits and bedrock.

11.5.73 The pathway between the ground surface and the water table can affect the degree of attenuation of contaminants. It can be influenced by the:

- permeability and clay content of the superficial deposits;
- thickness of the superficial deposits;
- mode of groundwater flow in bedrock aquifers (fracture or inter-granular flow);
- permeability and clay content of inter-granular bedrock aquifers; and,
- depth to the water table in both superficial and inter-granular bedrock aquifers.

11.5.74 It is the above factors that determine the vulnerability classification. Vulnerability has been divided into five categories, with Class 1 areas having the lowest risk of groundwater pollution and Class 5 the highest, as shown in Table 11-9 'Vulnerability definitions for potentially polluting activities'.

Table 11-9 Vulnerability definitions for potentially polluting activities

Vulnerability category	Description	Frequency of activity	Travel time
5	Vulnerable to most water pollutants with rapid impact in many scenarios	Vulnerable to individual events	Rapid
4	Vulnerable to those pollutants not readily adsorbed or transformed	↓	↓
3	Vulnerable to some pollutants with many significantly attenuated		
2	Vulnerable to some pollutants but only when continuously discharged/leached		
1	Only vulnerable to conservative pollutants in the long-term when continuously and widely discarded and leached	Vulnerable only to persistent activity	Very slow

Source: Adapted from Foster (1998).

11.5.75 Class 4 is further subdivided according to the nature of the pathway:

- 4a – sand and gravel cover;
- 4b – moderate permeability cover;
- 4c – low permeability cover;
- 4d – thin soil over bedrock; and,
- 4e – where superficial aquifers are present.

11.5.76 British Geological Survey (BGS) maps indicate that the uppermost aquifer generally has a moderate to low vulnerability to pollutants due to the thickness of superficial deposits, which restrict and slow their downward movement.

11.5.77 Due to the scale (1:250,000) of the digital geological mapping available, the classification of these areas is generalised and whilst this information provides an overall understanding as to how vulnerable the groundwater is to contamination, detailed geological information garnered from the Geotechnical Investigation is utilised to establish the actual site-specific risk to groundwater with scheme implementation.

Hydrology & Flood Risk

11.5.78 As noted previously, the FRA is included within Appendix 11.3 – Flood Risk Assessment. As detailed within this report, there were no historic flood records available at the site and surrounding areas. This does not however mean that the area has not experienced flooding in the past.

11.5.79 Whilst ground investigation works were being undertaken as part of the wider project, out of bank flow was observed downstream of the Lugton Bogs pond on the left-hand bank. This flow was sufficient to halt works although may have been somewhat exacerbated by pumping and operations in the area at the time.

SEPA Floodmaps

11.5.80 The most recent SEPA flood risk maps were published in March 2015. The maps cover the whole of Scotland and provide a strategic level of information on the potential sources and impacts of flooding, including coastal, fluvial, surface water (pluvial) flooding. They also show the Potentially Vulnerable Areas identified by SEPA as part of the flood risk management process under the Flood Risk Management (Scotland) Act 2009. Because the maps have been developed on a national scale, there are limitations in the data used, and they should be viewed as indicative only at local scale.

11.5.81 The fluvial flood maps were developed for all catchments greater than 3km^2. Flooding is seen to be well contained to the channel along much of the study reach. The mapping indicates flooding in the woodland around the irrigation pond. Out of bank ponding is also observed in a low-lying area on the right-hand bank upstream of the A7 culvert. A flow pathway extends across the left-hand bank between the A7 and Old Dalkeith Road, with the potential for some localised ponding. Downstream of the Old Dalkeith Road, flow exits the channel and runs along the southern edge of the Borders Railway embankment.

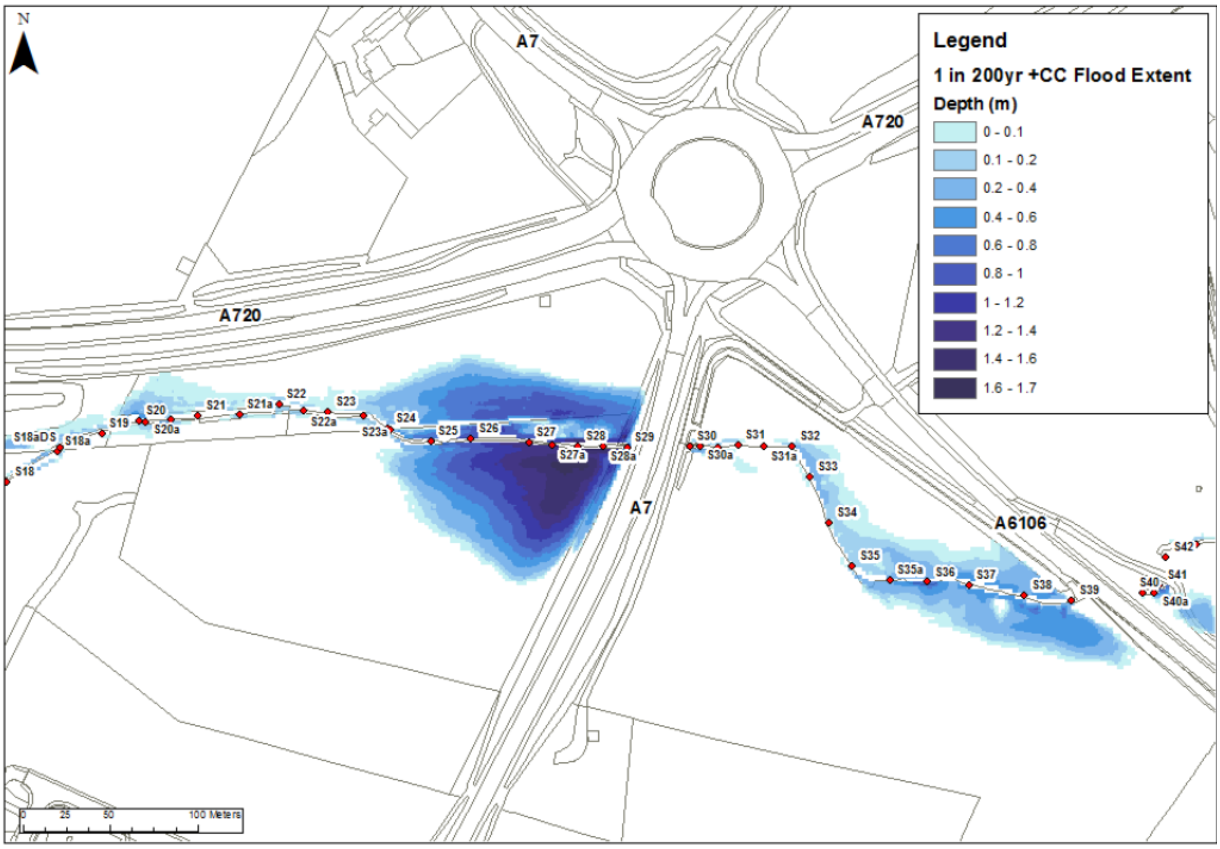
11.5.82 Surface water flood maps are derived from pluvial model results. Pluvial modelling assumes losses due to drainage networks in urban areas. Pluvial flooding is shown across much of the same extent as in the fluvial mapping.

11.5.83 Fluvial and surface water flooding can be viewed on SEPA's website: http://map.sepa.org.uk/floodmap/map.htm

Baseline Flood Model

11.5.84 A single hydraulic model has been constructed for the Dean Burn and surrounding areas at Sheriffhall consisting of a one-dimensional element representing the river channel built in Flood Modeller and a two-dimensional element representing the floodplain constructed in Tuflow.

Plate 11-8 1 in 200yr plus climate change flood depths.



11.5.85 As shown on Plate 11-8, during the 1 in 200yr plus climate change event, flooding first occurs on the right-hand bank, immediately upstream of the A7 culvert with out of bank flow spreading into a low-lying area. Flood depths reach a maximum of 1.65m in this area. As the event progresses, flooding occurs at Section 20, downstream of the pond at Lugton Bogs on the left-hand bank. Flood waters travel along the floodplain, parallel to the watercourse, to depths ranging from 50 - 200mm, before re-entering the channel at Section 22. At the same time, a flow pathway occurs across the left-hand bank between Section 32 and 37, equating to 0.4m^3/s at its peak.

11.5.86 Flow exits the channel at Section 32 and spreads across the floodplain. The majority of the out of bank spill re-enters the channel between Sections 36 and 38. Maximum flood depths in this area reach 280mm. At approximately the same time, flow spills out of the bank on the left-hand bank upstream of the A7 and the right-hand bank upstream of the A6106. Flood depths reach a maximum of 900mm and 500mm upstream of the A7 and A6106 respectively. The flooding extent for this event can be seen in Plate 11.8. Minor flooding is observed on the right-hand bank immediately downstream of the A6106 to depths of 300mm.

11.5.87 The remainder of the flow is contained within channel. No out of bank spill is observed downstream of the access track leading onto Old Dalkeith Road.

11.5.88 The A7 and the A6106 were not seen to be at flood risk during a 1 in 200yr plus climate change event.

11.5.89 The flood mechanism is largely replicated in lower return periods, with the first instance of spill at the various locations noted above occurring at different return periods. Flooding is observed in the area upstream of the A7 from the 1 in 5yr event. The onset of flooding for the area around Section 20 and flow pathway at Section 32 starts from the 1 in 30yr event.

11.5.90 Although there are no historic flood accounts in this rural area, the baseline flood maps tie in well with SEPA flood mapping as also with observed flow routes on site during GI investigations.

11.5.91 Receptors of surface water flooding are assessed to be the road network and rough ground. Their sensitivities are medium, and low respectively, which is based on the consequences and cost of repair/restoration following flood events. As the road network is not deemed to be at risk and the rough ground has minimal hydrological importance in terms of sensitive ecosystems and/or social and economic use, the overall sensitivity is deemed to be low. As set out in Table 11-1 “Estimating the importance of water environment attributes’, this is a water feature with little or no flood risk affecting land use or receptors (e.g. rough grazing land) in a 1 in 200-year event (0.5% AEP).

Existing Road Drainage

11.5.92 Based on Lidar information, the topography of the study area is such that it generally drains in an easterly direction (i.e. from Gilmerton towards Dalkeith), with a fall of approximately 25m across the study area. This is reflective of the flow path of the watercourses in this area.

11.5.93 As-built drawings of the A720 and Borders Railway, and Scottish Water public utility (PU) drawings have been reviewed to establish the extents, form and direction of flow of the existing drainage network. The information is only available for Sheriffhall Roundabout, the A720 to the west of Sheriffhall, the A720 east at the Borders Railway underpass, the A6106 North (Millerhill Road) realigned as part of the Borders Railway project and the A7 south of Sheriffhall roundabout. Improvement works at Sheriffhall Roundabout have been undertaken since the production of the original as-built plans, therefore the drainage network may no longer be as shown in the original plans. Further investigation will be required to gain a full understanding of the wider network and outfall locations for the detailed design of the drainage layout.

A720 Gilmerton to Sheriffhall

11.5.94 The existing A720 drainage network between Gilmerton and Sheriffhall typically consists of French drains (or filter drains) at the toe of embankment slopes, combined filter drains in the central reserve and at the edge of carriageway, and carrier drains crossing the carriageway to convey the various runoff flows to a single point of discharge. The pipe network, which flows east towards Sheriffhall Roundabout, drains towards two outfall locations.

11.5.95 The first section of the drainage network terminates directly north of a disused sewage works. As shown on Figure 11.1, longitudinal pipes feed into a carrier drain which traverses the A720 and connects into a Scottish Water Sewage pipe. The PU plans show the sewage pipe running in a south-eastern direction towards the Dean Burn but it is unclear if the outfall is into the groundwater or the Dean Burn.

11.5.96 The second section commences close to the outfall of the previous. The flow is principally in an eastern direction and the various flow channels are combined by a carrier drain traversing the A720 towards a single discharge point on the north edge of the eastbound carriageway. From here, a carrier drain crosses the roundabout and follows the southbound verge of the A6106 South (Old Dalkeith Road). The outfall for this flow is unknown as it was not detailed on the plans available.

Sheriffhall Roundabout

11.5.97 The drainage plan for Sheriffhall Roundabout shows the carrier drain on the A6106 South conveying runoff flows from multiple sources. The central island of the existing Sheriffhall Roundabout includes a combined filter drain in a hexagonal shape flowing into the carrier drain as it crosses the roundabout.

A720 Sheriffhall to Millerhill

11.5.98 The remaining source of flow into the carrier drain on the A6106 South comes from the A720 east of Sheriffhall. As-built plans show a combined filter drain on the eastbound edge of the A720 which flows into a carrier drain that crosses the A720 to connect into the A6106 drainage system. Review of this against the topographical information shows that the A720 to the east of Sheriffhall falls towards the roundabout for approximately 100m beyond which it falls towards the east. The primary direction of flow at the Borders Railway underpass is to the east. The Borders Railway as-built plans show a combination of filter and carrier drains which convey the flow to the toe of the embankment slopes to tie-into the existing drainage system. Details of the existing drainage system are not available on the Borders Railway plans.

A6106 North

11.5.99 A section of A6106 North to the north was realigned as part of the Borders Railway scheme. As-built plans show a new SuDS facility fed by filter drains in the northbound carriageway edge and at the toe of the northbound embankment. This attenuation pond is located out-with the study area however part of the realigned section of the A6106 falls within the study boundary and is within the catchment area for the pond. A review of the existing topography suggests that from Sheriffhall, the A6106 North drains north however it is not known if the runoff from the full catchment area is treated by the attenuation pond.

A6106 South

11.5.100 Available as-built drainage plans detail 70m of the A6106 South adjacent to Sheriffhall Roundabout. A combined filter drain and a carrier drain are located in the edge of the southbound carriageway. The carrier drain is shown to be one of the primary outfall distributers for the area as it carries runoff from the A720 towards an unconfirmed outfall location to the south. Topographical information shows that the existing A6106 falls away from Sheriffhall Roundabout for a further 120m before rising to cross the Borders Railway at the junction with Melville Gate Road.

A7 North

11.5.101 Available as-built drainage plans are limited to 50m of the A7 North adjacent to Sheriffhall Roundabout. A short length of combined filter drain is located in the edge of the northbound carriageway which flows into the carrier drain which crosses Sheriffhall Roundabout. Additionally, a longer section of combined filter drain is shown to be present in the southbound verge flowing towards the A6106 North. Topographical information for the A7 North shows there is a general fall towards Sheriffhall Roundabout and to the east therefore it is assumed that the section principally drains through the combined filter drain in the southbound verge and continues along the A6106 North.

A7 South

11.5.102 As-built information is not currently available for the A7 South therefore topographical information was used to develop an understanding on the behaviour of the drainage system in the area. The A7 South falls approximately 11m in elevation from Gilmerton Road Roundabout to Sheriffhall Roundabout; therefore, it is assumed that the drainage system outfalls via the carrier drain on the A6106 South.

Existing Outfalls

11.5.103 Most of the existing road network within the works area outfalls into the Dean Burn at various points along its route. The filter drains either side of the A720 on the eastern side of the roundabout up to approximately CH1250 (as shown on Figure 5.1 'Proposed Scheme Layout'), immediately cross beneath the existing A720 to outfall into the pond adjacent to the road.

11.5.104 The rest of the filter drains along with the road drains from the west side of the A720, the roundabout and the A7 north enter carrier drains and are taken through the roundabout to be discharged directly into the Dean Burn.

11.5.105 An attenuation pond is located to the north of the A6106 North and treats runoff from the A6106 realigned for the Borders Railway. The total extent of the catchment for this pond could not be confirmed but the existing topography indicates that the A6106 North falls in the direction of the SuDS pond from Sheriffhall Roundabout.

Culverts

11.5.106 The Dean Burn flows through a number of road culverts along its course including at the A7 South and A6106 South, south of Sheriffhall Roundabout. The Dean Burn was identified as being approximately 2m wide in the vicinity of the existing culverts during the walkover study and is described further below.

Drainage Networks

11.5.107 There are a number of Scottish Water assets in the vicinity of the Scheme, which could be affected by the proposals (as shown on Figure 11.1 'Road Drainage and the Water Environment – Receptors'). The Gilmerton Sewage Treatment Works (STW) is no longer in operation but is utilised as a wastewater pumping station. Surface water from nearby roads drain to the Dean Burn and foul flow is conveyed to the pumping station and pumped to a location near Dobbies Garden Centre, where it joins the gravity system, see Plate 11.9. There are two surface water outfalls discharging to the Burn in the vicinity of the pumping station. The first is located immediately downstream of the access road to the pumping station and conveys surface water drainage from a short section of the A720. The second is located approx. 70m downstream of the pumping station and conveys road drainage from the A772 Gilmerton Road.

Plate 11-9 Foul Drainage Pipe Crossing the Dean Burn at the Pumping Station and Behind, Surface Water Drainage Outfall from a Section of the A720

11.5.108 Management of the drainage of the A720 is the responsibility of Amey, as the network is not adopted by Scottish Water. It is unknown what drainage exists and where it is discharged, but it is likely to be a traditional form, with outfalls to the Dean Burn.

Private Water Supplies

11.5.109 Information provided by MLC Environmental Health Officer indicated that there are no private water supplies in the vicinity of the Proposed Scheme and therefore this has been scoped out of the assessment.

Summary of Water Feature Sensitivity

11.5.110 The assessed sensitivity of each identified receptor is provided in Table 11-10 'Sensitivities of Receptors' below which provides a summary of the baseline classification for hydrology and flood risk, hydrogeology and water quality attributes for all water features within the study area.

Table 11-10 Sensitivities of Receptors

Waterbody	WFD Status	Vulnerability to pollution	Recreation	Value to Economy	Flooding	Biodiversity	Overall Sensitivity
River North Esk	Overall WFD Status assessed as 'Poor' Low	Large catchment size and ability to buffer flows Low	Some fishing interest Medium	Used for recreational fishing. Medium	Medium size watercourse, moderate area of floodplain Medium	WFD ecological Status assessed as "Moderate". High	High
Dean Burn	WFD unclassified but taken to be similar to the River North Esk ('Poor') Low	Small catchment size and ability to buffer flows. Known discharge of contaminated mine drainage Low	None known Low	None known Low	Small size of watercourse, moderate area of floodplain Low	WFD unclassified High	Medium

Waterbody	WFD Status	Vulnerability to pollution	Recreation	Value to Economy	Flooding	Biodiversity	Overall Sensitivity
Esk Valley Sand and Gravel Aquifer	Overall WFD Status assessed as Good High	Moderate size of waterbody Medium	N/A	None known Low	Contribution to base flow of Dean Burn Medium	None known Low	Medium
Dalkeith Aquifer	Overall WFD Status assessed as 'Poor' Low	Moderate size of waterbody Medium	N/A	None known Low	Contribution to base flow of River North Esk Medium	None known Low	Medium
Scottish Water assets	N/A	N/A	N/A	Essential infrastructure High	N/A	N/A	High

11.6 Potential Impacts

Introduction

11.6.1 This section considers the potential for impact upon the water environment as a consequence of implementing the Proposed Scheme (as detailed within Chapter 5 – The Proposed Scheme). The assessment is undertaken in the absence of mitigation measures, other than those embedded within the design.

11.6.2 The water environment is intrinsically linked to ecological receptors, in particular fisheries. As such, reference has been made to Chapter 9 - Nature Conservation of this ES as necessary. Similarly, this chapter considers the potential for impacts to groundwater quality during operation (i.e. direct discharges to ground associated with road runoff and accidental spillage) and construction (i.e. dewatering). Other potential impacts to groundwater resulting from disturbances to flow including the establishment of preferential pathways for potentially contaminated groundwater to reach surface water are primarily addressed within Chapter 16 - Geology and Soils.

Construction

11.6.3 By their very nature, road schemes have the potential to pose a significant risk to the water environment, due to the variety of environments affected, their cumulative impacts, and the distances that require management. In essence, at every stage in the construction process, there is potential for water pollution issues to arise.

11.6.4 With reference to CIRIA guidance document C648 '*Control of Water Pollution from Linear Construction Projects*':

> *"Linear construction projects differ from other construction projects in that they have dynamic site boundaries and cover large areas exhibiting varied physical characteristics. The number of watercourse crossings, discharge points, site compounds and haul roads are inevitably greater than on a static site. The route may cross varied environments, topography, soil types, geology and habitats etc., each requiring differing water management techniques".*

11.6.5 This document is one of three published by CIRIA that provide key guidance on controlling water pollution from construction, the others include:

- C532 '*Control of water pollution from construction sites: guidance for consultants and contractors*' (CIRIA, 2001); and,
- SP156 '*Control of water pollution from construction sites – guide to good practice*' (CIRIA, 2002), comprising training presentation, site inspection checklists, best practice guidance sheets, toolbox talks and a poster.

11.6.6 Furthermore, SEPA has published a suite of supporting guidance and good practice guides on controlling water pollution from construction, including but not limited to:

- WAT-SG-26: Good Practice Guide - Sediment Management; and,
- WAT-SG-29: Good Practice Guide – Construction Methods.

11.6.7 As comprehensively detailed within these documents, the range of construction activities that may cause adverse water-related impacts are extensive and too numerous to discuss in detail within this ES. Nevertheless, the construction activities that pose the highest risk of impact upon the water environment are listed in Table 11-11' Construction Activities that Pose a High Risk of Impact upon the Water Environment'.

Table 11-11 Construction Activities that Pose a High Risk of Impact upon the Water Environment

Pollution Risk	Hazard
Activities that provide a pollution source.	Uncontrolled sediment erosion and contaminated silty runoff; Refuelling facilities, chemical and waste storage or handling areas; Polluted drainage and discharges from site; Contaminated groundwater from dewatering of contaminated sites.
Activities that cause significant variations in natural flow.	Unregulated and poorly considered abstractions and discharges e.g. dewatering; Changes to the existing drainage network, including interception and redirection of natural and artificial watercourses (e.g. field drains); Discharge of groundwater to surface water; Increased runoff from cleared and capped areas (relative to Greenfield values).
Activities that significantly modify or destroy physical habitats.	Watercourse crossings; Works within water; Outfall points.

Source: CIRIA 648 'Control of Water Pollution from Linear Construction Projects'.

11.6.8 As detailed within Chapter 5 -The Proposed Scheme of this ES, the existing at-grade Sheriffhall Roundabout shall be upgraded to a full grade-separated junction requiring vertical and horizontal realignment of the A720 over an approximate length of 1600m.

11.6.9 As shown on Figure 5.1 'Proposed Scheme Layout', the A720 would be conveyed across Sheriffhall Roundabout by two new bridges. Sheriffhall Roundabout would be enlarged and become an 8-arm roundabout but will be retained at its existing location and reduced to three lanes. The roundabout will connect the A7 North, the A6106 North, the A6106 South, A7 South and all four A720 east and west facing slips. The Proposed Scheme also includes non-motorised user (NMU) facilities including five dedicated NMU subways under the new roundabout providing an off carriageway through routes.

11.6.10 To attain full grade-separation, the vertical realignment of the A720 would be required to achieve a level raised platform for the running course of the road to the west and east of the roundabout, thus facilitating sufficient clearance over the roundabout for the two new bridge structures. This would require significant earthworks east and west of the roundabout and new structural elements to achieve this. Aside from foundation works, the subways for the NMU routes would represent the only notable structural element of the Proposed Scheme that would be at sub-ground level and thus in-cutting.

11.6.11 The four new slip roads tying into the roundabout would result in a change to the horizontal alignment of the A720, with localised widening to the north and south of the road. As a consequence, this would result in works encroaching closer towards the Dean Burn and Lugton Bogs. As a result, the onslip to the westbound carriageway would encroach directly into the channel of the Dean Burn, its functional floodplain and would partially infill the standing waterbody adjacent to the A720 at Lugton Bogs.

11.6.12 Consequently, these changes to the existing road layout present the greatest risk of pollution and sediment release during construction of the road and could give rise to numerous hazards as identified in Table 11-11' Construction Activities that Pose a High Risk of Impact upon the Water Environment'.

11.6.13 As an embedded mitigation measure, the construction of five SuDS ponds, particularly the three to the south of the A720 (as shown on Figure 11.2 'Road Drainage and the Water Environment - Proposals) also present a risk during construction as a consequence of their immediate proximity to the Dean Burn.

11.6.14 As shown on Figure 11.2 'Road Drainage and the Water Environment – Proposals', the increased physical footprint of the Proposed Scheme to the south of the A720, requires that the Dean Burn be realigned at two locations and three areas of flood compensation provided (as detailed below). This would require physical works within and in immediate proximity to the watercourse, thus presenting a risk of contamination during the works, particularly as a consequence of sediment release.

11.6.15 Due to the proximity of the road embankment to the Dean Burn, a section of the watercourse would be diverted upstream of the A7, to a location approximately 40m south of its original alignment. This diversion would be approximately 230m in length and would be installed as a restored two stage meandering channel to improve watercourse function and habitat. The sharp right-angle bend in the channel between the A7 and A6106 acts as a channel constriction and it is proposed that this be smoothed to improve river function and facilitate creation of the larger SuDS pond to the north (between the Dean Burn and Sheriffhall Roundabout).

11.6.16 Compensatory storage is required as part of the design as functional floodplain storage would be lost as a result of SuDS allocation and encroachment of road embankments. Land reprofiling to create this required storage would be provided at three separate locations (as shown on Figure 11.2 'Road Drainage and the Water Environment – Proposals'):

- inside the meander of the realigned channel,
- an area to the north of the channel upstream of the A7; and,
- along the right-hand bank between the A7 and A6106.

11.6.17 During construction of the Proposed Scheme, pollution from mobilised suspended solids would generally be the prime concern, but spillage of fuels, lubricants, hydraulic fluids and cement from construction plant may lead to incidents, especially where there are inadequate pollution mitigation measures. Other risks include:

- water abstraction;
- pollution due to vandalism of stores or plant;
- pollution due to waste materials, dust or residues from handling contaminated land; and,
- pollution from pumped discharges, for example, dewatering. These can also cause erosion.

Surface Water Quality and Flow

<u>Impacts of Pollution on Surface Water Quality by Suspended Sediments</u>

11.6.18 Pollution of surface waters by mobilised Suspended Solids (SS) can have significant adverse ecological (flora & fauna) impacts and can cover a considerable distance downstream of the site. Salmonids are particularly sensitive to reductions in water quality, and habitats can be damaged by siltation from settlement of SS. This is recognised within the '*UK Environmental Standards and Conditions (Phase 2)*' (UKTAG 2008) which specifies a normal maximum SS concentration of 25mg/l for Salmonids; although a precautionary annual mean target of less than 10mg/l is recommended by the Joint Nature Conservation Committee (JNCC) for most river reaches.

11.6.19 There is a range of potential impacts associated with mobilised SS, though most notably on fisheries (i.e. deposition of sediments in salmonid spawning areas of rivers and its impact on development of eggs and fry). There can also be a direct effect on fish gills, either through physical damage to the gill tissue or through clogging of the gills with waterborne particulate matter.

11.6.20 The settlement of sediments on the substrate can smother invertebrates and fish eggs, while the infiltration of coarse sediments (gravel and cobble) with fines can have longer term implications for the productivity of both groups. The characteristics of the riverbed are critical for fish spawning, and alevin survival is closely related to the level of fines with impacts detectable at a level of 10% fines.

11.6.21 Various construction activities have the potential to release sediment and cause unacceptable SS levels in the catchment area. Earthworks associated with the horizontal and vertical realignment of the A720, extension of two cross-carriageway culverts, the diversion of the Dean Burn, the SuDS ponds and the flood compensation areas all have the potential to disturb sediment and the arisings could cause silt pollution, potentially resulting in adverse impacts on aquatic flora and fauna, especially downstream of these operations.

11.6.22 While sediment release is unavoidable during some construction activities, low flows and levels in the watercourses subject to culverting works, may encourage settlement of sediments before reaching any of the sensitive water bodies, though mitigation measures would need to be implemented to minimise the quantity of sediment discharging to the watercourse.

11.6.23 Numerous other construction activities have the potential to cause mobilisation of solids and high sediment loadings within receiving surface waters. As a major junction improvement scheme, the movement of substantial quantities of materials around the site would be significant and as such, stockpiles would be located at key locations for reworking. If stockpiles are located in areas where runoff can reach the Dean Burn quickly, they present a major source for elevated sediment levels.

11.6.24 Topsoil stripping and bulk earthworks would also leave soil exposed to erosion by wind and/or rain, and this could also potentially lead to increases in sediment loading of the Dean Burn. Embankment construction and cuttings (particularly before slope stabilisation) could cause problems, particularly on the southern side of the works, due to difficulties containing runoff from slopes to achieve the grade-separation of the junction. Topsoil stripping adjacent to the existing A720 presents a significant risk to sediment loading within watercourses, as stripping can take place before the main works and associated mitigation measures are implemented fully on-site. This issue is also relevant to the general site clearance in advance of construction.

11.6.25 The build-up of dirt on road surfaces, caused by lorries and other plant entering and exiting the site, can also pose a significant risk of sediment release during construction, if washed off during inclement conditions or as part of the general site maintenance plan (i.e. washing of vehicles and/or roads). The drainage network associated with the existing public road network could present a significant pathway for sediment release during the works and would require careful management.

11.6.26 The characteristics of the underlying geology and soils has been addressed within Chapter 16 - Geology & Soils, however in terms of a worst-case scenario, it is prudent to assume that silt and clays may be encountered at any point during construction works. Particle size and density of sediment are key factors in determining the required retention time in temporary settlement ponds to ensure settlement has occurred prior to discharge to a watercourse.

11.6.27 Without prescriptive mitigation measures in place to restrict mobilised sediments from reaching any of the surface waters within the study area, there is the potential for moderate adverse transient impacts. This would result in a **moderate adverse** effect on the surface water quality of Lugton Bogs and the Dean Burn.

Impacts of Pollution of Surface Water Quality by Accidental Spillage

11.6.28 Any construction activities carried out close to watercourses involve a risk of pollution due to accidental spillage. While liquids such as oils, lubricants, paints, bituminous coatings, preservatives and weed killers present the greatest risk, other materials such as cement can also have serious environmental effects. The activities most likely to result in contamination include concreting bridge substructures and decks, waterproofing bridge substructures and decks, painting parapets, concreting for culverts, and fuel spillages from machinery operating close to watercourses. The refuelling of general construction plant also poses a significant risk of pollution, depending on how and where it is carried out. Pollution as a result of accidental spillage could potentially affect fish, aquatic flora and could also have a dramatic effect on invertebrate communities. Therefore, measures to control the storage, handling and disposal of such substances would need to be put in place prior to and during construction (as discussed in Section 11.7).

11.6.29 Without prescriptive mitigation measures in place to contain/restrict contaminants from reaching any of the surface waters within the study area, there is the potential for moderate adverse transient impacts. This would result in a **moderate adverse** effect on the surface water quality of Lugton Bogs and the Dean Burn.

Impact of Litter and Debris Pollution on Surface Water Quality

11.6.30 Litter and debris pollution can have a varying effect on watercourses, depending on the type of debris involved. Litter and debris will, at best, affect only the appearance of the watercourse but more serious cases of pollution can arise if the litter or debris contains contaminants such as open oil containers.

11.6.31 Without prescriptive mitigation measures in place to control litter and debris from reaching any of the surface waters within the study area, there is the potential for minor adverse transient impacts. This may result in a **slight adverse** effect of the surface water quality of the Dean Burn.

Groundwater Quality and Flow

Impacts on General Groundwater Quality and Flow

11.6.32 As detailed within Appendix 11.5- Hydrogeological Assessment Technical Note, impacts on the groundwater environment are likely to be most pronounced during the construction phase, due to the high level of activity and opportunity for the release of contaminants and disruption of groundwater flow. The main elements of this stage of the project which potentially could impact on groundwater are associated with:

- Fuel and chemical storage and use;
- Storage of wastes (hazardous and non-hazardous);
- Discharge of surface runoff and dewatering water, potentially containing high levels of suspended solids;
- Filling of small pond by proposed earthworks;
- Realignment of Dean Burn;
- Construction of site investigation and dewatering boreholes, trenches and other excavations;
- Excavation below superficial groundwater level for construction of SUDS ponds and NMU routes;
- Excavation of confining superficial deposits overlying the Coal Measures;
- Piling, retaining wall foundations and other permanent below ground structures impacting on groundwater flow;
- Grouting of below ground structures including old mine workings;
- Dewatering of superficial deposits via pump or gravity flow; and,

- Dewatering of the bedrock aquifer via pump, in order to control confined groundwater pressures and minimise the risk of heave.

11.6.33 Impacts on groundwater quality in both the superficial and bedrock aquifers could result from spillages and leaks of fuels and chemicals from bulk storage, and vehicle and plant usage and the associated contaminated surface run-off. Existing mine shafts, and the construction of further ground investigation boreholes or excavations into the superficial or bedrock aquifer could create pathways for near-surface pollutants to reach the groundwater in the Coal Measures. The high-water table makes groundwater in the superficial deposits especially susceptible to pollution, as the pathway length for a surface contaminant to reach groundwater generally is very short and hence minimises any potential for attenuation.

11.6.34 As noted previously, there are five proposed SuDS ponds constructed to segregate drainage from the Proposed Scheme. The ponds would be lined and then would drain under gravity to the Dean Burn. Impacts to surface water quality may occur from possible contaminated site drainage water, in addition to construction activity at the small pond at Lugton Bog, Dean Burn and River North Esk. This could result in a deterioration of the groundwater quality in the superficial deposits, which are assumed to be in hydraulic continuity with the surface water system.

11.6.35 The discharge of surface run-off with a high concentration of suspended solids from site runoff but also from dewatering of excavations has the potential to impact on the quality of groundwater and surface water bodies.

11.6.36 The lowest point across all proposed infrastructure is approximately 57.1mAOD, on the NMU route. The lowest proposed level of the SuDS ponds is 55.1mAOD. This is a small NMU drainage pond located in the south-eastern part of the scheme. The nearest boreholes monitoring groundwater level in the superficial deposits are BH89 and BH90 located in the immediate vicinity of the proposed SuDS pond. These recorded a maximum groundwater level of 54.82mAOD and 55.82mAOD respectively. It is therefore possible that minimal groundwater dewatering of the superficial deposits will be required to facilitate construction activities including excavation and installation of the SuDS ponds and carriageways in this part of the site. Inadequate provision for the pre-treatment and disposal of extracted groundwater, which may have a high concentration of suspended solids, has the potential to impact on local surface water quality.

11.6.37 Piling is required in the proposed scheme for several structures. The piles are assumed to be of significant depth and will penetrate through the overlying superficial deposits and at least 6m into competent layers of the bedrock aquifer. A maximum bedrock groundwater level has been recorded at 56.09mAOD (approximately 6.1m above the top of the bedrock aquifer) in Borehole BH17. BH17 is situated adjacent to the westbound carriage way of the A720, approximately 100m from the centre of the study area. Where located below the bedrock water table, the piles will act as a low permeability barrier to groundwater flow and may cause change to groundwater levels, flow rates and flow directions. Providing that there is a reasonable thickness of aquifer below the base of the piles, impacts will be localised. The placement of grout in the piles may impact on groundwater quality, as there will be direct contact between the grout and the groundwater. Where the piles terminate above the bedrock groundwater level, there will be no impacts to bedrock groundwater flow and negligible impacts on bedrock groundwater quality. There may be localised impacts to superficial groundwater flow and quality. This will result in a **slight adverse** effect on groundwater quality.

11.6.38 Retaining walls and foundations for the NMU routes are only proposed to extend into the superficial deposits, potentially causing changes to superficial groundwater conditions but not affecting the groundwater conditions in the bedrock aquifer.

11.6.39 Permanent excavations are not expected to extend below the superficial deposits. Groundwater confined in the bedrock aquifer has been shown to have pressure heads of up to 6.1m into the superficial deposits. Excavation of the overlying superficial deposits may result in ground heave of excavations and uncontrolled groundwater inflow from the bedrock aquifer. Dewatering may therefore be required in order to control the confined water pressure in the bedrock aquifer. Inadequate provision for the pre-treatment and disposal of extracted groundwater, which may have a high concentration of suspended solids, has the potential to impact local water quality. Discharge of surface run-off with a high concentration of suspended solids from dewatering of excavations has the potential to have a **moderate adverse** effect the quality of groundwater.

11.6.40 The proposed scheme of works details extensive grouting of the Coal Measures aquifer beneath the area to achieve ground stabilisation and remediate the significant historic shallow mining activity. The proposed extent of grouting activity is discussed in detail within Chapter 16 - Geology & Soils. The area of grout treatment includes a section approximately 325m in length and 100m wide under the eastern portion of the A720, and an extensive area under the current western portion of the Sheriffhall Roundabout, approximately 1500m in length and up to 700m wide. Grouting in the shallower coal seams under both the central and eastern sections is proposed; including the Whitehall Upper, Whitehall Great, Whitehall Rough, Whitehall Split, Whitehall Parrot Rough and Whitehall Jewel, and Splint and Rough respectively. Monitored water levels in the bedrock predominantly represent groundwater within the sandstone units. Water levels within the coal seams have not been explicitly monitored. However, it is expected that where these seams are below the groundwater level in the Coal Measures that they are in continuity with the groundwater and have a similar groundwater level.

11.6.41 The use of grout in mine working treatment, including these coal seams, or as part of other below ground structures, could impact temporarily the groundwater quality as a result of leaching from the cement slurry. This could result in a short-term release of contaminants, such as chromium, into the groundwater. Once the grout has cured, further contamination is unlikely. Displacement of groundwater from voids along the grouted coal seams will occur. It is likely that any groundwater within these seams is already of poor quality; however, water quality within the coal seams has not been explicitly monitored.

11.6.42 Grouting also has the potential to disrupt and/or act as a barrier to local groundwater flow. It is understood from ground investigations that many of the coal workings have collapsed, reducing the potential volume of groundwater. However, it is likely that the hydraulic conductivity of mining voids is significantly greater than that of the surrounding non-mined strata. Grouting will therefore remove or reduce the existing artificial flow paths through the worked seams and could also block any fractures and fissures though which groundwater movement currently occurs. Any displaced groundwater will travel along alternative flow paths offering the least resistance in the bedrock. This may include adits and untreated workings, although no additional features have been identified outside the area targeted for treatment. This may lead to a diversion of groundwater flow either under or around the grouted zones. Typically, groundwater would be expected to rise locally on the upstream side of the grouted areas and to be lower on the downstream side of the grouted areas. There is also the potential for contaminated groundwater to be mobilised towards local surface water features, such as the River North Esk or Dean Burn, or to the surface via grout treatment holes and untreated mine entrances. This would have a **slight adverse** effect on the groundwater flow. Groundwater in certain units within the Coal Measures has been monitored and shows high confined pressures.

Superficial and Bedrock Aquifer Quality and Flow

<u>Impacts on Superficial Aquifer Quality and Flow</u>

11.6.43 Groundwater levels in the superficial deposits have been monitored at a higher level than the proposed formation levels for the scheme and it is therefore assumed that the superficial deposits will require dewatering in order to enable construction. Impacts on groundwater flow are expected to be localised. The high-water table also makes the superficial aquifer susceptible to contamination from surface activities during construction. Piling and excavations, associated with the scheme's engineering works, also have the potential to impact on superficial groundwater flow locally.

11.6.44 The Proposed Scheme is considered to have a minor adverse magnitude of impact on the quality of the groundwater in the superficial deposits during construction due to surface potentially contaminative activities, such as the leakage and spillages of fuels and chemicals. This will result in a **slight adverse** effect on the groundwater quality of the superficial aquifer during construction.

11.6.45 The Proposed Scheme is considered to have a minor adverse magnitude of impact on the groundwater flow of the superficial aquifer during construction as impacts are expected to be localised. This will result in a **slight adverse** effect on the groundwater flow of the superficial aquifer during construction.

Impacts on Bedrock Aquifer Quality and Flow

11.6.46 The Proposed Scheme's deep engineering works, specifically piling and the grouting of mine workings, have the potential to impact on both the quality and flow of groundwater in the Coal Measures aquifer. Impacts on groundwater flow are expected to be localised compared to the overall aquifer extent. Contamination of bedrock groundwater from surface activities is also possible via pathways from mine workings. Excavation of the bedrock aquifer is not expected to be required.

11.6.47 The Proposed Scheme is considered to have a minor adverse magnitude of impact on groundwater flow in the Coal Measures aquifer during construction, but locally in the vicinity of the grouting works, impacts are considered moderate adverse. This will result in a slight adverse effect on the wider groundwater flow of the bedrock aquifer during construction. However, there will be a **moderate adverse** effect on the groundwater flow during construction in the area nearest the grouting works.

Impacts on Groundwater to Surface Water Bodies Interactions' Quality and Flow

11.6.48 Temporary dewatering of the superficial deposits and possibly the Coal Measures may result in changes to groundwater/surface water interactions and a deterioration in surface water quality. Mobilisation and discharge of contaminated groundwater in the Coal Measures aquifer, as a result of the piling and grouting operations, may impact on the quality and flow of the Dean Burn.

11.6.49 The Proposed Scheme is assessed as having a minor adverse magnitude of impact on the surface water bodies in the area during construction. This would have a **slight adverse** impact on the quality and flow of surface water bodies.

Floodplain Impacts

11.6.50 The methods of construction can also increase flood risk:

- temporary paved surfaces or roofed areas of site compounds may increase the rate of runoff;
- any works within the floodplain are likely to affect the local hydrology;
- ditch or drainage diversions may affect catchment characteristics;
- temporary bunding or material stockpiles may alter runoff from upstream areas; and,
- large areas stripped of vegetation can discharge runoff at a much higher rate than if grassed, and some provision for temporary storage of surface water may be required.

11.6.51 Whilst there may be a temporary increased flood risk during the works due to reduced floodplain capacity, the magnitude of impact would be negligible, due to the limited constraints and low probability of flooding of residential and industrial properties. This would result in a **slight adverse** impact on the floodplain during construction.

Operation

Proposed Road Drainage

11.6.52 The drainage design associated with the Proposed Scheme has been more appropriately detailed in Chapter 5 – The Proposed Scheme. Whilst acknowledging that the Proposed Scheme drainage proposals would be subject to detailed design development, the procedures utilised in the development of the drainage design at this stage have been consistent with the principles and requirements defined in DMRB and relevant legislation and policy.

11.6.53 The outline drainage design for the project has been considered in accordance with the requirements of the DMRB Volume 4, Section 2 (HD 33/06) 'Surface and Sub-surface Drainage Systems for Highways, which are as follows:

- quick removal of surface water to improve safety and minimise nuisance;
- provision of effective sub-surface drainage to maximise longevity of the pavement and its associated earthworks; and,
- minimisation of the impact of the run-off on the receiving environment.

11.6.54 It should be noted that HD 33/06 was updated by CG 501 'Design of highway Drainage systems' in October 2019, however the drainage design was complete by this time and the previous guidance was therefore used to inform the design.

11.6.55 The drainage design also took into consideration the CAR Regulations, SuDS guidance and was informed through consultation with SEPA.

11.6.56 The Proposed Scheme would require approximately 3.5km of new carriageway with road drainage, and the extension of two cross-carriageway culverts. The culverts would be required to pass a 1-in-200 year storm plus climate change flow. The drainage will have three separate outfalls into the Dean Burn.

11.6.57 The proposed surface drainage solution varies depending on the relevant road cross section, particularly considering whether it is kerbed, in-cut or on an embankment. Where the road is kerbed (e.g. Sheriffhall Roundabout and side roads), gullies or combined kerb drainage (CKD) units will be used. If the road is kerbed and on embankment, gullies or kerb drains are proposed with adjacent carrier drain and separate sub-surface drainage. If in-cut, it is proposed to connect the gullies directly to the combined surface and sub-surface drains. Where the road is not kerbed (e.g. A720 Mainline and slip roads), combined surface and sub-surface drains will be used.

11.6.58 Sub-surface drainage will convey any water from the sub-base or capping pavement layers to join the surface runoff in the surface water pipe network. This will be achieved using a combined drain or a separate system via carrier drain in conjunction with a narrow filter drain or fin drain.

<u>Attenuation and Treatment</u>

11.6.59 SuDS retention basins shall be utilised upstream of all proposed road drainage outfalls in order to reduce the impact of the Proposed Scheme drainage waters on the Dean Burn. A hydrological assessment has been carried out in order to determine the greenfield runoff from the area. This has allowed for the development of appropriately sized basins to detain the flow from the highway drainage network and outfall to the Dean Burn at the greenfield runoff rate.

11.6.60 In accordance with General Binding Rules (GBR)10 (SEPA, CAR – A practical guide) and “SUDS for Roads” two levels of treatment will be provided for the road drainage before discharge into the watercourse. The proposed treatment methods will be a combination of carriageway filter drains and SUDS ponds (as shown on Figure 11.2 ‘Road Drainage and the Water Environment – Proposals’).

11.6.61 Filter drains are trenches along the roadside that are filled with a permeable material or media that is designed to filter, temporarily detain and then convey runoff. At the base of the trench there is a perforated pipe, which conveys runoff downstream and not to soil. Filter drains can remove pollutants through:

- directly filtering out sediments, hydrocarbons and heavy metals;
- encouraging adsorption (adhesion of pollutants to the surface of the filter media);
- biodegradation (biological breakdown of pollutants by organisms that develop within the filter media); and,
- volatilisation (conversion of pollutants to a gas (predominantly hydrocarbons)).

11.6.62 In light of the high-water table, these filter drains shall have a geo-synthetic membrane and/or impermeable trench treatments to prevent groundwater ingress.

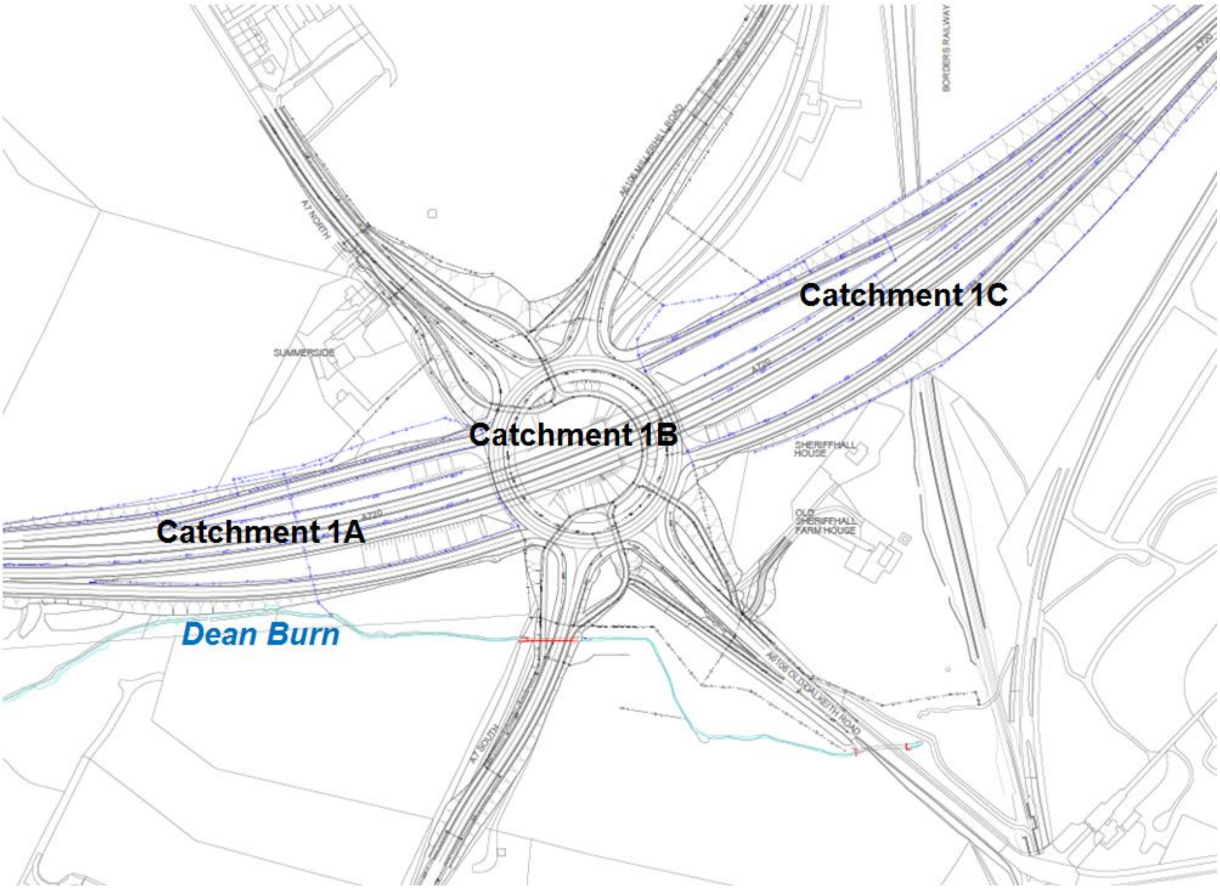
11.6.63 There will be five SuDS ponds in total to convey drainage towards the Dean Burn via three separate outfalls. With reference to Figure 11.2 ‘Road Drainage and the Water Environment – Proposals’, the discharges from the two SuDS ponds to the north of the A720 would be conveyed through the large SuDS pond to the south of the A720, between the A7 South and the A6106 South. These three ponds will effectively combine their discharges and outfall at the same location (OF2) on the Dean Burn, draining the area shown as Catchment 1 on Figure 11.2.

11.6.64 The section of the A720 to the east of the borders railway line would continue to drain into the existing drainage system (Catchment 2), the increase in area is minimal so would be able to be absorbed by the existing drainage network to the east.

11.6.65 As mentioned previously, the NMU routes and a number of permeable and impermeable areas which do not convey road traffic shall drain to the small SuDs pond to the east of the A6106. The Central NMU system of the roundabout, from the points where the footpaths deviate from the roadside to the centre of the roundabout are served by a single drainage net which only picks up the run-off from NMU systems, outfalling to the Dean Burn at OF3.

11.6.66 The SuDs pond to the immediate east of the A7 South shall drain the area shown as Catchment 4, discharging to the Dean Burn at OF1.

Plate 11-10 Proposed Drainage Network for Catchment 1



11.6.67 As shown on Plate 11-10, the proposed drainage network for Catchment 1 is compartmentalised into three individual sections as set out below:

- Catchment 1A – would include all drainage from the mainline carriageway and part of the slip roads to the west of Sheriffhall Roundabout;
- Catchment 1B; would include drainage from part of the slip roads on either side of Sheriffhall Roundabout, from Sheriffhall Roundabout itself, part of the A7 North, part of the A6106 North, part of the A7 South and part of the A6106 South; and
- Catchment 1C - would include all drainage from the mainline carriageway and part of the slip roads to the west of Sheriffhall Roundabout;

11.6.68 The discharges to the Dean Burn via OF2 would in all cases be subject to two levels of treatment (filter drain and SuDs pond); however run-off from Catchment 1A and 1C would be subject to three levels of treatment, passing through two SuDS ponds.

11.6.69 The SuDS ponds shall be designed as retention basins, which are depressions that include a permanent volume of water (normally a maximum of 1.2m deep (CIRIA, 2015)) and are designed to temporarily detain and treat runoff. The permanent volume of water enables:

- the establishment of aquatic vegetation;
- settlement of suspended sediments and other pollutants;
- filtration through aquatic vegetation;
- adsorption (adhesion of pollutants to sediment within the pond);

- biodegradation (biological breakdown of pollutants by organisms that develop within the permanent pool, within and around aquatic vegetation, biofilms and within sediments);
- precipitation (condensation of dissolved pollutants into solids);
- uptake of pollutants by plants and biofilms; and,
- nitrification (biological oxidation, particularly of ammonia, by bacteria).

11.6.70 All SuDS retention basins would be lined with either a natural (depending upon availability of suitable clay on-site) or artificial synthetic impermeable liner/membrane to restrict the movement of contaminants into the deeper soil layers over time and to the groundwater. This shall also protect from groundwater ingress.

11.6.71 Earthworks drainage will be installed to convey land runoff/intercept existing land drainage. This will preferably take the form of ditches wherever possible. However, due to the wider land take ditches require, filter drains may be used in constrained areas.

11.6.72 As the works required to accommodate the Proposed Scheme would be primarily online, changes to the existing drainage network would largely be minimal. Nevertheless, as a consequence of existing topography, cross-fall of the site, and new road construction to the north of Sheriffhall Roundabout, a number of field drains would be intercepted. This includes drainage from the following:

- field area north-west of Sheriffhall Roundabout, between the A720 and A7 north;
- field area north-east of Sheriffhall Roundabout, between A6106 North and the A720; and
- field area southwest of Sheriffhall Roundabout, between the A720 and the A6106.

11.6.73 The design for the Proposed Scheme has identified a range of drainage networks which need to be accommodated to ensure continuity of discharge to the Dean Burn. There will be very little change in terms of the large sections of field that currently drain beneath the A720 other than pre-earthworks drainage being installed to convey land runoff/intercept existing land drainage. This will take the form of filter drains and ditches. These will either tie in to the existing filter drain system and/or outfall to the Dean Burn. This will result in no perceptible change from the existing attenuation and treatment of road drainage; resulting in a **neutral** effect.

Surface Waters

11.6.74 Due to the proximity of the road embankment to the Dean Burn, a section of the watercourse will be diverted upstream of the A7, to a location approximately 40m south of its original alignment. This diversion would be approximately 230m in length and would be installed as a restored two-stage meandering channel to improve watercourse function and habitat. The sharp right-angle bend in the channel between the A7 and A6106 acts as a channel constriction and it is proposed that this be smoothed to improve river function and facilitate creation of the SuDS pond to the north. Appendix 11.2 – Dean Burn Diversion Hydromorphology Design Technical Note provides further information.

11.6.75 As noted in Section 11.6.11, the onslip to the westbound carriageway would encroach directly into the channel of the Dean Burn, its functional floodplain and would partially infill the standing waterbody adjacent to the A720 at Lugton Bogs. To ensure overall volume within the standing waterbody remains the same with the Proposed Scheme, the pond will be reconfigured and widened along its south-western apex.

11.6.76 Compensatory storage is required as part of the design as functional floodplain storage will be lost as a result of SuDS allocation and encroachment of road embankments. Land reprofiling to create this required storage will be provided in three separate locations:

- inside the meander of the realigned channel,

- an area to the north of the channel upstream of the A7; and,
- along the right-hand bank between the A7 and A6106.

11.6.77 This will result in no perceptible change from the existing surface water flood storage; resulting in a **neutral** effect.

Surface Water Quality and Flow

11.6.78 When considering routine runoff from road improvement schemes, relevant pollutants and their concentrations need to be identified. In accordance with the objectives identified in the WFD, there must not be any overall deterioration in water quality in any of the water bodies affected by the Proposed Scheme. Essentially, discharges from the road must not lead to deterioration in the classification status of the receiving surface water identified within the baseline conditions section, and if possible contribute to improved overall water quality. To establish environmental risk, the Highways Agency Water Risk Assessment Tool (HEWRAT) was utilised to investigate the effects of routine runoff on receiving waters and their ecology.

11.6.79 HEWRAT is a Microsoft Excel application which has been developed to assess the acute and chronic pollution impacts on aquatic ecology associated with soluble and sediment-bound pollutants respectively. To assess the water quality impacts from routine runoff on receiving watercourses, the following assessments were carried out for each outfall location conveying road discharges.

11.6.80 For soluble pollutants, HEWRAT calculates the available dilution in the receiving watercourse under low flow conditions. For the sediment-bound pollutants the ability of the receiving watercourse to disperse sediments is considered and, if sediment is expected to accumulate, the potential extent of sediment coverage is also considered. HEWRAT estimates the river velocity under low flow conditions and assumes that sediment arriving in the river when the velocity is less than 0.1m/s accumulates. A basic estimation of velocity is calculated iteratively using the cross-sectional area of the river channel and the flow volume at low flow conditions.

11.6.81 HEWRAT is a tiered consequential system which involves up to three assessment stages:

- Step 1 uses statistical models to determine pollutant concentrations in raw road runoff prior to any treatment or dilution in the receiving watercourse;
- Step 2 assesses in-river pollutant concentrations after dilution and dispersion but without active mitigation; and
- Step 3 considers the in-river pollutant concentrations with active mitigation. For an individual outfall to pass the HEWRAT assessment, it must pass both soluble pollutant and sediment pollutant impacts.

11.6.82 Step 1 considers Design Year (2039) Annual Average Daily Traffic (AADT) flow data, which has been provided by the Project Traffic Team for each road drainage catchment. One of three broad ranges of AADT must be selected within HEWRAT. The road drainage catchments within the Proposed Scheme have an AADT in the range of >10,000 and <50,000 vehicles (the lowest band), though are at the upper end of this band. There are a small number of road drainage catchments. Climatic region is also considered. Four options are available to choose from: Colder Wet, Colder Dry, Warmer Wet and Warmer Dry. The Colder Dry climatic region was selected as this includes Scotland. Having selected a Climatic Region, a restricted list of rainfall sites is available to choose from. The Edinburgh rainfall site was chosen due to its geographical location in relation to the Proposed Scheme.

11.6.83 Under the Step 1 assessment, the HEWRAT assessment predicts that all outfalls associated with the Proposed Scheme would fail against the toxicity thresholds for both soluble and sediment-bound pollutants, thus requiring a more realistic Step 2 assessment. Step 2 is an in-river assessment of impacts of highway run-off, which considers the dilution capacity of the receiving watercourse. There are three sets of design standards which must be considered in assessing highway runoff:

- RSTs (Runoff Specific Thresholds);
- EQSs (Environmental Quality Standards); and,
- SQGs (Sediment Quality Guidelines).

11.6.84 The Step 2 HEWRAT calculation sheets are contained within Appendix 11.1 – Water Quality Assessment and the results for each of the outfalls assessed are summarised in Table 11-12 to Table 11-15:

- Table 11-12 HEWRAT Step 2 Assessment Results for Short-Term Soluble Acute Impacts (Without Mitigation Measures).
- Table 11-13 HEWRAT Step 2 Assessment Results for Long-Term Annual Average Pollutant Concentrations
- Table 11-14 HEWRAT Assessment Results for Sediment-Bound Pollutants
- Table 11-15 Summary of the Serious Spillage Risk Surface Water Assessment

Acute Impacts of Highway Run-Off on Surface Water Quality

11.6.85 Ecologically-based Runoff Specific Thresholds (RSTs) for assessing the acute impacts caused by dissolved copper & dissolved zinc have been designed specifically for highway runoff and account for the fact that, due to the intermittent nature of highway runoff, soluble pollutant concentrations may be high but only for short periods. Relevant toxicity data from tests on a range of aquatic organisms have been used to develop RSTs to protect receiving organisms from short-term exposure (6-hours and 24-hours) to those significant pollutants identified in highway runoff. The RST 24-hour is designed to protect against worst case conditions, whereas the RST 6-hour is designed to protect against more typical exposure conditions of aquatic organisms to soluble pollutants in highway runoff.

Table 11-16 HEWRAT Step 2 Assessment Results for Short-Term Soluble Acute Impacts (Without Mitigation Measures).

Outfall Number	Catchment	Affected Watercourse	Soluble - Acute Impacts	
			Copper	Zinc
OF1	Catchment 4	Dean Burn	Pass	Pass
OF2	Catchment 1A	Dean Burn	Pass	Pass
OF2	Catchment 1B	Dean Burn	Pass	Pass
OF2	Catchment 1C	Dean Burn	Pass	Pass
OF2	Catchment 1 (combined)	Dean Burn	Pass	Pass

11.6.86 With reference to Table 11-2 'Estimating the Magnitude of an Impact on an Attribute', for a Step 2 assessment of short-term acute impacts of routine runoff, the estimated soluble pollutant levels which would be discharged at all outfall locations would pass the assessment. Thus, the predicted short-term runoff concentrations of dissolved copper and zinc discharging to the Dean Burn would be below the toxicity threshold levels; low enough not to warrant any further investigation and the environmental risk considered acceptable. A 'pass' indicates that there is a high level of confidence that there would be minimal short-term impact. This assessment also assumes the drainage system includes no pollution control measures to mitigate the risk (i.e. SuDS).

11.6.87 As noted previously, there will be five SuDS ponds in total to convey drainage towards the Dean Burn via three separate outfalls. Only two of the outfall points to the Dean Burn have been assessed, as whilst Outfall 3 would convey drainage to the Dean Burn via a SuDS pond, the run-off would be from the NMU routes only, and thus there would be no pollution source attributable to vehicular activity. On this basis, it is scoped out of the HEWRAT assessment.

11.6.88 The discharges to the Dean Burn via Outfall 2 would in all cases be subject to two levels of treatment (filter drain and SuDs pond), however run-off from Catchment 1A and 1C would be subject to three levels of treatment, passing through two SuDS ponds. This would include all drainage from the mainline carriageway and part of the slip roads. Routine run-off from the remainder of the slip roads, the roundabout and numerous arms would be conveyed via Catchment 1B. On this basis, a combined assessment of Catchment 1 has been undertaken and the findings detailed in Table 11-12 'HEWRAT Step 2 Assessment Results for Short-Term Soluble Acute Impacts (Without Mitigation Measures)'. to determine short-term soluble acute impacts within the Dean Burn in the absence of any mitigation. This assumes all discharges from Catchment 1 are unabated and unchecked.

11.6.89 As shown on Figure 11.2 Road Drainage and the Water Environment – Proposals', Catchment 4 would convey routine run-off from the A7 south, via a filter drain and SuDS pond to the Dean Burn, via Outfall 1.

11.6.90 For each of the outfalls assessed, the significance of effect with regards to short-term soluble acute impacts within the receiving surface water is likely to be **neutral** as a baseline conditions assessment has not been undertaken, thus the perceptibility of change has not been quantified. Nevertheless, the inclusion of filter drains and in particular SuDS retention basins (where none exist) would likely result in a reduced risk of a negative effect occurring, due to the ability of the proposed treatment system to attenuate flow, limit the discharge rate from the outfall, and to reduce pollutant concentration through in-basin treatment. There would be an improvement in discharge quality over the existing situation.

Impact on Average Annual Pollutant Concentration due to Highway Run-Off

11.6.91 Environmental Quality Standards (EQSs) are general standards for chemical pollutants which are derived according to methods set out in the WFD. In contrast to the RSTs, EQSs consider the annual average pollutant concentration in the water body rather than short lived peaks in concentration. EQSs are the means to assess water quality so that, while RSTs are arguably more appropriate for intermittent highway runoff, the EQSs must also be complied with.

11.6.92 With scheme implementation, it is a requirement that annual average concentrations of dissolved copper and zinc in the receiving surface water do not exceed published WFD EQSs.

Under the WFD, EQSs are expressed as annual average concentrations and are most appropriate for comparison against continuous discharges. Road runoff is an intermittent discharge and any breach of annual average concentrations is only likely to persist for a short duration (minutes/hours). This may go unnoticed by standard monitoring regimes for chemical parameters, but may have environmental impacts nonetheless.

11.6.93 Table 11-17 HEWRAT Step 2 Assessment Results for Long-Term Annual Average Pollutant Concentrations 'HEWRAT Step 2 Assessment Results for Long-Term Annual Average Pollutant Concentrations' reports the annual average concentration of dissolved copper and zinc for a Step 2 assessment of long-term impacts. In calculating annual average concentrations, HEWRAT assumes the background/upstream concentrations are zero. This enables an assessment of the added risk, rather than total risk (i.e. the additional risk to organisms in the receiving water when they are exposed to road runoff). These values are compared with the EQSs, to determine whether there would be a long-term impact or not. It should be noted that incorporating flow attenuation into the drainage system at Step 3 would not reduce the annual average concentration (all annual runoff would still be discharged within the year), only treatment of soluble pollutants prior to discharge would reduce annual average concentrations.

Table 11-17 HEWRAT Step 2 Assessment Results for Long-Term Annual Average Pollutant Concentrations

Outfall Number	Catchment	Affected Watercourse	Annual Average Concentration (µg/l)	
			Copper	Zinc
1	Catchment 4	Dean Burn	0.13µg/l	0.55µg/l
2	Catchment 1A	Dean Burn	0.11µg/l	0.45µg/l
2	Catchment 1B	Dean Burn	0.05µg/l	0.22µg/l
2	Catchment 1C	Dean Burn	0.11µg/l	0.44µg/l
2	Catchment 1 (combined)	Dean Burn	0.23µg/l	0.94µg/l

11.6.94 As the water hardness within the study area is low, the EQS annual mean concentration for dissolved copper and zinc is 1µg/l and 11.9µg/l respectively. With reference to

11.6.95 Table 11-17 'HEWRAT Step 2 Assessment Results for Long-Term Annual Average Pollutant Concentrations', for a Step 2 assessment of long-term impacts, it can be seen that the predicted annual average concentrations for dissolved copper and zinc would be below the EQS values for the respective pollutants. The EQS for dissolved copper and zinc is influenced by the hardness of the water, so that the softer the water, the lower the EQS value. On this basis, it can be confidently assumed that there would be a minimal long-term impact upon ecology with scheme implementation, as discharges would be below these values.

11.6.96 In summary, for Outfalls 1 and 2, the significance of effect with regards to long-term annual average pollutant concentrations within the receiving surface water is likely to be **neutral** as a baseline conditions assessment has not been undertaken, thus the perceptibility of change has not been quantified. Nevertheless, the inclusion of filter drains and in particular SuDS retention basins (where none exist) would likely result in a reduced risk of a negative impact occurring, due to the ability of the proposed treatment system to attenuate flow, limit the discharge rate from the outfall, and to reduce the pollutant concentration through in-basin treatment. In essence, there would likely be an improvement in discharge quality over the existing situation.

Chronic Impacts of Highway Run-Off on Surface Water Quality

11.6.97 Chronic pollution is the result of on-going low levels of pollution which may result in the accumulation of sediment-bound pollutants over a longer period of time (months/years). These low levels of pollutants can result in non-lethal effects, such as reduced feeding, growth rates and reproduction, or may result in the death of organisms. Sediment can also have indirect effects on ecosystems, such as the burial of spawning beds and the changing of gravel-dominated substrate to a substrate dominated by finer sediments.

11.6.98 Sediment Quality Guidelines (SQGs) refer to pollutant concentrations within the sediment derived from the highway. Research has shown that SQGs are exceeded in all highway-derived sediment. As such, the real test is whether sediment will disperse or whether it will accumulate in quantities that might have an adverse effect. For the sediment-bound pollutants that cause chronic impacts, the ability of the receiving watercourse to disperse sediments is considered and, if sediment is expected to accumulate, the potential extent of sediment coverage (the Deposition Index (DI)) is also considered. The following sediment-bound pollutants associated with chronic pollution impacts, expressed as Event Mean Sediment Concentrations (EMSCs), have been incorporated within the HEWRAT assessment:

- Total copper;
- Zinc;
- Cadmium;
- Pyrene;
- Fluoranthene;
- Anthracene;
- Phenanthrene; and,
- Total Polycyclic Aromatic Hydrocarbons (PAHs).

11.6.99 In situations where highway-derived sediment is likely to accumulate, the extent of deposition is assessed against a dimensionless Deposition Index (DI) value of 100. The Step 2 (Tier 1) assessment is calculated from a map-based estimation of river width. The area is then used for calculation of river velocity and deposition index. Generally the stream velocity under a Tier 1 assessment will be underestimated, thus the deposition index overestimated. Essentially, the Tier 1 assessment is provided as a simple and conservative check, which, if no risk is identified, will save further work being carried out. More accurate assessment for Tier 2 requires a site visit for the river dimensions to be physically measured.

Table 11-18 HEWRAT Assessment Results for Sediment-Bound Pollutants

Outfall Number	Affected Watercourse	Sediment - Chronic Impact			
		Step 2 (Tier 1)		Step 2 (Tier 2)	
		Accumulating	Extensive (DI)	Accumulating	Extensive (DI)
1	Dean Burn (Catchment 4)	Yes	Yes (189)	No	-
2	Dean Burn (Catchment 1A)	Yes	Yes (146)	No	-
2	Dean Burn (Catchment 1B)	No	No (68)	No	-
2	Dean Burn (Catchment 1C)	Yes	Yes (144)	No	-
2	Dean Burn (Catchment 1 (combined))	Yes	Yes (359)	No	-

(DI) – Deposition Index

11.6.100 With reference to Table 11-18 'HEWRAT Assessment Results for Sediment-Bound Pollutants' extensive sediment accumulation would occur at each outfall due to low flow velocities and fail the Step 2 Tier 1 assessment for chronic impacts. Whilst the Dean Burn Catchment 1B (Outfall 2) would indicate a pass for this assessment, this is not reflective of reality where the discharges from two other catchments that would outfall at the same location would affect the dispersal of sediments. As shown in Table 11-14, the accumulation of sediments associated with the combined discharges at Outfall 2 would be extensive.

11.6.101 A Step 2 Tier 2 assessment was then undertaken for all outfalls, which is based on measurements taken in the field regarding the characteristics of the river channel (i.e. bed width, side slope, long slope). In the case of all outfalls, it has been assessed that none of the outfalls would be accumulating with velocities under low flow conditions sufficient to disperse sediments.

11.6.102 In summary, the significance of effect with regards to sediment-bound pollutants within the receiving surface water is **neutral** as a baseline conditions assessment has not been undertaken, thus the perceptibility of change has not been quantified. Nevertheless, the inclusion of SuDS retention basins (where none exist) would likely result in a reduced risk of a negative impact occurring, due to the ability of the proposed treatment system (where none currently exists) to settle sediments. In essence, there would be an improvement in discharge quality over the existing situation.

Impacts of Pollution from Accidental Spillages on Surface Water Quality

11.6.103 The DMRB assessment of pollution impacts from accidental spillages is used to provide an indication of the risk of a spillage causing a pollution impact upon receiving water bodies.

11.6.104 The risk is defined as the probability that there will be an accidental pollutant spillage and that the pollutant will reach and impact the water body to such an extent that a serious pollution incident occurs. The probability is the product of two separate risks:

- The probability that there will be a spillage with the potential to cause a serious pollution incident; and,
- The probability, assuming such a spillage has occurred, that the pollutant will cause a serious incident.

11.6.105 The risk is expressed as the probability of an incident in any one year and calculated using road length (km), Design Year (2039) AADT, and percentage of HGVs. It is initially assessed without any mitigation measures. If measures are required, a pollution risk reduction factor is applied, specific to that type of mitigation.

11.6.106 In most circumstances, the acceptable risk of a serious pollution incident occurring is where the annual probability is predicted to be less than 1% (or a return period of 1-in-100 years).

11.6.107 The methodology gives the probability of a serious pollution incident occurring as a result of a serious accidental spillage. These rates vary according to the sensitivity of the watercourse and its location in relation to emergency response services. Serious accidental spillage rates are also given as a risk factor, varying according to junction and road type. Where a pollution risk is seen to exceed acceptable levels, pollution control measures and mitigation should be introduced.

11.6.108 The risk of a spillage causing a pollution impact as a result of the Proposed Scheme has been assessed for the Dean Burn and summarised below in Table 11-19 'Summary of the Serious Spillage Risk Surface Water Assessment'. Furthermore, the Serious Spillage Risk calculations are contained within Appendix 11-1 – Water Quality Assessment.

Table 11-19 Summary of the Serious Spillage Risk Surface Water Assessment

Outfall Number	Affected Surface water	Risk of Accidental Spillage Return Period (Years)	Risk of Accidental Spillage Return Period (Years)
		Without Mitigation	With Mitigation
1	Dean Burn (Catchment 4)	3,851	7,702
2	Dean Burn (Catchment 1A)	3,651	7,302
2	Dean Burn (Catchment 1B)	1,429	2,859
2	Dean Burn (Catchment 1C)	4,393	8,787
2	Dean Burn (Catchment 1 (combined))	853	1,279

11.6.109 With reference to Table 11-15 'Summary of the Serious Spillage Risk Surface Water Assessment', the annual probability of a serious pollution incident occurring is significantly lower than the acceptable risk limit of 1% (a return period of 1-in-100 years) for the Dean Burn, and thus no mitigation measures are deemed necessary.

11.6.110 The combined risk for Catchment 1 was calculated to give an indication of the absolute worst-case scenario, however, as the drainage from this catchment is compartmentalised into three individual sections (as detailed in sub-section 11.6.67), the likelihood of an accident affecting all three sub-catchments and that accident causing a serious spillage is remote. The return periods, as shown in Table 11-15 'Summary of the Serious Spillage Risk Surface Water Assessment for the individual sub-catchments would be a more realistic scenario.

11.6.111 With the inclusion of SuDS retention basins at all outfall locations, these would have an indicative pollution risk reduction factor of 50%, lowering the annual probability of a serious pollution incident taking place in the Dean Burn in the event of a serious accident.

11.6.112 In summary, the significance of effect with regards to the annual probability of a serious pollution incident occurring is **neutral**, though the inclusion of SuDS retention basins (where none currently exists) would provide a reduction in spillage risk over existing conditions, which is a betterment.

Hydrogeology

11.6.113 As detailed with Appendix 11.2 – Dean Burn Diversion Hydromorphology Design Technical Note of this ES, to accommodate to the Proposed Scheme, the Dean Burn would be subject to realignment.

11.6.114 The capacity of the channel would be designed to match the existing channel so as not to increase flood risk and the planform of the low flow channel developed to mimic the tight bends seen in upstream sections, which display morphological diversity and includes riffle features at strategic locations to create the expected features and to ensure no disruption to sediment transport continuity following construction.

11.6.115 A two-stage channel design is proposed, to allow for some enhancement of the watercourse where it has been canalised and straightened historically. This allows for a low flow channel proportioned to convey approximately the 1-in-2 year flow and a wider channel above this to convey higher flood flows. The bed features introduced to the diverted channel would be sustainable within the low flow channel and the flood flows would be contained in the wider channel area.

11.6.116 The magnitude of impact would be minor beneficial as the design would:

- provide partial improvement to sediment processes at the reach scale through the introduction of two-tier attenuation of discharges, including reduction in siltation and localised recovery of sediment transport processes;
- would provide partial improvement of the Dean Burn, including enhancements to in-channel habitat, riparian zone and morphological diversity of the bed and/or banks; and
- provide slight improvement on baseline conditions with potential to improve flow processes at the reach scale.

11.6.117 This would result in an overall **slight beneficial** effect on the surface water flow during operation.

General Groundwater Quality

<u>Impacts on General Ground Water Quality</u>

11.6.118 With reference to Appendix 11.5- Hydrogeological Assessment Technical Note, the main elements of this stage of the project which potentially could impact on groundwater are associated with:

- Permanent dewatering of the superficial deposits, via gravity flow; and,
- Permanent below ground features, such as pilings, foundations or grouted workings disrupting groundwater flow.

11.6.119 External groundwater conditions which potentially could impact on the operational phase of the project include:

- Changes to local mine treatment and dewatering operations.

11.6.120 It is considered unlikely that operation of the proposed scheme will have any additional impacts on the groundwater level or quality in the deeper Coal Measures aquifer. This will result in a **neutral** effect on the groundwater level and quality.

<u>Impacts of Pollution from Routine Runoff on Groundwater Quality</u>

11.6.121 The DMRB has developed a method for assessing risk to groundwater quality through a step-wise framework, identifying and assessing individual components of overall risk to groundwater quality posed by the discharge of road runoff to the ground. It provides a means of understanding and assessing generic processes that influence the level of groundwater protection inherent to different source and pathway characteristics. The framework is based on an examination of the ‘Source-Pathway-Receptor (SPR) protocol’ used in risk assessment developed for contaminated land evaluation, and is defined as follows:

- Source term comprises the road drainage;
- Pathway term represents the processes, which may modify the pollutants during transmission through the discharge system and soil and subsoil until the actual ‘point of entry’ to groundwater (this includes the unsaturated zone); and,

- Receptor, which is the groundwater.

11.6.122 All elements of the SPR linkage have to be present to create a pollutant linkage.

11.6.123 As part of the drainage design the filter drains would have a geo-synthetic membrane and/or impermeable trench treatments and the SuDS pons would be lined, therefore, no pathway to/from the groundwater exists.

11.6.124 As there would be no direct discharges to groundwater with the proposed drainage design, no ‘point of entry’ would exist and thus the SPR linkage is not complete. As such, there is no risk to groundwater from routine highway runoff. This will result in a neutral effect on the risk of pollution from routine runoff on groundwaters during operation. Consequently, there is no requirement to undertake a quantitative assessment of the risk of pollution impacts from accidental spillages to groundwater. With no measurable impact upon an aquifer and risk of pollution from spillages, this would result in a **neutral** effect on the risk of accidental spillages to groundwater during operation.

Superficial and Bedrock Aquifer Quality and Flow

Impacts on Superficial Aquifer Water Quality and Flow

11.6.125 Groundwater in the superficial deposits have been monitored at a higher level than the completed levels of parts of the Proposed Scheme and it is therefore assumed that superficial deposits may require permanent dewatering locally for operation. Impacts on groundwater flow are expected to be localised. Permanent piling associated with the scheme’s engineering works also has the potential to impact on superficial groundwater flow locally.

11.6.126 Whilst the vast majority of the Proposed Scheme would be on embankment, the NMU underpasses would be designed as sealed structures with sufficient load-bearing capacity and flexural strength to prevent flotation or seepage ingress from groundwater. This approach to the structural design of the underpasses would mean that there would be no requirement to collect and dispose of significant quantities of groundwater. The Proposed Scheme will therefore have a **neutral** effect on the water quality of the Superficial Esk Valley Sand and Gravel Aquifer during operation.

11.6.127 As discussed previously, there are five proposed SuDS ponds which segregate drainage from the project site. The SUDS ponds are to be lined and then drained under gravity to the local watercourses, as the groundwater level in the surrounding superficial deposits may be higher than the base of the pond and hence a soak-away drainage design may not practicable. As per SEPA requirements, they are also to retain water, which may offset any potential for uplift as a consequence of the locally high groundwater level. Furthermore, as the ponds are to be lined, there is no expected pathway for degradation of groundwater as the lining would be impermeable and limit any potential of ingress.

11.6.128 Consequently, the proposed scheme is considered to have a minor adverse magnitude of impact on the groundwater flow in the superficial aquifer during operation as impacts on groundwater flow are expected to be localised. This will result in localised **slight adverse** effects on the groundwater flow of the Superficial Esk Valley Sand and Gravel Aquifer during operation.

Impacts on Bedrock Aquifer Quality and Flow

11.6.129 The deep piling and the grouting of mine workings as part of the construction phase, have the potential to cause a long-term impact on the quality and flow of groundwater in the bedrock aquifer. The impacts on groundwater flow are expected to be localised compared to the overall aquifer extent.

11.6.130 The proposed scheme is considered to have a negligible magnitude impact on the groundwater quality of the bedrock aquifer during operation resulting in a **slight adverse** effect on groundwater quality of the bedrock. The proposed scheme is also considered to have a minor adverse magnitude impact on the groundwater flow of the bedrock aquifer during operation resulting in a **slight adverse** effect on the groundwater flow of the bedrock aquifer. However, locally in the vicinity of the site grouting the significance of effect on groundwater flow is considered to be **moderate adverse**.

Hydrology & Flood Risk

11.6.131 As detailed within Appendix 11.3 – Flood Risk Assessment, the scheme model results demonstrate that without mitigation, the Proposed Scheme has a negative impact on flood risk as a result of loss of floodplain and flow area and therefore does not comply with planning policy without mitigation.

11.6.132 Floodplain depths upstream of the A7 and the A6106 were increased by approximately 5-10mm during the 1 in 200yr event and 5-10mm in the 1 in 200yr plus climate change event. Pass forward flows were increased by 0.03m^3/s and 0.025m^3/s through the A6106 culvert for the 1 in 200yr and 1 in 200yr plus climate change events respectively.

11.6.133 The scheme results in a loss of floodplain storage as a result of land raising. The modelling has demonstrated that the Proposed Scheme increases water levels and pass forward flows. Therefore, the scheme requires mitigation measures to ensure the design complies with planning policy.

11.6.134 To mitigate against the loss of floodplain storage as a result land raising, it is recommended that compensatory storage be provided in the three areas as shown on Figure 11.2 'Road Drainage and the Water Environment – Proposals' Full details of the extent and contours of the land reprofiling can be found in Appendix F of Appendix 11.3-Flood Risk Assessment.

11.6.135 As the compensatory floodplain would result in a negligible change in peak flood level for the 0.5% AEP (200-year) plus CC design flood event of up to <+/-10mm, the magnitude of impact would be negligible. This will result in an overall **slight adverse** effect on flooding during operation.

11.7 Mitigation

11.7.1 As noted throughout the assessment of potential impacts, embedded mitigation measures are project specific and are included in the design of the Proposed Scheme. There is also project specific mitigation, which includes additional mitigation measures which have been identified as part of this EIA process and apply specifically to Road Drainage and the Water Environment attributes affected by the Proposed Scheme. These are collated in Table 11-20Summary of Road Drainage and the Water Environment Mitigation Measures, listing the specific mitigation commitments required for this chapter for ease of reference and for use by those overseeing the relevant Contract Documents.

11.7.2 The table below, Table 11-20Summary of Road Drainage and the Water Environment Mitigation Measures', includes the following information:

- Mitigation reference number;
- Description of the mitigation measure (including its purpose and location);
- Timing of the mitigation measure; and,
- Specific monitoring, consultation and approval required for the mitigation item.

11.7.3 This table is also included within Chapter 20 – Schedule of Environmental Commitments which will be used to inform the commitments in the contract document.

Table 11-20 Summary of Road Drainage and the Water Environment Mitigation Measures

Mitigation Item	Location/ Approximate Chainage	Timing of Measure	Description	Mitigation Purpose/ Objective	Specific Consultation or Approval Required	Potential Monitoring Requirements
RDWE-1	The Proposed Scheme	Detailed design & in advance of construction	The Water Environment (Controlled Activities) Regulations 2011 (CAR) (Scottish Government, 2011b) require licences to be sought for design and construction activities affecting watercourses, including engineering works (culverts and bridges) and discharges (outfalls, attenuation and treatment). The Contractor will be required to provide a detailed Construction Method Statement which will include proposed mitigation measures for specific activities including any requirements identified through the pre-CAR consultation process. A surface water quality monitoring plan should develop site specific monitoring protocols during the construction phase and be includes as part of the CEMP and risk assessment methods statements.	Ensure compliance with regulatory requirements for the protection and effective management of the water environment	It is intended that the appointed Contractor be responsible for submitting applications and securing CAR authorisation based on their detailed design. The CAR application and surface water quality monitoring plan may require approval from SEPA	Regular monitoring to ensure effective implementation on site as per the granted licence.
RDWE-2	Proposed Works	During construction	The documents listed below provide key guidance on likely impacts on the water environment as a result of construction, and the methods for controlling impacts. The guidance given in these documents should be followed as closely as is practicable. • C648 'Control of Water Pollution from Linear Construction Projects' (CIRIA, 2006); • C532 'Control of water pollution from construction sites: guidance for consultants and contractors' (CIRIA, 2001); • SP156 'Control of water pollution from construction sites – guide to good practice' (CIRIA, 2002); and • 'Engineering in the Water Environment Good Practice Guide – Temporary Construction Methods' (SEPA, 2009a). Adherence by the contractor to the relevant GPPs/PGGS shall also be a requirement. Site works should be planned so that activities likely to generate silt-laden runoff are carried out during drier months (if possible), and erosion of surface soils is controlled. Seasonal weather patterns should be taken into consideration when programming and planning construction activities. A CEMP must include an Erosion Prevention and Sediment Control Plan and this must be submitted to SEPA prior to commencement of any works. Measures specified within shall include but not be limited to: • avoiding unnecessary stockpiling of materials and exposure of bare surfaces, limiting topsoil stripping to areas where bulk earthworks are immediately programme; • installation of temporary drainage systems/SuDS systems (or equivalent) including pre-earthworks drainage;	Minimise sediment mobilisation or release of pollutants into the adjacent watercourses, or risk of contamination to groundwater.	SEPA	Monitored on-site during construction to ensure effectiveness of measures. Environmental Clerk of Works (EnvCoW) shall be required to have a good working understanding of these documents and effectively apply this knowledge onsite, providing an observational role in the event that if issues development that may present an unacceptable risk to the water environment, corrective action can be undertaken and reported as necessary.

Mitigation Item	Location/ Approximate Chainage	Timing of Measure	Description	Mitigation Purpose/ Objective	Specific Consultation or Approval Required	Potential Monitoring Requirements
			• pre-earthworks drainage/SuDS with appropriate outfalls to be in place prior to any earthworks activities; • treatment facilities to be scheduled for construction early in the programme, to allow settlement and treatment of any pollutants contained in site runoff and to control the rate of flow before water is discharged into a receiving watercourse; • the adoption of silt fences, check dams, settlement lagoons, soakaways and other sediment trap structures as appropriate; • the maintenance and regrading of haulage route surfaces where issues are encountered with the breakdown of the existing surface and generation of fine sediment; • provision of wheel washes at appropriate locations (in terms of proposed construction activities) and >10m from water features; • protecting soil stockpiles using bunds, silt fencing and peripheral cut-off ditches, and location of stockpiles at distances >10m from water features; and • restoration of bare surfaces (seeding and planting) throughout the construction period as soon as possible after the work has been completed, or protecting exposed ground with geotextiles if to be left exposed			
RDWE-3	Dean Burn Realignment	During Construction	In relation to in-channel working, the Contractor will be required to adhere to GPPs/PPGS and other good practice guidance (as noted above), and implement appropriate measures which will include, but may not be limited to: • construction the new channel in the dry before any diversion to minimise the risk of sediment release. • undertaking in-channel works (i.e. when connecting the new channel to the Dean Burn) in low flow periods as far as reasonably practicable to reduce the potential for sediment release and scour • no in-channel working during the salmonid spawning seasons unless permitted within any CAR licence. This is unlikely to be an issue with the Proposed Scheme as the Dean Burn does not contain any fisheries interest. • minimise the length of channel disturbed and size of working corridor, with the use of silt fences or bunds where appropriate to prevent sediment being washed into the water feature. • limit the removal of vegetation from the riparian corridor, and retaining vegetated buffer zone wherever reasonably practicable. • limit the amount of tracking adjacent to watercourses and avoid creation of new flow paths between exposed areas and new or existing channels.	Provide enhancement of riparian habitat and hydromorphology conditions within the realigned Dean Burn channel.	Method statements for any in-channel working require approval by SEPA	Monitored on-site by the EnvCoW during construction, in particular when connecting the new channel to the Dean Burn in order to minimise the risk of sediment release and ensure that the hydromorphological conditions within the new channel meet the design requirements.

Mitigation Item	Location/ Approximate Chainage	Timing of Measure	Description	Mitigation Purpose/ Objective	Specific Consultation or Approval Required	Potential Monitoring Requirements
RDWE-4	Dean Burn Floodplain (south of the scheme)	Construction	A Flood Response Plan shall be prepared as part of the CEMP and will set out mitigation requirements when working within the functional floodplain. This would include: • routinely checking weather warnings; • monitoring river levels during periods of extreme rainfall to allow for effective and safe management of the site; • Plant and materials being stored in areas outside the functional floodplain where practicable, with the aim for temporary construction works to be resistant or resilient to flooding impacts, to minimise/prevent movement or damage during potential flooding events. Where this is not possible, agreement will be required with the EnvCoW; • Stockpiling of material within the functional floodplain, if unavoidable, will be carefully controlled with limits to the extent of stockpiling within an area, to prevent compartmentalisation of the floodplain, and stockpiles will be located >10m from watercourse banks. • Temporary drainage systems will be implemented to alleviate localised surface water flood risk and prevent obstruction of existing surface runoff pathways.	To minimise the risk of flooding impacts on construction works.	SEPA and Local Authorities as necessary.	Monitored on-site during construction by the EnvCoW (i.e. checking weather warnings and observing river levels)
RDWE-5	Proposed Works	During construction	Measures to minimise the risk and potential effects of spillage incidents shall typically include; storage of oils and diesel, along with the general maintenance and refuelling of plant, shall be restricted to impermeable bunded areas with a minimum 110% storage capacity and away from or where spillages could reach a surface water. All fuel, chemicals and oils shall be stored within bunded areas in accordance with GPP 2 and PPG 26 and be compliant with Water Environment (Controlled Activities) (Scotland) Regulations 2011 [as amended]. The storage compound shall be fenced off and locked when not in use to prevent theft and vandalism. Refuelling of plant and machinery shall take place at least 10m away from watercourses and spill kits and oil absorbent material must be carried by mobile plant and located at vulnerable locations (e.g. crossings of land drains and ditches). Care must be taken whilst using shuttering oils when preparing formwork. An Emergency Response Plan shall be prepared. Concrete mixing must be undertaken in designated impermeable areas, at least 10m away from a watercourse or surface water drain to reduce the risk of runoff entering a watercourse, or the sub-surface, or groundwater environment.	To avoid spillages and reduce impacts on the water environment in relation to refuelling.	SEPA, Health and Safety Executive (HSE)	Monitored on-site during construction by the EnvCoW to ensures conformance with the measures identified to minimise the risk and potential effects of spillage incidents

Mitigation Item	Location/ Approximate Chainage	Timing of Measure	Description	Mitigation Purpose/ Objective	Specific Consultation or Approval Required	Potential Monitoring Requirements
			Equipment, batching and ready mix lorry washing and cleaning should be washed out on site into a designated area that has been designed to contain wet concrete/wash waters (see PPG 6).			
RDWE-6	Proposed Works	During construction	Sewage from site facilities will be disposed of appropriately either to a foul sewer (with the permission of Scottish Water) or via appropriate treatment (i.e. transported offsite for disposal at a Sewage Treatment Works (STW).	To ensure sewage from site facilities is disposed of appropriately.	Permission required from Scottish Water for disposal to foul sewer or SEPA, in advance of construction, for appropriate treatment and discharge to a watercourse	-
RDWE-7	Proposed Works	Before construction	Dewatering activities should require groundwater discharges to be directed into settlement lagoons, to reduce the suspended solids concentration, before subsequent discharge to surface watercourses.	To prevent pollution of watercourses and groundwater from construction activities	SEPA	Monitored on-site during construction to ensure effectiveness of measures
RDWE-8	Proposed Scheme	Construction & Operation	Controlling grout run-off on the ground surface and prevent grout reaching agricultural soils, watercourses or causing contamination of groundwater. Care should also be taken to prevent the grout extending past the target zone. This may be controlled by measures such as the use of gravel to form curtain walls to the grout. If practicable, large voids should also be filled with permeable granular materials, such as gravel, to allow some groundwater flow to remain and minimise hydraulic obstruction. This will include identifying any potential mine water discharges via a water features survey prior to construction and a visual monitoring assessment to observe for areas of seepage of migrated contaminated groundwater from grouting activities. A programme of regular groundwater level and quality monitoring should be established and implemented prior to the commencement of any construction works. Monitoring for potential impacts, including groundwater level and quality monitoring in both the superficial and bedrock aquifers, and surface water discharges, will allow for timely maintenance, remediation and restoration to minimise potential direct and indirect impacts. This is especially important before and during grouting operations to observe for any adverse effects on groundwater. Guidance from the Coal Authority and SEPA including Stabilising mine workings with PFA grouts. Environmental code of practice 2nd Edition, BRE Report 509, should be adopted throughout the design and construction process to minimise impacts on groundwater during these operations	To prevent pollution of watercourses and groundwater from construction activities	SEPA	Monitored on-site during construction to ensure effectiveness of measures
RDWE-9	Proposed Works	During construction	All piles should be installed in accordance with SEPA methodology. This is of particular importance where the proposed piles terminate below the groundwater level in the bedrock. Where the piles terminate above the groundwater level in the bedrock, there will be no impacts on bedrock	To prevent pollution of watercourses and groundwater from construction activities	SEPA	Monitored on-site during construction to ensure effectiveness of measures

Mitigation Item	Location/ Approximate Chainage	Timing of Measure	Description	Mitigation Purpose/ Objective	Specific Consultation or Approval Required	Potential Monitoring Requirements
			groundwater flow or negligible impacts on bedrock groundwater quality. A piling risk assessment may be required.			

11.8 Residual Effects

11.8.1 The following table, Table 11-21 Potential Road Drainage and the Water Environment Construction and Operation Impacts and Residual Effects, provides a summary of the pre-mitigation construction and operation impacts, mitigation measures and residual effects that have been described within this chapter.

Table 11-21 Potential Road Drainage and the Water Environment Construction and Operation Impacts and Residual Effects

Receptor	Predicted Impacts	Magnitude of Impact	Sensitivity of Feature	Scale of Effect (pre-mitigation)	Mitigation Measures	Residual Effects
Lugton Bogs - Surface Water Quality						
Construction	Sediment release to Lugton Bogs causing a deterioration in surface water quality as a consequence of general site activities, such as stockpiles locations, haul routes, etc.	Moderate	Medium	Moderate Adverse	RDWE-2, RDWE-3, RDWE-4,	Slight Adverse
	Accidental spillage (fuel, oils, lubricants, paints, bituminous coatings, preservatives and weed killers) during construction resulting in deterioration in surface water quality of Lugton Bogs.	Moderate	Medium	Moderate Adverse	RDWE 2, RDWE-5, RDWE-6	Neutral
Dean Burn - Surface Water Quality						
Construction	Sediment release to Dean Burn causing a deterioration in surface water quality as a consequence of general site activities, such as stockpiles locations, haul routes, etc.	Moderate	Medium	Moderate Adverse	RDWE-2, RDWE-3, RDWE-4,	Slight Adverse
	Accidental spillage (fuel, oils, lubricants, paints, bituminous coatings, preservatives and weed killers) during construction resulting in deterioration in surface water quality of Dean Burn.	Moderate	Medium	Moderate Adverse	RDWE 2, RDWE-8, RDWE-6	Neutral
	Litter and debris resulting in contamination, obstruction and reduced amenity of Dean Burn	Minor	Medium	Slight Adverse	RDWE-2	Neutral
	Mobilisation and discharge of contaminated groundwater in the Coal Measures aquifer, as a result of piling and grouting operations, may impact the quality and flow of the Dean Burn	Minor	Medium	Slight Adverse		
Operation	The inclusion of filter drains and in particular SuDS retention basins (where none exist) would likely result in a reduced risk of a negative effect occurring, due to the ability of the proposed treatment system to attenuate flow, limit the discharge rate from the outfall, and to reduce acute pollutant concentration through in-basin treatment. There would be an improvement in discharge quality over the existing situation.	Negligible	Medium	Neutral	-	Neutral
	The inclusion of filter drains and in particular SuDS retention basins (where none exist) would likely result in a reduced risk of a negative impact occurring, due to the ability of the proposed treatment system to attenuate flow, limit the discharge rate from the outfall, and to reduce the average annual pollutant concentration through in-basin treatment. There would likely be an improvement in discharge quality over the existing situation	Negligible	Medium	Neutral	-	Neutral
	The inclusion of SuDS retention basins (where none exist) would likely result in a reduced risk of a chronic pollution occurring, due to the ability	Negligible	Medium	Neutral	-	Neutral

Receptor	Predicted Impacts	Magnitude of Impact	Sensitivity of Feature	Scale of Effect (pre-mitigation)	Mitigation Measures	Residual Effects
	of the proposed treatment system (where none currently exists) to settle sediments.					
	The inclusion of SuDS retention basins (where none currently exists) would provide a reduction in spillage risk over existing conditions with regards to the annual probability of a serious pollution incident occurring.	Negligible	Medium	Neutral	-	Neutral
Dean Burn - Surface Water Flow						
Construction	Mobilisation and discharge of contaminated groundwater in the Coal Measures aquifer, as a result of piling and grouting operations, may impact the quality and flow of the Dean Burn	Minor	Medium	Slight Adverse		
Operation	The proposed hydromorphological changes to the Dean Burn would provide partial improvement to sediment processes at the reach scale through the introduction of two-tier attenuation of discharges, including reduction in siltation and localised recovery of sediment transport processes. Would provide partial improvement of the Dean Burn, including enhancements to in-channel habitat, riparian zone and morphological diversity of the bed and/or banks. Would provide slight improvement on baseline conditions with potential to improve flow processes at the reach scale.	Minor	Medium	Slight Beneficial	RDWE-3	Slight Beneficial
General Groundwater - Groundwater Quality						
Construction	The use of grout in mine working treatment areas, including these coal seams, or as part of other below ground structures, could impact the groundwater quality either as a result of chemical leaching. Displacement of groundwater from voids along the grouted coal seams will occur. It is likely that any groundwater within these seams is already of poor quality; however, water quality within the coal seams has not been explicitly monitored.	Negligible	Medium	Slight Adverse	RDWE-2, RDWE-7, RDWE-8	Neutral
	Discharge of surface run-off with a high concentration of suspended solids from dewatering of excavations, has the potential to impact on the quality of groundwater.	Moderate	Medium	Moderate Adverse	RDWE-2, RDWE-7, RDWE-8	Neutral
Operation	With the inclusion of filter drains and SuDS retention basins, there would be a reduced risk of a negative effect occurring in terms of water quality, due to the ability of the proposed treatment system (where none currently exists) to attenuate flow, limit the discharge rate from the outfalls (to increase in-river dilution), to reduce the pollutant concentration through in-basin treatment, and reduce existing spillage risk.	Negligible	Medium	Neutral	-	Neutral

Receptor	Predicted Impacts	Magnitude of Impact	Sensitivity of Feature	Scale of Effect (pre-mitigation)	Mitigation Measures	Residual Effects
	As there would be no direct discharges to groundwater with the proposed drainage design, no 'point of entry' would exist and thus the SPR linkage is not complete. As such, there is no risk to groundwater from routine highway runoff.	Negligible	Medium	Neutral	-	Neutral
	As there would be no direct discharges to ground with the Proposed Scheme, there is no requirement to undertake a quantitative assessment of the risk of pollution impacts from accidental spillages to groundwater.	Negligible	Medium	Neutral	-	Neutral
General Groundwater – Groundwater Flow						
Construction	Grouting also has the potential to disrupt and/or act as a barrier to local groundwater flow. This may lead to a diversion of groundwater flow either under or around the grouted zones. Typically, groundwater would be expected to rise locally on the upstream side of the grouted areas and to be lower on the downstream side of the grouted areas. There is also the potential for contaminated groundwater to be mobilised towards local surface water features, such as the River North Esk or Dean Burn, or to the surface via grout treatment holes and untreated mine entrances.	Minor	Medium	Slight Adverse	RDWE-2, RDWE-7, RDWE-8	Slight Adverse
Superficial Esk Valley Sand and Gravel Aquifer - Groundwater Quality						
Construction	Deterioration in groundwater quality of the superficial aquifers resulting from spillages and leaks of fuels and chemicals from bulk storage, vehicle and plant usage and the associated contaminated surface run-off.	Minor	Medium	Slight Adverse	RDWE-2, RDWE-5	Neutral
Operation	Retaining walls and foundations for the NMU routes are only proposed to extend into the overlying superficial deposits, potentially causing changes to superficial groundwater conditions but not affecting the groundwater conditions in the bedrock aquifer.	Negligible	Medium	Neutral	RDWE-2, RDWE-7	Neutral
Superficial Esk Valley Sand and Gravel Aquifer - Groundwater Flow						
Construction	Piling and excavations, associated with the scheme's engineering works, also have the potential to impact on superficial groundwater flow locally.	Minor	Medium	Slight Adverse	-	Slight Adverse
Operation	Groundwater in the superficial deposits have been monitored at a higher level than the completed levels of parts of the Proposed Scheme and it is therefore assumed that superficial deposits may require permanent dewatering locally for operation. Impacts on groundwater flow are expected to be localised. Permanent piling associated with the	Minor	Medium	Slight Adverse	-	Slight Adverse

Receptor	Predicted Impacts	Magnitude of Impact	Sensitivity of Feature	Scale of Effect (pre-mitigation)	Mitigation Measures	Residual Effects
	scheme's engineering works also have the potential to impact on superficial groundwater flow locally					
Dalkeith Bedrock and Localised Sand and Gravel Aquifer - Groundwater Quality						
Construction	Deterioration in groundwater quality of the bedrock aquifers resulting from spillages and leaks of fuels and chemicals from bulk storage, vehicle and plant usage and the associated contaminated surface run-off.	Minor	Medium	Slight Adverse	RDWE-2, RDWE-5	Neutral
Operation	Piling will penetrate through the overlying superficial deposits and at least 6m into competent layers of the bedrock aquifer. Where located below the bedrock water table, the pilings will act as a low permeability barrier to groundwater flow and may cause change to groundwater levels, flow rates and flow directions. Where the piles terminate above the bedrock groundwater level, there will be no impacts to groundwater flow and negligible impacts on groundwater quality. The placement of grout in the piles may impact on groundwater quality, as there will be direct contact between the grout and the groundwater.	Negligible	Medium	Slight Adverse	RDWE-2, RDWE-7, RDWE-9	Slight/Neutral Adverse
Dalkeith Bedrock and Localised Sand and Gravel Aquifer - Groundwater Flow						
Construction & Operation	The Proposed Scheme's deep engineering works, specifically deep piling and the grouting of mine workings, have the potential to impact on the flow of groundwater in the bedrock aquifer. Contamination of bedrock groundwater from surface activities is also possible via pathways from mine workings. Excavation of the bedrock aquifer is not expected to be required.	Minor	Medium	Slight Adverse	RDWE8, RDWE-9	Slight Adverse
	The Proposed Scheme's deep engineering works, specifically deep piling and the grouting of mine workings, have the potential to impact more significantly on the flow of groundwater in the bedrock aquifer nearest the grouting works. Contamination of bedrock groundwater from surface activities is also possible via pathways from mine workings. Excavation of the bedrock aquifer is not expected to be required.	Moderate	Medium	Moderate Adverse	RDWE8, RDWE-9	Slight Adverse
Floodplain						
Construction	Surface run-off and site drainage during construction may result in degradation of surface water quality. Temporary dewatering of the superficial deposits and possibly the Coal Measures may result in changes to groundwater/surface water interactions and a deterioration in surface water quality. Mobilisation and discharge of contaminated groundwater in the Coal Measures aquifer, as a result of the piling and grouting operations, may impact on the quality and flow of surface water bodies.	Negligible	Medium	Slight Adverse	-	Neutral

Receptor	Predicted Impacts	Magnitude of Impact	Sensitivity of Feature	Scale of Effect (pre-mitigation)	Mitigation Measures	Residual Effects
Operation	Compensatory floodplain would be at a level similar to that lost to the Proposed Scheme, thus would not introduce flooding to adjacent land or properties.	Negligible	Medium	Slight Adverse	-	Neutral
Road Drainage						
Operation	SuDS retention basins shall be utilised upstream of all proposed road drainage outfalls to reduce the impact of the Proposed Scheme drainage waters on the Dean Burn. There will be very little change in terms of the large sections of field that currently drain beneath the A720 other than pre-earthworks drainage being installed to convey land runoff/intercept existing land drainage.	No Change	Medium	Neutral	-	Neutral
	Compensatory storage is required as part of the design as functional floodplain storage will be lost due to SuDS allocation and encroachment of road embankments. Land reprofiling to create this required storage will be provided in three separate locations.	No Change	Medium	Neutral	-	Neutral

11.9 Compliance with Policies and Plans

11.9.1 As noted previously, two key pieces of legislation, namely; the EU Directive 2000/60/EC Water Framework Directive (WFD) transposed into the Water Environment and Water Services Act (Scotland) 2003 and The Water Environment (Controlled Activities) (Scotland) Regulations 2011 [as amended] regulate the water environment aspects for development of this nature. This legislation 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.

11.9.2 The Proposed Scheme would comply with the requirements of this legislation by facilitating two levels of treatment (filter drains and SuDs Ponds) for road drainage before discharge into the Dean Burn. As demonstrated through the assessment of operational impacts, this shall help to prevent further deterioration and serve to protect the Dean Burn through progressive reduction of discharges, emissions and losses of priority substances through treatment, discharge and settlement efficiencies.

11.9.3 Furthermore, the planform of the low flow channel of the Dean Burn would be developed to mimic the tight bends seen in upstream sections, which display morphological diversity and include riffle features at strategic locations to create the expected features and to ensure no disruption to sediment transport continuity following construction. A two-stage channel design would also allow for some enhancement of the watercourse where it has been canalised and straightened historically. This would provide enhancements over existing conditions and improvement of the aquatic environment.

11.9.4 The capacity of the Dean Burn channel would be designed to match the existing channel so as not to increase flood risk and the planform of the low flow channel would be proportioned to convey approximately the 1-in-2-year flow and a wider channel above this to convey higher flood flows. The bed features introduced to the diverted channel would be sustainable within the low flow channel and the flood flows would be contained in the wider channel area. Furthermore, compensatory floodplain would be at three locations in the vicinity of the Dean Burn at a level similar to that lost to the Proposed Scheme, would not introduce flooding to adjacent land or properties, thus contributing to mitigating the effects of flooding.

11.9.5 The Proposed Scheme would also ensure the progressive reduction of groundwater pollution and prevention of further pollution, as all SuDS basins would be lined with either a natural (depending upon availability of suitable clay on-site) or artificial synthetic impermeable liner/membrane to restrict the movement of contaminants into the deeper soil layers over time and to the groundwater. This shall also protect from groundwater ingress.

11.9.6 These design elements are fundamentally critical to compliance with the range National Policy and Guidance, Regional Policy and Local Policy as set out in Section 11.3 of this chapter.

11.10 Statement of Significance

11.10.1 No moderate (or greater) significant residual effects are anticipated after taking into account the mitigation measures with the Proposed Scheme.

11.11 Monitoring

11.11.1 No significant effects are predicated and on that basis no monitoring is required.

11.12 References

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