

10 Geology, Soils and Groundwater

10.1 Introduction

- 10.1.1 This chapter presents the results of the geology, soils and groundwater assessment undertaken as part of the Design Manual for Roads and Bridges (DMRB) Stage 3 Environmental Impact Assessment (EIA) for Project 7 – Glen Garry to Dalwhinnie of the A9 Dualling Programme, hereafter referred to as the Proposed Scheme, described in **Chapter 5**.
- 10.1.2 This includes assessment of potential impacts related to superficial and solid geology, designated geological sites, geodiversity features, mineral extraction, soils, potential contamination sources, groundwater and associated receptors, including Groundwater Dependent Terrestrial Ecosystems (GWDTE), groundwater abstractions and private water supplies (PWS).
- 10.1.3 The assessment is supported by the following appendices presented in **Volume 2**:
- **Appendix 10.1:** Peat Survey Information
 - **Appendix 10.2:** Groundwater Dependent Terrestrial Ecosystems
 - **Appendix 10.3:** Groundwater Abstractions and Private Water Supplies
 - **Appendix 10.4:** Potential Contamination Sources
 - **Appendix 10.5:** Preliminary Peat Landslide Risk Assessment
 - **Appendix 10.6:** Outline Peat Management Plan
- 10.1.4 Supporting considerations related to the assessment have also been addressed separately within **Chapter 8**, **Chapter 11** and **Chapter 12**, and associated appendices in **Volume 2**, with regards agricultural land use, ecology, hydrology, fluvial geomorphology, drainage and flooding. National and local planning policies which are relevant to geology, soils and groundwater are described in **Chapter 19**, together with an assessment of the Proposed Scheme compliance against these.

10.2 Approach and Methods

Scope and Guidance

- 10.2.1 This EIA has been undertaken using the guidance in DMRB Volume 11 Section 3 Part 11 '*Geology and Soils*' (The Highways Agency *et al.*, 1993), taking account of updated guidance on contaminated land in '*CLR11 – Model Procedures for the Management of Land Contamination*' (Environment Agency, 2004) where appropriate, and DMRB Volume 11 Section 3 Part 10 HD 45/09 '*Road Drainage and the Water Environment*' (The Highways Agency *et al.*, 2009).
- 10.2.2 Consideration of soil includes potential impacts in terms of conservation value and potential impacts on peat and peaty soils. Potential agricultural productivity of the soils is also considered, though impacts in relation to general agricultural land use interests and land-take are assessed in **Chapter 8**. Made ground is included in the assessment of potential contamination sources, while earthworks volumes and 'cut and fill balance' of the Proposed Scheme is described in **Chapter 5**.

- 10.2.3 For groundwater, the assessment considers potential impacts on quality, level, flow, GWDTE and groundwater-related changes to surface water, groundwater abstractions and PWS. Impacts in relation to fluvial geomorphology, surface water quality and flooding are assessed in **Chapter 11**.

Study Area

- 10.2.4 The assessment covers a study area extending to 250m from the permanent and temporary works boundaries of the Proposed Scheme. For GWDTE, the study area extends to at least 100m from the permanent and temporary works boundaries, and up to 250m where required.
- 10.2.5 Impacts on groundwater abstractions and PWS have been assessed to a distance of 850m from the permanent and temporary works boundaries of the Proposed Scheme. This was considered to correspond to the minimum study areas applied for groundwater abstractions under The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR).

Baseline Data Collection

- 10.2.6 Baseline conditions described cover the following aspects:
- Superficial and solid geology
 - Designated geological receptors and features of geodiversity interest
 - Mineral extraction
 - Soils and peat
 - Groundwater and associated receptors, including GWDTE, abstractions and PWS
 - Potential contamination sources.
- 10.2.7 Baseline conditions were determined through desk-based data assessments, consultation with statutory and non-statutory bodies and landowners, ground investigations and field surveys.

Desk-based Assessment

- 10.2.8 The desk-based assessment included a review of the following information:
- Ordnance Survey (OS) historical maps (sourced from Envirocheck Reports) dating back to 1856 for information on former land use, potential contamination and information on PWS
 - British Geological Survey (BGS) data including BGS Geological Maps, BGS Hydrogeological and Groundwater Vulnerability Maps, BGS borehole logs and BGS publications
 - James Hutton Institute (JHI) published soil maps, thematic data and derived information, including the National Soil Map of Scotland (1981)
 - Scottish Environment Protection Agency (SEPA) Groundwater Vulnerability Maps, interactive River Basin Management Plan map and Scottish Wetland Inventory
 - Scottish Natural Heritage (SNH) designation database (SNH, 2016a) and Carbon and Peatland Map (SNH, 2016b)
 - Previous assessments and information, including the Strategic Environmental Assessment (SEA) and Addendum Reports for the A9 Dualling Programme (Transport Scotland, 2013 and

2014a), DMRB Stage 1 Preliminary Engineering Services Report (Transport Scotland, 2014b) and Geotechnical Preliminary Sources Study Report (PSSR) (CFJV, 2016)

Field Surveys

10.2.9 Several site walkovers were conducted by the CH2M Fairhurst Joint Venture (CFJV) to obtain information on the baseline geology, soil, groundwater, potential contamination conditions and PWS locations where possible. These were also supplemented by the following field surveys:

- Phase 1 Habitat Surveys (CH2M, June to September 2014)
- Preliminary ecological peat probing surveys (CFJV, August 2014)
- National Vegetation Classification (NVC) Surveys (MacArthur Green, June to July 2015)
- Detailed peat probing and sampling surveys (CFJV, July to August and December 2016).

Consultations

10.2.10 Consultations were undertaken with the following:

- Cairngorms National Park Authority (CNPA), Perth and Kinross Council (P&KC) and The Highland Council (THC) for information on potential contamination sources and PWS
- SEPA for information on groundwater abstractions and potential contaminated land uses
- SNH for information on the location, extent and boundaries of environmental sensitivities and geodiversity features in the vicinity of the Proposed Scheme
- HighWater (Scotland) Ltd and private landowners/ residents via questionnaire, for additional information on groundwater abstractions or PWS, their source, location, type and use.

Ground Investigations

10.2.11 Intrusive ground investigations (GI) were conducted by Raeburn Drilling and Geotechnical Ltd (Raeburn) between August and December 2015 (Advanced GI) and between December 2016 and April 2017 (Preliminary GI). Both phases of work consisted of boreholes, trial pit excavations and peat depth probes across the Proposed Scheme area, in addition to groundwater and ground gas monitoring, and selected chemical testing of soil, groundwater and surface water samples.

10.2.12 The results of the Advanced and Preliminary GI are presented in the '*A9 Dualling – Glen Garry to Dalraddy, Project 7 Glen Garry to Dalwhinnie Report on Ground Investigation*' (Raeburn, March 2017) and '*A9 Dualling – Glen Garry to Dalwhinnie Project 7, Report on Preliminary Ground Investigation*' (Raeburn, June 2017), respectively.

Impact Assessment

10.2.13 The impacts in relation to geology, soils, groundwater and potential contamination have been assessed individually as per the methodologies provided below. The criteria outlined are based on those that have been applied to similar schemes in Scotland and are designed to comply with DMRB Stage 3 EIA requirements.

Geology and Soils

10.2.14 For superficial and solid geology, soils, designated geological receptors, features of geodiversity interest and mineral extraction, the sensitivity and magnitude criteria in **Table 10-1** and **Table 10-2** were applied. The impact significance was then determined using **Table 10-3**.

10.2.15 In relation to soils and peat, the criteria for defining sensitivity has initially been informed based on environmental designations, SNH priority peatland and Land Capability for Agriculture (LCA) categories but refined based on field survey data where possible. Soil conservation value is recognised based on rarity, representivity and diversity within the Cairngorms National Park (CNP) context (Towers *et al.*, 2005), with overall functional value afforded indirect cross-topic consideration in the context of potential ecology, geodiversity and carbon storage impacts.

Table 10-1: Sensitivity Criteria for Geology and Soils

Sensitivity	Assessment Criteria
High	<p>Areas containing geological or geomorphological features considered to be of a national interest such as Sites of Special Scientific Interest (SSSI), candidate SSSI or Geological Conservation Review (GCR) sites</p> <p>Presence of extensive areas of economically important minerals valuable as a national resource</p> <p>Presence of high quality topsoil or soils (typically indicated by LCA Class 1 and Class 2)</p> <p>Areas of peatland within designated sites such as SSSI, Special Area of Conservation (SAC) or Special Protection Area (SPA) with national or European importance and/ or SNH priority peatland Class 1 (nationally important carbon-rich and peaty soils, deep peat and priority peatland habitat likely to be of high conservation value) and Class 2 (nationally important carbon-rich and peaty soils, deep peat and priority peatland habitat likely to be of potentially high conservation value and restoration potential)</p>
Medium	<p>Areas containing geological features of designated regional importance considered worthy of protection for their educational, research, historic or aesthetic importance, such as Local Geodiversity Sites (LGS)/ Regionally Important Geological Sites (RIGS) of national/ regional importance</p> <p>Presence of areas of economically important minerals of regional value</p> <p>Presence of medium quality topsoil or soils (typically indicated by LCA Class 3 and Class 4)</p> <p>SNH priority peatland Class 3 (dominant vegetation cover is not priority peatland habitat but is associated with wet and acidic type. Occasional peatland habitats can be found. Most soils are carbon-rich and peaty soils, with some areas of deep peat)</p>
Low	<p>Sites and geological features not currently identified as SSSI, GCR or LGS/ RIGS but that may require protection in the future</p> <p>Presence of mineral areas or resource of local importance only</p> <p>Presence of low quality topsoil or soils (typically indicated by LCA Class 5 and Class 6)</p> <p>SNH priority peatland Class 5 (soil information takes precedence over vegetation data and there is no peatland habitat recorded, but all soils are carbon-rich and peaty soil and deep peat)</p>
Negligible	<p>Geological features not currently protected and unlikely to require protection in the future</p> <p>No exploitable minerals or geological resources</p> <p>Presence of very low quality topsoil or soils (typically indicated by Land Capability for Agriculture Class 7)</p> <p>SNH priority peatland Class 4 (areas unlikely to be associated with peatland habitats or wet and acidic type, and unlikely to include carbon-rich or peat soils), Class 0 (mineral soils where peatland habitats are not typically found), Class -1 (unknown soil types) and Class -2 (non-soil (i.e. loch, built up area, rock and scree))</p>

Table 10-2: Impact Magnitude Criteria for Geology and Soils

Magnitude	Assessment Criteria
Major	<p>Partial (greater than 50%) or total loss of a geological site or mineral deposit, or where there would be complete severance of a site such as to affect the value of the site/ resource</p> <p>Major or total loss of topsoil, soils or peatland, or where the value of the area would be severely affected</p>
Moderate	<p>Loss of part of a geological/ geodiversity site or mineral deposit, major severance, major effects to the setting, or disturbance such that the value of the site would be affected, but not to a major degree</p> <p>Partial loss of topsoil, soils or peatland, or where the value of the area would be affected, but not to a major degree</p>
Minor	<p>Small effect on a geological/ geodiversity site or mineral deposit (up to 15%) or a medium effect on its setting, or where there would be a minor severance or disturbance such that the value of the site would not be affected</p> <p>Partial loss of topsoil, soils or peatland, or where soils will be disturbed but the value of the area would not be affected</p>
Negligible	<p>Very slight change from geological, mineral and soil baseline conditions</p>

Table 10-3: Matrix for Determination of Impact Significance for Geology and Soils

Sensitivity	Magnitude			
	Major	Moderate	Minor	Negligible
High	Large	Moderate/ Large	Moderate	Slight
Medium	Moderate/ Large	Moderate	Slight/ Moderate	Neutral/ Slight
Low	Moderate	Slight/ Moderate	Neutral/ Slight	Neutral
Negligible	Slight	Neutral/ Slight	Neutral	Neutral

Groundwater

- 10.2.16 For groundwater, the assessment considers sensitivity in the context of the known or anticipated hydrogeological conditions, including potential groundwater receptors. The sensitivity and magnitude criteria for this are shown in **Table 10-4** and **Table 10-5** respectively. The impact significance was then determined using the matrix as shown in **Table 10-6**.
- 10.2.17 The criteria for defining the magnitude of impact on the quality, level and flow of groundwater is based primarily on the type of proposed road profile (cutting, widening or embankment) facing the receptor, vulnerability of the groundwater to disruption and estimates of drawdown and potential zones of dewatering influence in accordance with 'CIRIA C750 Groundwater Control: Design and Practice, Second Edition' (CIRIA, 2016) using the Scharadt formula (Powers *et al.*, 2007). Impacts on the quality, level and flow of groundwater may also have effects on GWDE, surface water, groundwater abstractions and PWS.
- 10.2.18 For GWDE, the sensitivity criteria have been informed based on analysis of NVC Survey findings (MacArthur Green, 2015) against 'LUPS-GU31 Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and GWDE (Version 2)' (SEPA, 2014a). These were used to identify NVC communities as 'potentially' groundwater dependent, but with additional hydrogeological and ecological consideration of 'likely' dependency undertaken to refine this.

Table 10-4: Sensitivity Criteria for Groundwater

Sensitivity	Assessment Criteria
Very High	Groundwater aquifer(s) with very high productivity or Water Framework Directive (WFD) good groundwater quality and quantity status Exploitation of groundwater resource is extensive for public, private domestic and/ or agricultural use (i.e. feeding ten or more properties) and/ or industrial supply Important sites of nature conservation dependent on groundwater as per importance criteria attributed in Chapter 12 or groundwater is considered likely to support wetland vegetation which is highly groundwater dependent Surface water features with hydrological importance to designated sensitive ecosystems of national/ international importance
High	Groundwater aquifer(s) with moderate/ high productivity or WFD good groundwater quality and quantity status Exploitation of groundwater resource is not extensive (i.e. private domestic and/ or agricultural supply feeding less than ten properties) Local areas of nature conservation dependent on groundwater as per importance criteria attributed in Chapter 12 , or groundwater is considered likely to support wetland vegetation which is moderately groundwater dependent Surface water features with hydrological importance to sensitive ecosystems of regional importance
Medium	Groundwater aquifer(s) with low productivity or WFD variable groundwater quality and quantity status No current known exploitation of groundwater as a resource and aquifer(s) properties make potential exploitation appear unlikely Minor areas of nature conservation with a degree of groundwater dependency, as per importance criteria attributed in Chapter 12 Surface water features with some but limited hydrologic importance to sensitive or protected ecosystems of authority area importance

Sensitivity	Assessment Criteria
Low	Groundwater aquifer(s) with very low productivity or WFD poor groundwater quality and quantity status No known past or present exploitation of groundwater aquifer(s) as a resource Areas of vegetation with no groundwater dependency Surface water features with minimal/ insignificant hydrological importance to sensitive ecosystems of less than authority area importance

Table 10-5: Impact Magnitude Criteria for Groundwater

Magnitude	Assessment Criteria
Major	Major or long term change to groundwater aquifer(s) flow, water level, quality or available yield Groundwater resource use is irreparably impacted upon, with a major or total loss of an existing supply or supplies Changes to water table level or quality would result in a major or total change in or loss of a groundwater dependent area, where the value of a site would be severely affected Changes to groundwater aquifer(s) flow, water level and quality would result in major changes to groundwater base flow contributions to surface water and/ or alterations in surface water quality, resulting in a major shift away from baseline conditions such as change to WFD status
Moderate	Moderate changes to groundwater aquifer(s) flow, water level, quality or available yield Groundwater resource use is impacted slightly, but existing supplies remain sustainable Changes to water table level or quality would result in partial change in or loss of a groundwater dependent area, where the value of the site would be affected, but not to a major degree Changes to groundwater aquifer(s) flow, water level and quality would result in moderate changes to groundwater base flow contributions to surface water and/ or alterations in surface water quality, resulting in a moderate shift from baseline conditions that may be long-term or temporary
Minor	Minor changes to groundwater aquifer(s) flow, water level, quality or available yield Changes to water table level, quality and yield result in little discernible change to existing resource use Changes to water table level or quality would result in minor change to groundwater dependent areas, but where the value of the site would not be affected Changes to groundwater aquifer(s) flow, water level and quality would result in minor changes to groundwater base flow contributions to surface water and/ or alterations in surface water quality, resulting in a minor shift from baseline conditions (equivalent to minor but measurable change within WFD status)
Negligible	Very slight change from groundwater baseline conditions, approximating to 'no change' conditions.

Table 10-6: Matrix for Determination of Impact Significance for Groundwater

Sensitivity	Magnitude			
	Major	Moderate	Minor	Negligible
Very High	Very Large	Large/ Very Large	Moderate/ Large	Neutral
High	Large/ Very Large	Moderate/ Large	Slight/ Moderate	Neutral
Medium	Large	Moderate	Slight	Neutral
Low	Slight/ Moderate	Slight	Neutral	Neutral

Potential Contamination

- 10.2.19 The assessment of potential contamination has focused on the potential for impacts on receptors as a direct consequence of the Proposed Scheme encountering contamination, within the context of a preliminary conceptual site model (CSM). A receptor can be a person (construction or maintenance workers, road users or local residents), the water environment (groundwater and surface water features), ecological receptors (GWDTE, agricultural land or livestock) and/ or property receptors (structures, buried concrete, services and PWS).
- 10.2.20 The preliminary CSM represents an outline of potential 'pollutant linkages' (PL) that may be present between a source of contamination, pathways by which it may move and ultimately, affected receptors. Should any element of that linkage (contaminant, pathway or receptor) be

missing or removed, the contamination is considered unlikely to represent a potential risk or impact. The potential receptors and pathways were compiled based on the definitions in Part IIA of the Environmental Protection Act 1990, as provided in the Statutory Guidance (Scottish Executive, 2006).

10.2.21 Potential contamination sources are identified in the baseline information and the pollutant pathways and receptors used within the assessment of these are provided in **Table 10-7**, with individual references for each linkage, PL1 to PL24, during construction and operation.

Table 10-7: Potential Pollutant Linkages for Potential Contamination

Pollutant Linkage	Receptor	Pathway
Construction		
PL1	Human Health (construction workers)	Ingestion, inhalation and dermal contact with soil, soil dust and fibres (asbestos), deep and shallow groundwater and surface water
PL2		Migration of ground gases into shallow pits or site buildings
PL3	Human Health (local residents and transient traffic (foot, road and rail)) Property (Scheduled Monuments (SM), buildings)	Ingestion, inhalation and dermal contact with wind-blown dust created during excavation works
PL4		Migration of ground gases into homes or workplaces through preferential pathways created during construction posing a potential asphyxiation/ explosion risk
PL5	Water Environment (superficial groundwater)	Leaching and migration of contaminants
PL6	Water Environment (bedrock groundwater)	Migration of contaminants or contaminated shallow groundwater into the deeper rock aquifer
PL7	Water Environment (surface water) Ecological Receptors (GWDTE) Property (PWS and services)	Migration/ mobilisation of contaminated shallow groundwater through drift deposits or made ground
PL8	Water Environment (surface water)	Runoff from contaminated source(s)
PL9		Migration of contaminated bedrock groundwater towards surface water receptor
PL10		Discharge of intercepted contaminated groundwater during passive or active dewatering
PL11	Ecological receptors (agricultural land/ livestock)	Inhalation, ingestion and direct contact with contaminated soils, soil dust, fibres (asbestos) and water
PL12	Property (SM, buried concrete and services)	Direct contact with made ground, superficial deposits, groundwater and bedrock materials
Operation		
PL13	Human Health (maintenance workers)	Ingestion, inhalation and dermal contact with soil, soil dust, fibres (asbestos), deep and shallow groundwater, surface water in the long-term during routine maintenance e.g. drainage inspections
PL14		Migration of ground gases into confined spaces e.g. service pits, accommodation buildings creating an asphyxiation/ explosion risk
PL15	Human Health (local residents and transient traffic (foot, road and rail)) Property (SM and buildings)	Ingestion, inhalation and dermal contact with wind-blown dust from contaminated soils re-used within road features such as embankments and landscaped areas
PL16		Migration of ground gases into homes or workplaces through preferential pathways remaining following construction thus posing a potential asphyxiation/ explosion risk
PL17	Water Environment (superficial groundwater)	Leaching and migration of contaminants
PL18	Water Environment (bedrock groundwater)	Migration of contaminated shallow groundwater into the deeper rock aquifer

Pollutant Linkage	Receptor	Pathway
PL19	Water Environment (surface water) Ecological Receptors (GWDTE) Property (PWS and services)	Migration of shallow groundwater through drift deposits or made ground
PL20	Water Environment (surface water)	Runoff from contaminated source(s)
PL21		Migration of contaminated shallow groundwater through drainage channels and associated granular bedding materials or engineered structures
PL22		Discharge of intercepted contaminated groundwater
PL23	Ecological receptors (agricultural land/ livestock)	Inhalation, ingestion and direct contact with contaminated soils/ water
PL24	Property (buried concrete and services)	Direct contact with made ground, superficial deposits, groundwater and bedrock materials

10.2.22 For the purposes of this assessment, the preliminary CSM has disregarded those pollutant linkages that are incomplete and cannot pose a risk to identified receptors. Where a complete pollutant linkage exists, a generic qualitative risk assessment has been undertaken.

10.2.23 The output of the assessment cannot be reported in terms of ‘sensitivity’. Instead, it is reported as the ‘likelihood’ of a complete pollutant linkage being present, which is defined within CIRIA C552 ‘Contaminated Land Risk Assessment: A Guide to Good Practice’ (CIRIA, 2001), ‘CLR11 – Model Procedures for the Management of Land Contamination’ (EA, 2004) and summarised in **Table 10-8**. The magnitude, or consequence, of the effect on likely receptors is outlined in **Table 10-9** and overall risk (significance), taking account of both likelihood and consequence, is identified with reference to the matrix in **Table 10-10**.

Table 10-8: Likelihood Criteria for Potential Contamination

Likelihood	Assessment Criteria
High Likelihood	There is a complete pollution linkage and an event that either appears very likely in the short-term and almost inevitable over the long-term, or there is evidence at the receptor of harm or pollution
Likely	There is a complete pollution linkage and all the elements are present and available, which means that it is probable that an event will occur Circumstances are such that an event is not inevitable, but possible in the short-term and likely over a long-term
Low Likelihood	There is a complete pollution linkage and the circumstances are possible under which an event could occur However, it is by no means certain that even over a longer period such an event would take place, and is less likely in the shorter term
Unlikely	There is a complete pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long-term

Table 10-9: Impact Magnitude (Consequence) Criteria for Potential Contamination

Consequence	Assessment Criteria
Severe	Short-term (acute) damage to human health (significant harm) Pollution of sensitive water resources as a result of short-term exposure Damage to a particular ecosystem as a result of acute exposure Catastrophic damage to buildings/ property/ services/ SM
Medium	Long-term (chronic) damage to human health (significant harm) Pollution of sensitive water resources as a result of chronic exposure A significant change in a particular ecosystem, or organism forming part of such an ecosystem Substantial damage to buildings/ property/ services/ SM

Consequence	Assessment Criteria
Mild	No appreciable impact on human health based on the potential effects on the critical human health receptor Pollution of non-sensitive water resources Damage to ecological systems with no significant impairment Significant damage to sensitive buildings/ structures/ SM/ services or the environment
Minor	Harm (not necessarily significant), which may result in financial loss or require expenditure to resolve Non-permanent health effects to human health No appreciable pollution Easily repairable effects or damage to ecological systems Easily repairable damage to buildings, structures, SM and services

Table 10-10: Matrix for Determination of Impact Significance (Risk) for Potential Contamination

Consequence	Likelihood			
	High likelihood	Likely	Low likelihood	Unlikely
Severe	Very high	High	Moderate	Moderate/ Low
Medium	High	Moderate	Moderate/ Low	Low
Mild	Moderate	Moderate/ Low	Low	Very Low
Minor	Moderate/ Low	Low	Very Low	Very low

Limitations to Assessment

- 10.2.24 Information obtained from both the Advanced and Preliminary GI works has been used in the assessment. In areas where no data is available, geological and hydrogeological information has been extrapolated or used from the nearest available data points. Groundwater monitoring for the Preliminary GI is scheduled for completion by April 2018. Monitoring results available from between April and August 2017 have been taken into account in the assessment.
- 10.2.25 Groundwater abstraction and PWS features have been identified based on information supplied by P&KC, THC, SEPA, HighWater (Scotland) Ltd, landowner consultations, historical or current mapping and site walkovers (CFJV, 2017). Additional consultation regarding some supplies may be required as part of pre-construction activities.
- 10.2.26 In certain conditions, groundwater dewatering effects have the potential to cause differential ground settlement. This is a geotechnical consideration, outwith the scope of this assessment. However, mitigation is included for a detailed assessment of this to be completed prior to construction in areas of excavation located nearby existing infrastructure, properties or structural cultural heritage receptors. This assessment will be supported by the complete groundwater monitoring dataset from the Preliminary GI, as well as additional data from Detailed GI scheduled for completion in 2018.
- 10.2.27 The identification of potential contamination sources has been reliant on the accuracy of historical mapping and available GI information. Potential sources not encountered during GI or identified through desk-based assessment and consultation are not reported. The assessment of historical quarrying activity has also been based on desk-based review of historical mapping. It is possible that quarrying works could have been undertaken and the void backfilled between the recorded years of mapping, such that no map evidence exists.

10.3 Baseline Conditions

Geology

- 10.3.1 As shown in **Drawing 10.1** in **Volume 3** of this report, published BGS mapping indicates superficial deposits within the study area to variably include till, hummocky (moundy) glacial deposits, head, talus, alluvial fan, alluvium, river terrace deposits and peat.
- 10.3.2 The solid geology comprises Precambrian Psammite of the Gaick Psammite Formation; recorded as predominantly quartzose psammite with scattered biotite flakes and laminae, as shown in **Drawing 10.2 (Volume 3)**. BGS mapping also records the Grampian Group (locally arkosic psammite with subsidiary semipelite to pelite), several areas of faulting and local Ordovician and Siluro-Devonian igneous intrusions (microdiorite, microgranite, felsite and pegmatite) that cross or outcrop beneath or adjacent to the existing carriageway.
- 10.3.3 These conditions have broadly been substantiated by GI information, as summarised below. Findings in relation to peat are described in **Appendix 10.1 (Volume 2)** and the soils sub-section.

Made Ground

- 10.3.4 Made ground has been encountered at several locations across the Proposed Scheme extent. The materials ranged from 0.05 to 3.50m in thickness, and were described to vary between clayey, silty or peaty sand, clayey silty, sandy or gravelly topsoil and sand and gravel with low cobble and boulder content. Areas of tarmac and bituminous material were also recorded.
- 10.3.5 Extraneous material fragments including wood, timber, rubber, brick, rope, tarmac, plastic, metal, fabric and glass were occasionally observed, with organic traces, organic odours and hydrocarbon odours in seven locations; including areas at Dalnaspidal (ch. 325), the Pass of Drumochter (ch. 2,900, ch. 4,500 and ch. 6,100), Balsporran (ch. 6,900) and Drumochter Lodge (ch. 7,650). Possible made ground was also observed in three locations as clayey sandy slightly gravelly topsoil and gravelly sand with some organic and boulder content between ground level and 1.60m. These were noted to be indicative of possible landslips at locations northward of Dalnaspidal (ch. 800 and ch. 1,100).
- 10.3.6 Based on **Table 10-1**, made ground is considered to be of **negligible** sensitivity. However, each occurrence has been reviewed and incorporated as a potential contamination source in **Appendix 10.4 (Volume 2)** and their locations are shown in **Drawings 10.31 to 10.37 (Volume 3)**.

Superficial Geology

- 10.3.7 Superficial deposits identified from available GI include alluvium (underlying the River Truim and Allt Dubhaig floodplains and various watercourses) and alluvial fans (fanning out from watercourses including Allt Coire Chuirn, Allt Coire Mhic Sith and Allt an Creagach). Alluvium deposits were described to vary between silty, gravelly, fine to medium and fine to coarse sand and gravel, with variable cobble and boulder content. Alluvial fans were encountered in central portions of the Proposed Scheme near Balsporran and northward past Drumochter Lodge; described as silty, clayey and gravelly fine to coarse sand and sandy fine to coarse gravel with variable cobble content and locally, organic materials including roots and traces of peat.
- 10.3.8 Glacial deposits including hummocky glacial deposits and till, were also observed throughout the study area. These were predominantly recorded as granular, varying between silty or clayey and gravelly fine to medium and coarse sand with fine to coarse gravel, and clayey or silty sandy fine to coarse gravel, with variable cobble and boulder content, occasional pockets of peat and local

layers of sandy gravelly clay or sandy gravelly silt. The thickness of the alluvial and glacial superficial units varies from 2.80 to 19.00m, with the greater thicknesses generally being present to the west of the Proposed Scheme on the valley floor through the Pass of Drumochter and northward past Drumochter Lodge.

10.3.9 Mass movement deposits comprising head and blanket head were identified locally on the eastern side of the existing carriageway through the Pass of Drumochter. These were recorded to comprise silty fine to coarse sand and silty gravelly fine to medium sand with gravel and variable cobble content and occasional traces of peat. The thickness of the deposits was unconfirmed.

10.3.10 Based on **Table 10-1** and, with the exception of those associated with designated geological receptors and features of geodiversity interest, the superficial deposits are considered to be of **negligible** sensitivity.

Solid Geology

10.3.11 The available GI information has identified bedrock at depths between 2.80 and 19.00m below ground level (m bgl), but with bedrock close to or at the surface on the eastern side of the existing carriageway in central portions of the study area through the Pass of Drumochter and towards the north. The rock observed is predominantly composed of interlayered psammite, semi-pelite, quartzite and schist, with heavy fracturing and partial or distinct weathering. Granite also been encountered in the north of the study area near Allt Coire Chuirn, while intrusive bands of dolerite, pegmatite and granite were recorded between 4.55 and 14.10m bgl at Dalnaspidal and through the Pass of Drumochter.

10.3.12 Based on **Table 10-1**, solid geology in the study area is considered to be of **negligible** sensitivity.

Designated Geological Receptors and Features of Geodiversity Interest

10.3.13 The Allt Dubhaig GCR site lies within the study area and is the qualifying geological interest of the Drumochter Hills SSSI for fluvial geomorphology. Additional features of geodiversity interest include the Drumochter Hummocky Moraines, alluvial fan at Allt Coire Chuirn, an important pollen record site, the Drumochter debris cones and hillsides in the Pass of Drumochter. CFJV field visits (CFJV, 2016) have also identified three partial rock exposure areas on the existing A9.

10.3.14 Details of these features are provided below and shown in **Drawing 10.3 (Volume 3)**.

Allt Dubhaig

10.3.15 The Allt Dubhaig GCR site is located to the north west of Dalnaspidal Lodge between the Sow of Atholl and Highland Main Line (HML) railway, which forms its eastern boundary adjacent to the west of the Proposed Scheme, as illustrated in **Drawings 10.10 to 10.12 (Volume 3)**. The site is around 3km in length (between ch. 400 and ch. 2,950) and is between 250 and 650m in width across the floodplain associated with the Allt Dubhaig watercourse.

10.3.16 The Allt Dubhaig watercourse is an alluvial, gravel-bed channel that emerges from a mountain torrent (Allt Coire Dhomhain) through hummocky moraine drift, and flows south along the base of the Pass of Drumochter. South of Dalnaspidal Lodge, it flows into Loch Garry, the River Garry and ultimately, the River Tay. Across its length, minimal additional discharge from tributaries and no lateral input of sediment is received by the channel (Ferguson *et al.*, 1990; Werritty, 1997), though there is a close hydrological connection between the site and A9 via several watercourse crossings that pass under the existing carriageway and HML railway.

- 10.3.17 Local base-level control is exerted by a debris alluvial fan at the base of Allt Coire Mhic Sith near to the outflow of Loch Garry; causing the channel gradient to decline rapidly. This has generated a significant decrease in the size of the bed material, and progressive changes in channel planform in a downstream sequence toward this, from near braided to meandering to stable sinuous types, are evident (Werrity, 1997). The alluvial valley floor in the lower reaches of the watercourse is marshy and comprises silty sands and peat, with few signs of gravel beyond the base of Allt Coire Mhic Sith. The channel pattern toward Dalnaspidal Lodge here is also likely to have been influenced by a hydroelectric diversion sluice which is present and was built in 1935.
- 10.3.18 The Allt Dubhaig GCR is an example of a dynamic fluvial area, with the interests being progressive change in channel morphology and the unusual floodplain. The combination of a highly concave long profile, the absence of significant lateral inputs of water or sediment and historical field studies have unequivocally confirmed that size-selective transport is responsible for the rapid downstream fining of bed material (Werrity, 1997; Barron *et al.*, 2011). This is found in many rivers, but the Allt Dubhaig offers an ideal site within which the relative roles of this can be observed, studied and understood.
- 10.3.19 Based on **Table 10-1**, the Allt Dubhaig GCR site is considered to be of **high** sensitivity.
- Drumochter Hummocky Moraines*
- 10.3.20 As illustrated in **Drawings 10.10 to 10.16 (Volume 3)**, the lower slopes and edges of the valley bottoms through the Pass of Drumochter and across the Proposed Scheme extent are underlain by hummocky (moundy) glacial deposits and contain numerous examples of bouldery moraine that formed during the Loch Lomond Stadial (the period between deglaciation and the start of the Holocene). The moraines are associated with meltwater channels that were eroded parallel to ice margins and take the form of ridge fragments and mounds, which mark standstills in the glacial retreat.
- 10.3.21 Two main groups of moraine can be distinguished in the area based on previous studies (Lukas 2003; Lukas *et al.*, 2004) and field visits (CFJV, 2016); smaller ridges and mounds (5 to 20m wide, up to 150m long and up to 5m high) and larger ridges and mounds (up to 140m wide, 260m long and up to 10m high). Both are typically confined to the lowermost 50m of slopes, bordering the valley floors, and the length and abundance of moraine ridges usually increases upslope, with mounds dominating on steep slope sections.
- 10.3.22 The study area contains numerous examples of these features, and the indicative locations illustrated in **Drawings 10.10 to 10.16 (Volume 3)** have been informed through previous mapping of ridges, mounds and terraces (Lukas 2003; 2004). The moraines are of importance because the landform assemblage through the Pass of Drumochter is commonly cited to contain textbook examples of the hummocky moraine formed during the Loch Lomond Stadial, albeit their origin and age remain an active field of research (Barron *et al.*, 2011). Taken together, the features provide an important record of glacial recession across the district.
- 10.3.23 The Drumochter Hummocky Moraines have been identified as a candidate LGS (Barron *et al.*, 2011) and are therefore considered to be of **medium** sensitivity, based on **Table 10-1**.
- Allt Coire Chuirn Alluvial Fan*
- 10.3.24 A large alluvial fan is present underlying and adjacent to the north of the Proposed Scheme between ch. 7,850 and ch. 9,550 as illustrated in **Drawings 10.15 and 10.16 (Volume 3)**. The largest parts of the fan are situated within, or at the margins of, the Drumochter Hills SSSI, SAC and SPA, and appear to be associated with the Allt Coire Chuirn and Allt Coire Bhotie major

watercourse tributaries to the River Truim. The deposits extend both east and west from the existing A9, fanning out from these and other minor watercourses between them.

- 10.3.25 The alluvial fan is likely to have formed during deglaciation in the early Holocene, representing debris transported by melting glaciers and snow melt. Qualitative catchment analysis indicates there is currently ample sediment and debris flow supply from the upper catchments, which is transported through steep channels and deposited where the slopes reduce on the fan. The fan is largely contained within the channel, which helps contribute to active morphological processes and further sediment production. There also appears to be morphological evidence for avulsion events (the formation of new or alternate river channels) associated with Allt Coire Chuirn; with either high flow distributaries or additional channels present to the north of it, which diverge from the main channel at the fan apex.
- 10.3.26 Field visits by the CFJV (2016) identified several unvegetated bar locations along the banks of and near the fan apex on Allt Coire Chuirn, as illustrated in **Drawings 10.15** and **10.16 (Volume 3)**. Although frequently obscured by slumping, some of these reveal partial cross-sections through the upper parts of the fan and terrace sediments.
- 10.3.27 Taken together; the fan area, soils and landform, active morphology and stratigraphic insight from some partial exposure areas provide a basis for studying the local present-day and longer-term fan formation, together with the river and morphological processes. Although it is not currently identified as a GCR, LGS or SSSI geological qualifying feature, the area may require protection in the future and has previously been described by SNH as regionally important (Transport Scotland, 2014a). Based on this and the criteria in **Table 10-1**; the Allt Coire Chuirn alluvial fan is therefore considered to be of **medium** sensitivity.

Drumochter Debris Cones and Hillsides of Drumochter Pass

- 10.3.28 At the base of An Torc (the Boar of Badenoch) and the Sow of Atholl approximately 250m to the west of the Proposed Scheme in the Pass of Drumochter, there are several substantial debris cones; comprising steep, cone-shaped accumulations of rock fragments (Ballantyne, 2004). Debris cones are mainly formed during heavy rainfall as a result of landslides that develop quickly downslope into debris flows and many cones are bounded by levées up to 2.50m high.
- 10.3.29 The cones in the Pass of Drumochter represent good examples that have been studied in detail, and they were interpreted by Ballantyne and Benn (1996) as the products of delayed or renewed paraglacial re-working of glacial deposits by debris flows. The gullies feeding the debris cones are incised into steep drift-mantled slopes that support a thick cover of glacial sediment, interpreted by Sissons (1974) to be of Loch Lomond Stadial age. If Sissons' (1974) interpretation of the age of deglaciation in Drumochter is valid, this indicates that the cones have accumulated since the retreat of glacier ice at the end of the Loch Lomond Stadial; making them important in studies of paraglacial processes, Holocene climate change, and possible impacts on the landscape resulting from changing land use and climate.
- 10.3.30 Examples of debris flow are also present on the hillsides of Creagan Doire Chonaich through the Pass of Drumochter, with one distinct cone at the base approximately 85m to the east of the Proposed Scheme at ch. 4,200. This and other examples to the east are considered to be of **low** sensitivity based on the criteria in **Table 10-1**. However, the substantial debris cones located to the west of the Proposed Scheme have been identified as a candidate LGS (Barron *et al.*, 2011) and are considered to be of **medium** sensitivity.

Pass of Drumochter Pollen Record Site

- 10.3.31 Historical pollen investigations (Walker, 1975) in the Pass of Drumochter identified a former lake or lochan within the Drumochter Hummocky Moraines, that progressive hydrosere development has converted into a Sphagnum peat bog; approximately 1km in length and 130m in width at its widest point. This is located adjacent to the west of the A9 carriageway, between this and the HML railway, from approximate ch. 3,400 to ch. 4,600. The investigations identified that 8.00m of infill had accumulated near the centre of the basin (approximated to be ch. 4,000), comprising sphagnum peat with fragments of birchwood and pinewood to approximately 6.19m, underlain by fibrous lake mud, organic-rich sediment, clay and gravel.
- 10.3.32 Sample results from pollen analysis undertaken identified three assemblage zones within the infill profile; spanning the mid- and late-Postglacial periods. The earliest vegetational record is of birch and hazel woodland, which was in turn succeeded by establishment of pine forest, possibly around 7,000 BP (before present) (Walker, 1975). Pollen percentages declined in the upper profile, interpreted by Walker (1975) to be reflective of Neolithic man impact in the area; with the destruction of forest and the spread of dwarf shrub heath and heather moor.
- 10.3.33 Taken together with the stratigraphy and pollen content of sediment at Loch Etteridge (13km north of the Proposed Scheme) (Gordon *et al.*, 1993), the site in the Pass of Drumochter has implications for Late Devensian glacial sequences across the region. Notwithstanding, the site is considered to be of **low** sensitivity based on the criteria in **Table 10-1**; as it is not identified as a GCR, LGS or SSSI geological qualifying feature, but may require protection in the future.

Rock Exposures

- 10.3.34 As illustrated in **Drawing 10.3 (Volume 3)**, three areas of partially exposed rock are present on the A9 in the Pass of Drumochter. Field mapping visits (CFJV, 2016) recorded these as follows:
- **P07-RE01:** Light grey and pink strong to very strong psammite with quartz veins. No water seepages noted, but existing wedge and toppling failures were evident. Southbound carriageway (ch. 4,850 to ch. 4,925), with approximately 4.00 to 7.00m slope height (60 to 80°) and 50% exposure due to soil or vegetative cover
 - **P07-RE02:** Pink/ purple medium strong to strong slightly weathered psammite, thinly to medium bedded with occasional felsite veins. Several water seepages were noted, with ravelling, with blast/ frost damage, toppling and wedge failures evident. Southbound carriageway (ch. 4,975 to ch. 5,150), with approximately 2.00 to 6.00m slope height (40 to 60°) and 40 to 90% exposure due to variable soil or vegetative cover
 - **P07-RE03:** Light pink/ grey and light pink strong to very strong psammite with quartz lenses, a fault with a crystallised face and approximately 5cm weathered fault gouge. Water seepage was noted, with plane toppling and wedge failures all event. Southbound carriageway (ch. 5,325 to ch. 5,550), with approximately 2.00 to 3.00m slope height (50 to 60°) and 80 to 90% exposure due to limited soil or vegetative cover.
- 10.3.35 Based on the criteria in **Table 10-1**, the exposures are considered to be of **negligible** sensitivity.

Mineral Extraction

- 10.3.36 BGS mapping and mineral resources publications (BGS, 2014) indicate that there are no records of historic or current coal mining within the study area. Available information also did not highlight the presence of any current or historical areas of mining or mineral extraction.

- 10.3.37 Based on the criteria in **Table 10-1**, mineral extraction potential is therefore considered to be of **low** sensitivity, given the absence of current or historical extraction activities and the likelihood of any potential superficial or solid geological resources present being of local importance only.

Soils

- 10.3.38 The soils present within the study area have been identified using BGS mapping, the National Soil Map of Scotland (1:250,000 Scale) (JHI, 2013), LCA maps (JHI, 1983), available GI and publications related to Scotland's soils and their conservation value.

Soil Conservation

- 10.3.39 As illustrated in **Drawings 10.4 and 10.5 (Volume 3)**, the majority of the study area is underlain by peaty and peaty gleyed podzols, with peaty gleys, humus-iron podzols with peat, peaty rankers and mineral and peaty alluvial soils also present. These soil types are derived from metamorphic rock or fluvioglacial sands and gravels, and in the case of peats, accumulations of organic material.
- 10.3.40 Some of the soils are rare within Scottish and/ or CNP contexts; including peaty gleys and peat (Towers *et al.*, 2005). Rare soils in a Scottish context, but common in the CNP, are subalpine soils associated with some montane environments of the Drumochter Hills (Gauld *et al.*, 2003). However, these are shown to be present outwith the study area, higher up the surrounding hillsides.
- 10.3.41 Previous studies of soil conservation value in the CNP (Bruneau *et al.*, 2003; Towers *et al.*, 2005) generated conservation index values of less than 100 (humus-iron podzols and peaty gleys), between 100 and 200 (peaty gleyed and peaty podzols, mineral and peaty alluvial soils) and greater than 200 (peat) for those present within the study area. These respectively indicate these soils are of **low**, **moderate** and **high** soil conservation interest.
- 10.3.42 This correlates well with the typical properties of the soil types (drainage, organic content, nutrient levels) (JHI, 1986; Bruneau *et al.*, 2003; Bruneau, 2006; CNPA, 2015); though is based solely on rarity, representivity and diversity. In real terms, it is recognised that the overall soil conservation (functional) value will vary, with them providing a range of ecological services and functions at a local scale and within wider environmental frameworks.

Agricultural Productivity

- 10.3.43 Only proportions of the study area are currently utilised for sheep grazing or herding, associated with the South and North Drumochter, Dalnacardoch and Dalnaspidal Estates, as described in **Chapter 8**. As shown on **Drawing 8.7 (Volume 3)**, the predominant LCA Classes are 6.2 and 6.3 (rough grazing) across the study area and no prime agricultural land has been identified.
- 10.3.44 Based on **Table 10-1**, soils within the study area are therefore considered to be of **low** sensitivity in terms of potential agricultural productivity.

Peat

- 10.3.45 As shown in **Drawings 10.1, 10.4 and 10.5 (Volume 3)**, BGS mapping identifies two areas of peat adjacent to the west of the existing A9 at ch. 6,200 and ch. 7,600 near Balsporran and Drumochter, while soil mapping shows complex peaty soils with peat across the study area. Class 1 and Class 2 priority peatland (nationally important carbon-rich, peaty soils and deep peat) are shown on SNH Carbon and Peatland mapping (SNH, 2016b) to the east and/ or west across the central and northern portions of the Proposed Scheme, with Class 3 areas (not priority peatland,

but where most soils are carbon-rich, peaty soils and deep peat) shown to the east and west around Dalnaspidal, Balsporran and Drumochter, as illustrated in **Drawing 10.6 (Volume 3)**.

- 10.3.46 Based on this information, field surveys were undertaken and considered alongside Phase 1 Habitat (CH2M, 2014) and NVC Surveys (MacArthur Green, 2015) to develop an understanding of peaty soil and peat presence, depth and characteristics. These surveys are described in **Appendix 10.1 (Volume 2)** and were used to create a peat depth model for the Proposed Scheme and adjacent areas, as shown in **Drawings 10.17 to 10.23 (Volume 3)**.
- 10.3.47 Ecology surveys identified several peatland and heathland habitats with peat-forming vegetation types, including mire, blanket bog and wet heaths, or mosaics of these, swamp and fen as shown in **Drawings 12.7 to 12.24 (Volume 3)**. A feature morphologically resembling a raised bog (but ecologically identified as blanket bog) is also present to the west of the Proposed Scheme at ch. 9,300, with a possible low dome perched on a low terrace above the River Truim floodplain. Dry heaths and other semi-natural vegetation such as grassland and woodland are also present.
- 10.3.48 Peaty soils and topsoil (less than 0.50m thickness) are predominant in areas of dry and wet heath and grassland transitions on hummocky ground or steeper and drier slopes, with discontinuous and localised shallow peat (between 0.50 and 1.00m thickness) within these and mire mosaics on gentler slopes, flatter ground or hollows. Deep peat (greater than 1.00m thickness) up to 8.40m but generally between 1.00 and 4.50m depth, is present within and adjacent to the Proposed Scheme in several areas. Notable areas of this are to the east at Dalnaspidal (ch. 500 to ch. 1,100), to the west through the Pass of Drumochter (ch. 3,000 to ch. 4,600) and near Balsporran (ch. 7,050 to ch. 7,250), and to the east and west at Drumochter Lodge (ch. 7,500 to ch. 7,700).
- 10.3.49 The basic peat characteristics across the study area are considered in **Appendix 10.1 (Volume 2)**. This identifies several areas are affected by a network of artificial drainage channels of varying continuity and length; which are most frequent at the margins of existing or recent infrastructure and areas of grouse habitat or grouse drives. However, several areas of blanket bog, transition mire, swamp and wet heath appear sufficiently wet with relatively intact hydrological regimes and contain bog pool communities indicative of good condition. Many of the habitats and vegetation identified are also recognised under Annex 1 of the European Council Habitats Directive 92/43/EEC (Council of the European Communities, 1992), the Scottish Biodiversity List (Scottish Government, 2013) and Cairngorms Nature Action Plan (CNPA, 2013), while additionally being present within or connected to habitats in the Drumochter Hills SSSI, SAC and SPA.
- 10.3.50 Based on the criteria in **Table 10-1**, peaty soils and peat across the Proposed Scheme would therefore generally be considered **high** sensitivity for one or more reasons (such as locally good condition, presence and role in notable habitats, priority peatland class or designated sites); though lower quality or impacted areas of dry or wet heath and grasslands across the Proposed Scheme may reasonably be considered **medium** sensitivity. The key areas are considered to include the expanse of blanket bog, transition mire, swamp and mosaic adjacent to the west between ch. 3,400 and ch. 4,600 (which corresponds to the pollen record site identified by Walker (1975)), additional areas of blanket bog and/ or transition mire to the west of the HML railway (ch. 5,800 to ch. 6,400), near Balsporran (ch. 7,050 to ch. 7,250) and at Drumochter Lodge (ch. 7,500 to ch. 7,700), and areas of blanket bog with deep peat to the east at Dalnaspidal (ch. 500 to ch. 1,100) and through the Pass of Drumochter in the Drumochter Hills SSSI, SAC and SPA.

Groundwater

- 10.3.51 The groundwater characteristics of the study area are summarised below, based on information obtained from BGS and SEPA publications, available GI information and previous reports.

Hydrogeology

- 10.3.52 The SEPA River Basin Management Plan (RBMP) interactive map (SEPA, 2017) indicates the study area is predominantly underlain by the Upper Spey Bedrock and localised sand and gravel aquifer, with parts of the River Truim floodplain to the west being underlain by the Truim Valley sand and gravel aquifer and the Allt Dubhaig valley to the south being underlain by the Garry and Loch Rannoch bedrock and localised sand and gravel aquifer. The WFD classification from 2008 for groundwater in both the superficial and bedrock deposits is ‘good’ with ‘high’ confidence for both quantity and quality, with no trend for pollutants and no current pressures.
- 10.3.53 As shown in **Drawing 10.7 (Volume 3)**, head and glacial deposits (till and hummocky glacial deposits) within the study area are identified as being not a significant aquifer. Talus deposits are low to moderate in productivity and intergranular flow is significant, while fluvial deposits (alluvium, alluvial fan and river terrace deposits) are moderate to high or high in productivity, with intergranular flow. The Gaick Psammite Formation and Grampian Group are classified as a very low productivity aquifers, as shown in **Drawing 10.8 (Volume 3)**. Within these, groundwater storage and flow is likely to be limited to near surface weathered zones and fractures.
- 10.3.54 Groundwater flow in superficial deposits is likely to follow surface topography towards local surface watercourses. However, flows are likely to be locally complex, influenced by rainfall and snowmelt from surrounding hillsides and the presence of peat, shallow rock and man-made features associated with the existing A9, Beauly to Denny Power Line (BDL), HML railway, tracks and structures. Groundwater emergence, seepage and through-flow has also been observed to be locally significant in the east of the study area, with several spring and flush areas identified and shown in **Drawings 10.24 to 10.30 (Volume 3)**.
- 10.3.55 The flow direction of bedrock groundwater is unconfirmed, but is likely to follow the direction of local surface watercourses and may be locally discontinuous due to fracturing and folding.
- 10.3.56 Based on the criteria in **Table 10-4**, the hydrogeological characteristics and sensitivity of the superficial and solid geology units within the study area are summarised in **Table 10-11**. This is based on combined consideration of their productivity, WFD classifications for quality and quantity, and available GI information related to groundwater levels and quality. As such, the sensitivities assigned are applicable to groundwater quality, levels and flow.

Table 10-11: Hydrogeological Characteristics and Sensitivity of Superficial and Solid Geology Units

Geological Unit		Geological Characteristics	Hydrogeological Characteristics	Sensitivity
Made Ground		Clayey sandy, gravelly topsoil, sandy gravelly clay and sand with concrete, cobbles, boulders and pockets of peat	Assumed poor groundwater potential due to local nature and surface/ near surface location, likely variable permeability and perched nature	Low
Peat		Variable from insignificant to strongly decomposed and of variable type, condition, fibre and water content	Low value in terms of resource and productivity, but variable permeability and variable water contents from rainfall, run-off and groundwater and influenced by artificial drainage in several locations	Medium
Fluvial Deposits	Alluvium	Clayey, silty or gravelly fine to coarse sand and silty sandy fine to coarse gravel	Moderate to high or high productivity with intergranular flow and good quality and quantity status within the Upper Spey bedrock and localised sand and gravel aquifers and Truim Valley sand and gravel aquifer. Groundwater within alluvial deposits would also be expected to be hydraulically connected to surface waters	High
	River Terrace Deposits	Clayey, silty or gravelly fine to coarse sand and silty sandy fine to coarse gravel		
	Alluvial Fan Deposits	Sandy gravelly silt and silty fine to coarse gravel		

Geological Unit		Geological Characteristics	Hydrogeological Characteristics	Sensitivity
Glaciofluvial Deposits		Clayey, silty and sandy fine to coarse gravel	Moderate to high or high productivity with intergranular flow and good quality and quantity status in the Upper Spey bedrock and localised sand and gravel aquifers and Truim Valley sand and gravel aquifer. Groundwater in glaciofluvial deposits would also be expected to be hydraulically connected to surface waters	High
Glacial Deposits	Till	Clayey silty sandy fine to coarse gravel and sandy gravelly silt	Although mapped and present within the Upper Spey bedrock and localised sand and gravel aquifers with good quality and quantity status, till and hummocky glacial deposits are predominantly identified as not being a significant aquifer	Medium
	Hummocky Glacial Deposits	Clayey, silty and sandy fine to coarse gravel or clayey, silty gravelly sand	This may be because of their variable permeability, but they have been recorded as predominantly granular and therefore may therefore be locally connected to surface waters, with groundwater presence also likely to be heavily influenced by rainfall and snowmelt	
Mass Movement	Talus	Rock fragments	Mapped and present within the Upper Spey bedrock and localised sand and gravel aquifers with good quality and quantity status; talus and head deposits are identified as being low to moderate in productivity and may support reasonable intergranular flow, but limited coverage	Medium
	Head	Gravel, sand, silt and clay		
Gaick Psammite Formation		Psammite and quartzose psammite	Very low productivity with fracture flow, but good quality and quantity status within the Upper Spey bedrock and localised sand and gravel aquifers	Medium
Grampian Group		Quartzose psammite	Very low productivity with fracture flow, but good quality and quantity status within the Upper Spey bedrock and localised sand and gravel aquifers, although limited spatial extent within study area	Medium

Groundwater Abstractions and Private Water Supplies

- 10.3.57 Based on consultation undertaken with P&KC, THC, HighWater (Scotland) Ltd and SEPA; five PWS source locations were identified in the study area, supplying properties at Drumochter Lodge, Balsporran Cottage and Dalnaspidal. One possible well was also recorded on historical mapping and during CFJV site walkovers (2016 and 2017) near Dalnaspidal.
- 10.3.58 Landowner and resident consultation was undertaken to obtain additional information on these and establish if any other such features may be present. The information obtained is described in **Appendix 10.3 (Volume 2)** and summarised in **Table 10-12**. The sensitivity of each feature has been assigned based on the criteria in **Table 10-4**. Where the status of an abstraction or PWS is unconfirmed or unclear, it is considered to be of high sensitivity.

Table 10-12: *Groundwater Abstractions and Private Water Supplies*

Feature ID	Feature Type	Chainage (ch.)	Source of Information	Landowner Response	Sensitivity
ABS 7.2	Spring	ch. 6,800	Landowner/ THC	Resident consultation/ THC identified an active PWS sourced from a spring, supplying Balsporran Cottage and associated bed and breakfast lettings for domestic use. Residents confirmed the supply source, network and treatment locations.	High

Feature ID	Feature Type	Chainage (ch.)	Source of Information	Landowner Response	Sensitivity
ABS 7.3	Spring	ch. 7,000	Landowner/ THC/ Walkover	Landowner/ THC identified a PWS sourced from a spring supplying Drumochter Lodge, North Drumochter Cottage and a larder for domestic use. CFJV walkovers (2017) confirmed the spring and capture tank locations.	High
ABS 7.4	Surface Water	ch. 500	P&KC/ Walkover	No landowner response received. However, P&KC identified a PWS sourced from the Allt Coire Mhic Sith watercourse, supplying Dalnaspidal Lodge. CFJV walkovers (2017) confirmed the locations of intake from Allt Coire Mhic Sith and tanks for ABS 7.5 and it is assumed that ABS 7.4 is connected.	High
ABS 7.5	Surface Water	ch. 500	Landowner/ Residents/ P&KC/ Walkover	Landowner/ residents/ P&KC identified an active PWS sourced from Allt Coire Mhic Sith, supplying the Old Schoolhouse and Station Cottages at Dalnaspidal for domestic use and consumption. CFJV walkovers (2017) confirmed the locations of the intake from Allt Coire Mhic Sith and tanks.	High
ABS 7.6	Borehole	ch. 200	P&KC/ HighWater	P&KC information identified a PWS borehole supplying Dalnaspidal Lodge. Consultation with HighWater (Scotland) Ltd confirmed this to be a 15m deep well which supplies five properties at Dalnaspidal, including the lodge.	High
ABS 7.7	Possible Well	ch. 100	OS Mapping/ Walkover	Local resident understands this to be a well formerly associated with Dalnaspidal Lodge. However, confirmation of the status from the landowner has not been received.	High

10.3.59 The location of the PWS sources and supplied properties are shown on **Drawings 10.24 to 10.30 (Volume 3)**. These also identify natural spring and flush features based on ecological surveys or current mapping. However, these have not been identified as existing PWS sources.

Groundwater Monitoring

10.3.60 Groundwater has been encountered in several boreholes and trial pits during the Advanced and Preliminary GI, with water strikes between 0.20 and 12.40m bgl in superficial deposits and between 3.70 and 14.00m bgl in bedrock. Some locations were also recorded as dry.

10.3.61 Groundwater monitoring data has been collected from 14 borehole locations between January and December 2016 for the Advanced GI, and from 44 borehole locations between April and August 2017 for the Preliminary GI. The data collected indicates water levels ranging from ground level (ch. 800 near Dalnaspidal) to 15.52m bgl (ch. 5,950 in the Pass of Drumochter), but typically within 4.00m of the ground surface. Equivalent piezometric levels have varied from 398.80 (ch. 9,225 toward Dalwhinnie) to 475.46m (ch. 1,800 in the Pass of Drumochter) Above Ordnance Datum (AOD) across the Proposed Scheme area.

10.3.62 Tests conducted during previous GI for the existing dual carriageway at Crubenmore identified permeability estimates between 5×10^{-7} and 9×10^{-7} metres per second (m/s) for superficial glacial soils and at least 1×10^{-4} m/s for bedrock. Similar test results from the Preliminary GI identified estimates of between 4.23×10^{-7} and 1.40×10^{-5} m/s in glacial soils. Taken together, these results suggest permeability of the materials across the Proposed Scheme is likely to be variable and may indicate the presence of lower and higher permeability bands; which also corresponds to indications from particle size distribution testing and published literature values (Freeze and Cherry, 1979; Wheeler, 2009; Natural England, 2010).

Groundwater Quality

- 10.3.63 The BGS publication ‘*Scotland’s aquifers and groundwater bodies – OR/15/028*’ (BGS, 2015) provides an outline of groundwater quality in the Precambrian bedrock underlying the Proposed Scheme. It describes the groundwater as weakly mineralised, with variable redox conditions, and with nitrate concentrations between 0.15 to 17.46 milligrams per litre (mg/ l). The study area is not located in a Nitrate Vulnerable Zone, but is within a Drinking Water Protection Zone.
- 10.3.64 Consultation with SEPA indicates seven discharge consent records within the study area; six associated with the discharge of septic tank effluent to soakaways, and one associated with the same to land. Details of these are provided in **Appendix 10.4 (Volume 2)**.
- 10.3.65 The results of available soil leachate and groundwater chemical analysis from the Advanced and Preliminary GI have been compared against water quality standards for drinking water, surface water and GWDTE in accordance with SEPA Position Statement WAT-PS-10-01 ‘*Assigning Groundwater Assessment Criteria for Pollutant Inputs*’ (SEPA, 2014). The comparison identified localised elevated concentrations of arsenic, lead, mercury, copper, ammoniacal nitrogen, nitrate, polycyclic aromatic hydrocarbons (PAHs) and total petroleum hydrocarbons (TPH) in soil leachate analysis. Groundwater results identified localised and slightly raised cadmium, nitrate and PAHs, with ammoniacal nitrogen and mercury more frequently raised in several borehole locations.

Groundwater Dependent Terrestrial Ecosystems

- 10.3.66 As described in **Appendix 12.2 (Volume 2)**, NVC Surveys (MacArthur Green, 2015) identified a number of habitats which may be groundwater dependent; including wet heaths, mires, flushes, springs, rush pasture and grasslands, or mosaics of these. The location and extents of the areas based on the groundwater dependence ratings in ‘*LUPS-GU31 Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and GWDTE (Version 2)*’ (SEPA, 2014a) are illustrated in **Drawings 10.24 to 10.30 (Volume 3)**.
- 10.3.67 Three hundred and eighty-eight potential GWDTE were identified as requiring assessment within the study area, and the vegetation details of each and consideration of their likely dependence on groundwater is presented in **Appendix 10.2 (Volume 2)**. This identifies that groundwater is unlikely to be a contributory source to some 43 of the habitats – particularly those comprising existing road verge, embankment or cut slopes, and where the wet vegetation are fragmented or discontinuous parts of these, associated with surface water features or run-off. A total of 135 have also been assessed as being likely to have only a low dependency on groundwater inputs due to their topographic setting, likely influence of surface water and run-off, presence in areas of floodplain or association with ombrotrophic (rain-fed) areas of peatland.
- 10.3.68 Several areas of wet heath (NVC M15 and M16), mire (NVC M5 and M6), soakaway (NVC M29), rush pasture (NVC M23), calcifugous and mesotrophic grasslands (NVC U6, MG9, MG10, CG10) however have been recorded as dominant or sub-dominant communities in multiple habitat areas and considered likely to be dependent on groundwater to varying degrees. In this respect, 151 have been identified to have moderate dependence on groundwater input, 22 have been identified to have moderate/ high dependence on groundwater input, and 37 have been identified to have a high dependence on groundwater input. These are located throughout the Proposed Scheme extents, to the east and west; where either the topographic setting and presence of faulting correspond to potential or evidenced increased groundwater supply from fractured bedrock via emergence, seepage and through-flow from spring heads (NVC M32) and soligenous (NVC M15a) or base-enriched (NVC M10 and M11) flushings, or the hydrogeological conditions are such that regional groundwater through-flow within permeable and productive superficial soils are likely to support GWDTE presence.

- 10.3.69 Based on the criteria in **Table 10-4**, the sensitivity of individual GWDTE in the study area are presented in **Appendix 10.2 (Volume 2)**. These are considered to vary between **medium** and **very high** sensitivity based on their likely groundwater dependence. Those determined to have no dependency on groundwater input are considered **low** sensitivity and are assessed further as part of the ecological impact assessment in **Chapter 12**.

Surface Water Features

- 10.3.70 All surface water features within the study area are described within **Chapter 11** and shown in **Drawings 11.1 to 11.7 (Volume 3)**. These are variably expected to have a groundwater baseflow component, and groundwater may be a contributor to local flooding mechanisms.
- 10.3.71 Among the principal surface watercourses, are the River Garry and Allt Dubhaig. As previously described, the Allt Dubhaig is located to the west of the Proposed Scheme between the Sow of Atholl and HML railway; where it emerges from a mountain torrent (Allt Coire Dhomhain) through hummocky moraine drift, and flows south along the base of the Pass of Drumochter. The watercourse and surrounding area comprise the Allt Dubhaig GCR, which is the qualifying geological interest of the Drumochter Hills SSSI for fluvial geomorphology. South of Dalnaspidal, the Allt Dubhaig flows into Loch Garry, the River Garry and ultimately, the River Tay.
- 10.3.72 The other principal surface water feature in the study area is the River Truim, whose head waters emerge in the Pass of Drumochter and flow northwards through the valley, before confluence with the River Spey. The River Truim is located to the west along the length of the Proposed Scheme from ch. 4,000, and it forms part of the River Spey SAC, which is designated for the protection of freshwater pearl mussel, sea lamprey, Atlantic salmon and otter.
- 10.3.73 In addition to these features, there are several other major and minor watercourse tributaries, predominantly to the River Truim, which cross under the Proposed Scheme. Based on **Table 10-4** and corresponding sensitivity criteria in **Chapter 11** and **Chapter 12**, surface watercourse features within the study area are considered to vary between **low** and **very high** sensitivity.
- 10.3.74 Samples were retrieved following the Preliminary GI at 14 surface watercourse locations – including the River Garry, Allt Dubhaig, River Truim, Allt Coire Mhic Sith and others across the Proposed Scheme. The results of subsequent chemical testing have been compared against water quality standards for drinking water and surface water. This identified raised PAH concentrations in four sample locations (Allt Fuarr Bheann, Allt a'Chaorainn, Allt an Creagach and the River Truim), with ammoniacal nitrogen, nitrate and mercury more frequently raised; which is generally consistent with the groundwater analysis.

Potential Contamination

- 10.3.75 Twenty principal potential contamination sources have been identified in the study area as part of the assessment, together with 54 individual occurrences of made ground or visual/ olfactory indications of contamination. Details of these are provided in **Appendix 10.4 (Volume 2)** and each has been assigned a reference (prefixed 'GGD'), to assist identification and assessment. The locations of each potential source are shown in **Drawings 10.31 to 10.37 (Volume 3)**.
- 10.3.76 Available soil sample chemical testing results have been compared against published generic assessment criteria for residential, commercial and open space end uses (DEFRA, 2014; LQM/ CIEH, 2015) to assess potential risks to construction/ maintenance workers, transient site users and local residents during construction. Potential exposure pathways to end users and local residents during operation are likely to be limited, but may remain valid along access tracks and for maintenance workers during inspection or repair activities.

- 10.3.77 The vast majority of samples analysed did not identify contaminant concentrations in excess of the criteria. Fourteen samples recorded local concentrations for contaminants such as PAHs (including benzo(a)pyrene and dibenzo(ah)anthracene), TPH, lead and nickel marginally in excess of the residential and/ or open space criteria, but all below the commercial criteria.
- 10.3.78 Most instances did not appear to be associated with any particular source area, so are considered to be attributable to incidental, though numerous areas of made ground (GGD-21 to GGD-74) and likely to be associated with the existing A9 carriageway (GGD-01). Two samples were noted to be within/ nearby the former telephone exchange at Dalnaspidal (GGD-05) and a former cottage in the Pass of Drumochter (GGD-10). One sample also identified a small bundle of chrysotile asbestos at 0.001% concentration, within an area of made ground (GGD-73) adjacent to the east of the existing A9 at ch. 9,500.
- 10.3.79 Ground gas data has been collected from 14 borehole locations on up to 12 occasions between January and December 2016 for the Advanced GI, and on up to 8 occasions from 44 borehole locations between April and August 2017 for the Preliminary GI. As ground gases may pose risks to humans working below ground and in confined spaces during construction, concentrations were compared to published assessment criteria (HSE, 2011; CIRIA, 2007; BS 8485, 2015;) for elevated methane, carbon dioxide, carbon monoxide, hydrogen sulphide and depleted oxygen.
- 10.3.80 Isolated raised detections of methane (between 4.10 and 45% volume (v/v)) have been recorded in three monitoring locations, with the concentrations observed to exceed the safety threshold of 1% v/v. Each of the locations is situated to the west of the Proposed Scheme at ch. 800, ch. 2,025 and ch. 2,950 near Dalnaspidal and in the Pass of Drumochter, within installations screened in or across alluvial or made ground material; suggesting these may be the potential source. All other detected concentrations elsewhere are less than the recommended safety threshold of 1% v/v.
- 10.3.81 Carbon dioxide concentrations exceed the short term occupational exposure limit (1.5% v/v) in 27 boreholes and the long term exposure limit (0.5% v/v) in 35 boreholes on one or more occasion across the Proposed Scheme, with detected concentrations ranging between 0.10 and 8.00% v/v. Depleted oxygen concentrations below 19% v/v have been observed in 26 boreholes on one or more occasion, with levels considered to be very low (less than 16% v/v) in several instances and frequently coinciding with methane or carbon dioxide detections.
- 10.3.82 Hydrogen sulphide was consistently below the monitoring equipment's level of detection (0.1 part per million (ppm)) and thus, below the short and long term exposure limits. Two boreholes recorded isolated detections of 13 and 17 ppm for carbon monoxide, but these levels are below the short and long term exposure limits for this gas.

10.4 Potential Impacts

Embedded Mitigation

- 10.4.1 Throughout the DMRB Stage 3 design development process described in **Chapter 4**; a number of environmentally-led workshops considered each aspect of the developing design and made recommendations for certain features to be included, or aspects of the design to be reconsidered. These aspects have been defined as 'embedded mitigation'.
- 10.4.2 With respect to geology, soils and groundwater, the approach to achieving a first-level of embedded mitigation for the Proposed Scheme was to avoid or minimise impacts on receptors as far as practicable. This was achieved through the following:
- layout and positioning of infrastructure to avoid or minimise disturbance of soils of high conservation value, priority peatland, deep peat and GWDTE

- where avoidance has not been possible, local level assessments were completed where possible, to determine local solutions such as earthworks extent reductions to minimise potential impacts and inform management plans for storage, re-instatement and re-use
- layout and positioning of infrastructure to avoid or minimise disturbance of designated and non-designated geological receptors or features of geodiversity interest
- incorporation of access tracks with cross-drainage where relevant, to alleviate potential spring and flush overland or shallow groundwater flow disruption
- watercourse diversions, culverts and drainage to re-direct and maintain hydrological regimes across the Proposed Scheme as far as practicable.

Potential Impact Assessment

- 10.4.3 When assessing potential impacts from the Proposed Scheme, construction and operation phases have been considered together, as the majority of construction impacts (such as removal of excavated material) will be permanent and extend through operation. Where differences are predicted between construction and operation, these have been assessed for each phase in turn.
- 10.4.4 There are several ways that the Proposed Scheme may impact on geology, soils or groundwater features during construction and operation. These include:
- excavation or masking of bedrock or superficial deposit exposures or sites of specific scientific or geodiversity interest, particularly if the features are not reproduced elsewhere in the area
 - constraint or limitation to existing or potential commercial exploitation of mineral resources
 - excavation, removal or sealing of local soil resources, such as those of high conservation interest or potentially productive agricultural soils
 - excavation or removal of peat, with resultant carbon release and potential permanent loss, unless environmentally beneficial re-use or restoration can be achieved
 - impacts on groundwater during construction and operation, through dewatering or aspects of infrastructure which may impede or alter local hydrological regimes and groundwater flows
 - spillage or leakage of fuels or oils from storage tanks or construction plant which, without suitable mitigation measures, can enter aquifers and subsequently migrate
 - groundwater change may impact peat, GWDTE, surface water, abstractions or PWS; GWDTE are also susceptible to direct loss and drawdown via dewatering
 - during operation, surface run-off may contain elevated pollutant concentrations such as oils, suspended solids and metals, leading to pollution of groundwater.
- 10.4.5 A key aspect of the impact assessment has been to identify areas of excavation for the Proposed Scheme, as shown in **Drawings 10.24 to 10.37 (Volume 3)** and summarised in **Table 10-13**. Only excavations equal to or greater than 1.00m depth are identified, and widening of existing cuttings have been labelled as ‘widening’ and new cuttings labelled as ‘cutting’.

Table 10-13: Excavation Areas and Depths (equal to or greater than 1.00m depth)

Earthwork Ref. ¹	Cutting/Widening	Chainage (approx.)	Maximum Excavation Depth (m bgl)	Local Groundwater Depth Range (m bgl)	Local Bedrock Depth Range (m bgl)	Likelihood to Intercept Groundwater	Likelihood to Intercept Bedrock
Mainline, Junctions and Access Tracks							
P7-MC-01	Widening	ch. -500 to ch. 0	2.60	Dry ²	-	Low	Low
P7-MC-02	Widening	ch. -450 to ch. 0	3.95	2.10 ²	-	Likely	Low
P7-MC-03	Widening	ch. 100 to ch. 200	2.46	2.30 to 3.70 ²	5.00	Likely	Low
SuDS 001	Access Cutting	ch. 100 to ch. 200	1.01	2.60 ²	5.00	Low	Low
P7-MC-04	Widening	ch. 275 to ch. 325	3.78	0.80 to 1.00 ²	5.00	Likely	Low
P7-DJ-01	Cutting	ch. 400 to ch. 500	6.36	5.33 to 5.61	3.20	Likely	Likely
P7-DJ-02	Cutting	ch. 425 to ch. 625	18.14	3.84 to 6.37	7.15	Likely	Likely
P7-NCN-01	Cutting	ch. 600 to ch. 750	3.44	3.02 to 4.13	7.15	Likely	Low
P7-DJ-03	Widening	ch. 625 to ch. 975	8.59	0.05 to 4.53	6.20 to 7.15	Likely	Likely
P7-MC-05	Widening	ch. 975 to ch. 1,150	3.39	3.24 to 3.75	7.90	Likely	Low
P7-MC-06	Widening	ch. 1,150 to ch. 1,500	5.42	2.97 to 3.58	12.10	Likely	Low
P7-MC-07	Widening	ch. 1,500 to ch. 1,850	6.54	1.35 to 4.55	5.40 to 6.50	Likely	Likely
P7-NCN-02	Widening	ch. 1,700 to ch. 1,850	3.94	0.88 to 6.02	5.40 to 6.50	Likely	Low
SuDS 020	Access Cutting	ch. 1,900 to ch. 2,050	2.63	4.01 to 5.99	6.45	Low	Low
P7-MC-08	Widening	ch. 2,100 to ch. 2,200	4.52	2.35 to 3.62	-	Likely	Low
P7-MC-09	Widening	ch. 2,175 to ch. 2,450	3.70	1.40 ²	6.70	Likely	Low
P7-MC-10	Widening	ch. 2,325 to ch. 2,375	3.83	1.40 to 3.36 ²	6.70	Likely	Low
P7-MC-11	Widening	ch. 2,425 to ch. 2,600	3.59	2.54 to 3.36	5.00 to 7.30	Likely	Low
P7-MC-12	Widening	ch. 2,700 to ch. 2,850	1.24	Dry ²	19.00	Low	Low
P7-MC-13	Widening	ch. 2,850 to ch. 3,000	1.63	Dry ²	-	Low	Low
P7-UP-01	Cutting	ch. 3,050 to ch. 3,100	3.27	2.76 to 3.41	-	Likely	Low
P7-MC-16	Widening	ch. 3,450 to ch. 3,625	5.53	Dry ²	-	Low	Low
P7-MC-17	Widening	ch. 3,625 to ch. 3,750	4.21	Dry ²	-	Low	Low
P7-MC-18	Widening	ch. 3,375 to ch. 3,850	1.23	Dry ²	-	Low	Low
P7-MC-21	Widening	ch. 4,125 to ch. 4,225	4.43	2.30 ²	-	Likely	Low
P7-MC-22	Widening	ch. 4,725 to ch. 4,775	1.70	0.80 ²	-	Likely	Low
P7-MC-23	Widening	ch. 4,775 to ch. 4,850	2.91	2.90 ²	-	Low	Low
P7-MC-25	Widening	ch. 4,925 to ch. 4,950	2.46	3.96 to 10.14 ²	5.00	Low	Low
P7-MC-26	Widening	ch. 4,950 to ch. 5,075	4.79	3.96 to 10.14 ²	5.00	Likely	Low
P7-MC-27	Widening	ch. 5,075 to ch. 5,200	4.28	3.96 to 10.14	5.60	Likely	Low
P7-MC-28	Widening	ch. 5,200 to ch. 5,275	3.07	0.30 to 6.25 ²	2.80 to 5.60	Likely	Likely
P7-NCN-05	Cutting	ch. 5,225 to ch. 5,375	1.07	4.44 to 4.70	2.80	Low	Low
P7-MC-29	Widening	ch. 5,275 to ch. 5,375	4.33	3.70 to 4.90	4.20	Likely	Likely
P7-MC-30	Widening	ch. 5,375 to ch. 5,750	4.39	1.53 to 3.37	4.55	Likely	Likely
P7-MC-32	Widening	ch. 5,975 to ch. 6,025	1.55	1.84 to 7.88	-	Low	Low
P7-MC-33	Widening	ch. 6,100 to ch. 6,250	2.53	Dry ²	-	Low	Low
P7-MC-34	Widening	ch. 6,250 to ch. 6,450	2.66	Dry ²	-	Low	Low
P7-NCN-06	Cutting	ch. 6,400 to ch. 6,450	1.57	1.82 to 2.13 ²	-	Low	Low
P7-MC-35	Widening	ch. 6,450 to ch. 6,600	1.74	Dry ²	-	Low	Low
P7-NCN-07	Cutting	ch. 6,500 to ch. 6,600	1.92	2.90 ²	6.00 to 9.90	Low	Low
P7-MC-35	Widening	ch. 6,600 to ch. 6,700	1.20	1.50 to 2.70 ²	-	Low	Low
P7-MC-36	Widening	ch. 6,700 to ch. 6,800	2.35	1.50 to 2.70 ²	-	Likely	Low
P7-BJ-01	Cutting	ch. 7,400 to ch. 7,575	7.26	0.60 to 7.17	-	Likely	Low
P7-MC-39	Widening	ch. 9,300 to ch. 9,600	3.49	2.00 to 3.50 ²	4.30	Likely	Low

Earthwork Ref. ¹	Cutting/Widening	Chainage (approx.)	Maximum Excavation Depth (m bgl)	Local Groundwater Depth Range (m bgl)	Local Bedrock Depth Range (m bgl)	Likelihood to Intercept Groundwater	Likelihood to Intercept Bedrock
Sustainable Drainage System (SuDS) Basins							
SuDS 000	Cutting	ch. -900	3.00	0.87 to 1.10	7.40	Likely	Low
SuDS 001	Cutting	ch. 100	1.80	2.10 to 2.60 ²	-	Low	Low
SuDS 003	Cutting	ch. 300	3.80	0.70 to 1.80 ²	-	Likely	Low
SuDS 004	Cutting	ch. 400	2.50	1.80 ²	-	Likely	Low
SuDS 042	Cutting	ch. 4,200	2.90	4.00 ²	-	Low	Low
SuDS 065	Cutting	ch. 6,500	2.06	2.90 ²	-	Low	Low
SuDS 069	Cutting	ch. 6,900	3.40	0.86 to 1.40	6.00	Likely	Low
SuDS 078	Cutting	ch. 7,800	3.80	8.40 to 10.50 ²	-	Low	Low
SuDS 083	Cutting	ch. 8,300	1.40	6.10 to 9.12	-	Low	Low
SuDS 092	Cutting	ch. 9,200	1.80	2.40 to 4.21	-	Low	Low
Compensatory Flood Storage Areas³							
CSA-030a	Cutting	ch. 3,000	1.50	Dry ²	19.00	Low	Low
CSA-030b	Cutting	ch. 3,050	1.50	4.50 ²	19.00	Low	Low
CSA-031	Cutting	ch. 3,175	1.50	1.80 to 6.70 ²	-	Low	Low
CSA-033	Cutting	ch. 3,300	1.50	1.60 to 6.50 ²	-	Low	Low
CSA-041	Cutting	ch. 4,100	1.50	1.30 to 3.50 ²	-	Likely	Low
CSA-046	Cutting	ch. 4,600	1.50	0.40 to 0.43	-	Likely	Low
CSA-048	Cutting	ch. 4,800	1.50	2.80 ²	-	Low	Low
CSA-049-1	Cutting	ch. 4,900	1.50	2.80 ³	-	Low	Low
CSA-049-2	Cutting	ch. 4,950	1.50	2.80 ²	-	Low	Low
CSA-064	Cutting	ch. 6,400	1.50	1.82 to 2.13 ²	9.90	Low	Low
CSA-066	Cutting	ch. 6,600	1.50	2.90 ²	6.00 to 9.90	Low	Low
CSA-071	Cutting	ch. 7,100	1.50	1.20 to 4.40 ²	4.25	Likely	Low
CSA-079	Cutting	ch. 7,900	1.50	3.00 ²	-	Low	Low
CSA-092	Cutting	ch. 9,200	1.50	3.57 to 3.88	4.30	Low	Low
CSA-093	Cutting	ch. 9,300	1.50	3.57 to 3.88	4.30	Low	Low

Table Notes:

1. Earthworks references and proposed SuDS basins/ compensatory flood storage areas are shown on **Drawings 10.24 to 10.37 (Volume 3)**
2. Groundwater level information based on water strike data or nearby locations
3. Each flood storage area will be subject to detailed design, be terraced in nature and depths of excavation will vary. However, the assessment has been based on these typically involving removal and setting aside of soils/ peat turves to a maximum depth of 0.50m and removal of a further 1.00m of material, prior to re-instatement of the soils/ peat turves to create an area 1.00m lower than existing ground level.

10.4.6 Cuttings for the mainline of the Proposed Scheme predominantly relate to widening of existing cuts on sloping ground; which is likely to have lesser effects on baseline groundwater conditions. However, SuDS basins, compensatory flood storage areas, some access tracks and the proposed Dalnaspidal and Balsporran Cottage/ Drumochter Lodge Junctions will require new cuttings.

10.4.7 Additionally, excavations below embankments for the removal of silt and peat may occur, while filter drain networks associated with the twelve SuDS basins, pre-earthworks drainage ditches, fifty-eight proposed culverts (extensions or replacements), five changes to existing structures (demolition and replacement or extension) and two new structures are proposed.

10.4.8 Ten retaining walls of varying length are also proposed northward of Dalnaspidal and through the Pass of Drumochter. Nine of these would be located on the southbound carriageway to minimise encroachment into the Drumochter Hills SAC and avoid undermining BDL pylons to the east. The

other is required on the northbound carriageway where the mainline alignment passes close to the National Cycle Network Route 7 (NCN7) access track and HML railway line to the west.

Geology

Superficial Geology

- 10.4.9 Made ground, fluvial and glacial superficial deposits of **negligible** sensitivity (alluvium, river terrace deposits, glaciofluvial deposits and till) within the permanent and temporary works boundaries of the Proposed Scheme are likely to be impacted by construction of all widenings, cuttings, access tracks, SuDS basins, drainage, structures, culverts and watercourse diversions, to varying extents.
- 10.4.10 The reduction in extent of these deposits as a result of the construction activities is considered to be of **minor** magnitude because of their widespread occurrence in the region and the country, and therefore minimal percentage loss. There is also the potential for these deposits to be re-used within the Proposed Scheme. As a result, the overall impact significance is considered to be **Neutral** for both the construction and operation phases.

Solid Geology

- 10.4.11 Bedrock of **negligible** sensitivity is considered likely to be intercepted by mainline widening P7-MC-07 and cuttings P7-DJ-01, P7-DJ-02 and P7-DJ-03 for Dalnaspidal Junction, as identified in **Table 10-13**. Due to the widespread occurrence of the rock types in the region and the country, these are expected to represent a **minor** magnitude of impact on the solid geology, resulting in an overall impact significance of **Neutral** for both construction and operation. There is also the potential for excavated rock to be re-used in the Proposed Scheme.
- 10.4.12 The use of blasting in areas of anticipated rock cut cannot be ruled out, which may impact upon the existing rock structure and have the potential to generate new fractures, extend existing ones and have indirect impacts on groundwater flow paths. The impacts of blasting on such flow paths has been considered in the groundwater assessment. However, based on the anticipated depth of rock cut at the locations identified in **Table 10-13** and the structural geology present, the impacts of blasting on the solid geology is expected to be of **minor** magnitude and **Neutral** significance for construction and operation.
- 10.4.13 Widenings for the mainline at P7-MC-28, P7-MC-29 and P7-MC-30 may also intercept bedrock; but are discussed in the geodiversity sub-section in relation to existing rock exposures.

Designated Geological Receptors and Features of Geodiversity Interest

Allt Dubhaig

- 10.4.14 The Allt Dubhaig GCR is of **high** sensitivity and located adjacent to the west of the permanent and temporary works boundaries beyond the HML railway; from ch. 400 at Dalnaspidal to ch. 2,950 in the Pass of Drumochter. No encroachment will occur through construction or operation of the Proposed Scheme and no direct impacts are anticipated as a result.
- 10.4.15 Notwithstanding; the GCR is a dynamic fluvial area, with a close hydrological connection to several watercourse crossings that pass under the existing A9 carriageway and HML railway. As the Proposed Scheme will cross the catchment area; it may therefore be vulnerable to potential impacts during construction or operation, through any un-natural changes in the magnitude and frequency of run-off, water and sediment discharge, which could lead to changes in the nature and rate of fluvial geomorphological processes operating at the site.

- 10.4.16 These potential indirect impacts during construction and operation of the Proposed Scheme, including impacts to sediment regime, channel morphology, fluvial processes and flow conditions in the catchment, are identified and assessed in **Chapter 11**.

Drumochter Hummocky Moraines

- 10.4.17 Moraine ridges and mounds associated with the Drumochter Hummocky Moraines landform assemblage and candidate LGS (Barron *et al.*, 2011) of **medium** sensitivity, are located to the east and west of the Proposed Scheme across its extents, as indicatively illustrated in **Drawings 10.10 to 10.16 (Volume 3)**. The abundance of the features and prevalence of the landform assemblage predominantly increases upslope and outwith the permanent and temporary works boundaries, particularly west of the HML railway. However, marginal valley-bottom examples of remnant ridges and mounds as documented by Lukas (2003; 2004) are located in vicinity of the Proposed Scheme earthworks extents; most notably at Dalnaspidal and through the Pass of Drumochter.
- 10.4.18 These features are likely to be impacted by construction of mainline widenings, embankments, establishment of retaining walls and temporary works through the Pass of Drumochter and cuttings, winter resilience planting, SuDS basins and access tracks at Dalnaspidal Junction. The resultant disturbance, partial or total loss of individual mounds, ridges, or groups of these, is considered to be of **minor** magnitude overall given the marginal nature of the examples present within the Proposed Scheme extents, and their wider distribution across the study area.
- 10.4.19 The Proposed Scheme is therefore likely to represent a medium effect on the overall landform assemblage and setting, but disturbances are considered to be such that the overall geodiversity value of the moraines across and outwith the study area would not be affected. The impact is therefore assessed to be of **Slight/ Moderate** significance for construction and operation.

Allt Coire Chuirn Alluvial Fan

- 10.4.20 An access track is proposed to follow the alignment of an existing track that was constructed for the BDL Power Line development in the area of Allt Coire Chuirn, with alluvial fan deposits here being **medium** sensitivity. Assuming the existing track infrastructure stays in place, the works proposed would comprise upgrading to make it permanent, an additional track at the central portion which connects down to the A9, a new crossing structure of Allt Coire Chuirn and a widened access track leading towards Drumochter Lodge.
- 10.4.21 Shallow widening, embankment and drainage upgrades would be required throughout and may intercept or seal alluvial fan deposits and soil (peaty gleys and peaty podzols with blanket peat some humus-iron podzols) in the area. Within the northern extents of the Proposed Scheme, from ch. 7,900 through the northern tie-in to Project 8 – Dalwhinnie to Crubenmore; widenings and cuttings for the mainline, drainage, SuDS basins, culverts and watercourse crossings may also intercept these as shown in **Drawings 10.15 and 10.16 (Volume 3)**.
- 10.4.22 Most works are distanced from and would avoid direct disturbance of observed partial exposure areas near the Allt Coire Chuirn fan apex and along its length, while interception of fan deposits and soil across the wider area is likely to result in only a small overall direct effect on and additional disturbance to these and the local landform (additional to that of the existing track and other infrastructure).
- 10.4.23 Some additional disturbance is therefore considered likely as a result of the Proposed Scheme, but such that the soils and geodiversity value of the area would not be affected. Based on **Table 10-2**, this is therefore considered to represent an impact of overall **minor** magnitude and **Slight/ Moderate** significance during construction and operation. In terms of hydromorphology in the

area (sediment regime, channel morphology and fluvial processes), impacts during construction and operation are identified and assessed in **Chapter 11**.

Drumochter Debris Cones and Hillsides of Drumochter Pass

- 10.4.24 Neither the Drumochter debris cones at the base of An Torc and the Sow of Atholl to the west (**medium** sensitivity) or other examples of debris flow and cones on the hillsides of Creagan Doire Chonaich to the east through the Pass of Drumochter (**low** sensitivity) are considered likely to be directly or indirectly impacted by construction of the Proposed Scheme.

Pass of Drumochter Pollen Record Site

- 10.4.25 The **low** sensitivity pollen record site (Walker, 1975) in the Pass of Drumochter is likely to be impacted by the construction of mainline embankments, temporary works areas, watercourse diversions, compensatory flood storage, drainage and the proposed realignment of the NCN7 access track. The area also corresponds to an expanse of blanket bog, transition mire, swamp and wet heath, with deep peat recorded throughout, and up to 8.40m near the centre of the basin.
- 10.4.26 Walker (1975) recorded that pollen percentages declined in the upper peat profiles in the area, which suggests shallow surface disturbance of these and the near-surface hydrology as a result of cuttings for the NCN7 track realignment, temporary works, compensatory flood storage, drainage or diversion of existing watercourses across the area are unlikely to result in the disruption or loss of vegetational records at greater depth. Given the nature of the habitat and peat conditions in the area however, the possible requirement for excavation below and beyond the mainline embankments and other scheme elements between ch. 3,950 and ch. 4,300 may be significant. This would result in major effects to the setting and cause disturbance of the stratigraphy, sediments and vegetational records at depth, such that the value of the site may be affected.
- 10.4.27 Based on **Table 10-2**, this would result in potential impacts of **moderate** to **major** magnitude and **Slight/ Moderate** to **Moderate** significance for both construction and operation.

Rock Exposures

- 10.4.28 Based on **Table 10-13**, proposed retaining walls through the Pass of Drumochter and widenings for the mainline at P7-MC-28, P7-MC-29 and P7-MC-30 are likely to be founded on or intercept bedrock in existing exposure areas P07-RE01, P07-RE-02 and P07-RE03, which are of **negligible** sensitivity. These will have a **major** magnitude of impact, relative to the proportion of concealment or exposure loss defined in **Table 10-2**, resulting in impacts of **Slight** significance.

Mineral Extraction

- 10.4.29 There is an absence of historical/ recent mineral extraction activities within the study area, and widenings or cuttings within superficial deposits or bedrock are considered unlikely to result in future mineral exploitation or mineral resources being limited or sterilised.
- 10.4.30 The impact magnitude is therefore considered to be **negligible** based on the minimal percentage loss of potential local resources and the criteria in **Table 10-2**, resulting in an impact of **Neutral** significance during both construction and operation.

Soils

Soil Conservation

- 10.4.31 Soils of medium (peaty gleyed and peaty podzols, peaty rankers, mineral and peaty alluvial soils) and high (peat) conservation interest are likely to be impacted by the construction of widenings, cuttings, access tracks, SuDS basins, drainage, structures, culverts and watercourse diversions throughout the Proposed Scheme extents.
- 10.4.32 The impact on the conservation interest of the soils as a result of the construction activities is considered to be of **minor** magnitude. This equates to partial losses and soil disturbance across the Proposed Scheme, but where their overall rarity, representivity and diversity is unlikely to be significantly diminished and conservation value in the area and region will not be significantly affected. There is also the potential for the soils to be re-used within the Proposed Scheme or re-instated. The impact significance in terms of conservation interest is therefore considered to be **Slight/ Moderate to Moderate** for both construction and operation.

Agricultural Productivity

- 10.4.33 Temporary and permanent land-take impacts in relation to agricultural land use interests of the Dalnacardoch, Dalnaspidal, North and South Drumochter Estates are assessed in **Chapter 8**. Based on this, an approximate and combined 118ha of agricultural land area and **low** sensitivity soil in terms of agricultural productivity, will be disturbed by construction.
- 10.4.34 Due to the wider distribution of the soils and areas that are actively under some form of grazing or sheep herding use, this is considered to represent an impact of **minor** magnitude in terms of agricultural soil productivity. There is also the potential for soils to be re-used as part of the Proposed Scheme or re-instated. The overall impact significance is therefore considered to be **Neutral/ Slight** during both construction and operation.

Peat

- 10.4.35 The Proposed Scheme has been designed at this stage to avoid and/ or minimise disturbance or impact in areas of peat and minimise potential excavation volumes, as detailed in the Outline Peat Management Plan (OPMP) within **Appendix 10.6 (Volume 2)**. However, some areas have proven to be unavoidable and will be disturbed during the construction of widenings, embankments, cuttings, tracks, SuDS, drainage, structures, culverts, watercourse diversions and compensatory flood storage areas.
- 10.4.36 Based on the dimensions and anticipated design nature for each of these Proposed Scheme elements, and utilising the peat depth model shown in **Drawings 10.17 to 10.23 (Volume 3)**; the volumes of peaty soil/ topsoil, shallow peat and deep peat (including separation as acrotelm and catotelm) estimated to be excavated during construction are summarised in **Table 10-14**.

Table 10-14: Estimated Peaty Soil/ Topsoil and Peat Excavation Volumes

Scheme Element	Estimated Excavation Volume ¹ (m ³)			Estimated Acrotelm-Catotelm Excavation Volume ² (m ³)	
	Peaty Soil/ Topsoil	Shallow Peat	Deep Peat	Acrotelm	Catotelm ³
Mainline Alignment	57,805	25,234	44,090	10,872	58,452
Dalnaspidal Junction	12,529	5,912	3,078	2,278	6,713
Balsporran/ Drumochter Junction	5,670	5,767	8,485	2,812	11,440
Permanent SuDS Basins	5,887	6,160	3,553	2,401	7,312

Scheme Element	Estimated Excavation Volume ¹ (m ³)			Estimated Acrotelm-Catotelm Excavation Volume ² (m ³)	
	Peaty Soil/ Topsoil	Shallow Peat	Deep Peat	Acrotelm	Catotelm ³
SuDS Access	1,043	1,380	0	347	1,033
Underpass (ch. 3,000)	263	0	0	0	0
Watercourse Diversions	3,410	2,676	2,437	1,775	3,337
Compensatory Flood Storage Areas	0	1,372	3,644	76	4,940
Drainage	5,364	2,395	1,323	1,787	1,931
Totals	91,971	50,896	66,610	22,348	95,158

Table Notes:

1. Estimated volumes are residual (i.e. net volumes after any re-instatement at the point of excavation has been accounted for, as detailed in **Appendix 10.6 (Volume 2)**). Volumes also assume that existing BDL/ Drumochter access track is not re-instated prior to construction.
2. Acrotelm and catotelm are defined in **Appendix 10.1 (Volume 2)** and quantities are based upon the measured thickness of acrotelm in the field in shallow and deep peat as described in **Appendix 10.6 (Volume 2)**. If the top 0.50m were to be treated as acrotelm (as suggested in **Appendix 10.6 (Volume 2)**), the volume estimated for this would increase and that for catotelm would decrease.
3. Based on data presented in **Appendix 10.1 (Volume 2)**, evidence of nearly complete to completely decomposed (amorphous) peat (H9 or H10) has been observed at depth in selected areas based on von Post (Hobbs, 1986) classifications. Of the initial calculated residual catotelm quantities, approximately 10% (equivalent to **9,515m³**) may be more strongly decomposed (H7 or greater).

- 10.4.37 At a broad scale, the excavation volumes correspond to the direct disturbance of 1.11 ha of Class 1 and 34.52 ha of Class 2 priority peatland areas in the Proposed Scheme extents, with 14.67 ha Class 3 and 16.49 ha Class 5 near Dalnaspidal and south of Drumochter Lodge. At a local scale, they correlate to the permanent and temporary disturbance of natural and semi-natural peaty soil and/ or peat-based habitat such as blanket mire, mire, wet heath, mosaics of these, dry heath and grasslands, as described in **Chapter 12**.
- 10.4.38 Based on these considerations and the criteria in **Table 10-2**, the magnitude of direct disturbance impacts from the Proposed Scheme in relation to peaty soil, topsoil and peat are anticipated to be **minor to moderate** overall. This equates to partial disturbance and loss of individual peatland areas of **medium to high** sensitivity throughout, but predominantly where their value would either not be affected, or would be, but not to a major degree. This results in impacts of **Slight/ Moderate to Moderate** significance during construction and operation.
- 10.4.39 The key areas of potential higher magnitude impact are located within and adjacent to the Proposed Scheme at Dalnaspidal (ch. 500 to ch. 1,100), through the Pass of Drumochter (ch. 3,000 to ch. 4,600), near Balsporran (ch. 7,050 to ch. 7,250), and Drumochter Lodge (ch. 7,450 to ch. 7,650). Proposed infrastructure (widening, cuttings, embankments, SuDS basins, access tracks, drainage and watercourse diversions) in these locations intercept and/ or border **high** sensitivity areas of shallow or deep peat within blanket bog, transition mire, swamp or wet heath/ bog mosaics. Based on **Table 10-2** and the estimated excavation volumes; the impact in these areas is assessed to be of **moderate** magnitude and **Moderate/ Large** significance.
- 10.4.40 Areas of excavation within and adjacent to peat may also lead to its oxidation via dewatering, while other infrastructure may alter local hydrological regimes. Based on estimates of potential dewatering extents (JNCC, 2005; CIRIA, 2016), published literature and typical peat permeabilities (Stewart and Lance, 1991; Nayak *et al.*, 2008; Dargie, 2009; Scottish Government, 2011c); the magnitude of such impacts are anticipated to be **minor**, resulting in impacts of **Slight/ Moderate** significance for the majority of the Proposed Scheme and **Moderate** significance in the vicinity of the Dalnaspidal and Balsporran/ Drumochter Junctions.
- 10.4.41 A Preliminary Peat Landslide Risk Assessment for the Proposed Scheme identified risks across the majority of it and adjacent areas to be negligible or slight. However, localised areas assessed to be of moderate and/ or substantial risk have been highlighted. The location of these are detailed in **Appendix 10.5 (Volume 2)** and illustrated in **Drawings 10.5.15 to 10.5.18 (Volume 3)**.

Groundwater

10.4.42 Potential impacts on groundwater levels and flow are outlined below, followed by consideration of impacts that may apply to groundwater quality, GWDTE, surface water features and PWS.

Groundwater Flow

10.4.43 Several areas of mainline widening or other cutting have the potential to intercept groundwater as identified in **Table 10-13**. This is expected to result in lowering of groundwater levels and alter local flow directions in these areas. The excavations are anticipated to be predominantly formed in coarse granular till and hummocky glacial deposits (**medium** sensitivity) to the east and west, but also alluvium and alluvial fan (**high** sensitivity) in northern extents of the Proposed Scheme, to the west at Dalnaspidal and to the east and west near Balsporran and Drumochter.

10.4.44 Due to the nature of the existing topography across the Proposed Scheme and that the majority of cuttings relate to widening of existing ones to the east, the impacts on groundwater level and flow in superficial deposits in these areas are assessed to be of predominantly **minor** magnitude. This equates to impacts of **Slight** significance on glacial (till and hummocky glacial) deposits, and **Slight/ Moderate** significance on fluvial (alluvium and alluvial fan) deposits during construction and operation. The magnitude of potential impact is assessed to be higher for the Dalnaspidal (P7-DJ-01 to P7-DJ-03) and Balsporran/ Drumochter Lodge Junctions (P7-BJ-01), due to the depth of excavations, potential drawdown and greater likelihood for local flow patterns to be altered. Retaining walls through the Pass of Drumochter may also alter local flows at the superficial-bedrock interface due to piled foundations. Potential groundwater level and flow impacts in these areas are therefore assessed to be of **moderate** magnitude and **Moderate** significance.

10.4.45 Bedrock groundwater may be intercepted in seven areas of widening or cutting underlain by the Gaick Psammite Formation and the Grampian Group (**medium** sensitivity) through the Pass of Drumochter, while the requirement for rock blasting cannot be ruled out. Based on the location of these areas, the structural geology present (including faulting), depth of possible rock cut and the criteria in **Table 10-5**, potential impacts on bedrock groundwater levels and flow are considered to be of **moderate** magnitude and **Moderate** significance during construction and operation.

10.4.46 The construction of embankments across the Proposed Scheme may also result in excavation or compaction of shallow soil and superficial deposits below their footprint, while pre-earthworks drainage during construction, and filter drains during operation could create localised drawdown of shallow groundwater. These are assessed to result in local impacts of **negligible** to **minor** magnitude and **Neutral** to **Slight** significance on groundwater levels and flow.

Groundwater Quality

10.4.47 Based on groundwater vulnerability mapping shown in **Drawing 10.9 (Volume 3)**, all groundwater within the study area may be vulnerable to accidental spillages during construction or operation, and subsequent contamination impact on groundwater in the underlying superficial deposits or bedrock. The areas at highest risk are those in the vicinity of widenings and cuttings anticipated to intercept groundwater in **Table 10-13** and receptors such as GWDTE or PWS. The magnitude of impact is assessed as **moderate** on both superficial deposits (**medium** to **high** sensitivity) and bedrock (**medium** sensitivity), resulting in potential groundwater quality impacts of **Moderate** to **Moderate/ Large** significance.

10.4.48 SuDS basins and filter drains could also act as pathways for contamination to enter groundwater. However, at least two levels of treatment for mainline and junction drainage will be provided

(one level for access tracks), while filter drains and SuDS basins are proposed to be lined. This is anticipated to prevent ingress of potential contaminants to groundwater and provide attenuation before discharging to surface waters. As such, impacts of **negligible** magnitude and **Neutral** significance are expected on groundwater quality in superficial soils and bedrock with respect to these features.

Groundwater Dependent Terrestrial Ecosystems

- 10.4.49 The Proposed Scheme has been designed at this stage to avoid and/ or minimise disturbance of GWDTE. However, almost all proposed infrastructure is located within 100m of areas assessed to have at least a degree of groundwater dependence. Several have therefore proven to be unavoidable and are likely to be impacted.
- 10.4.50 The quantified extent of areas directly affected due to the permanent and temporary works are detailed in an assessment for each GWDTE habitat in **Appendix 10.2 (Volume 2)**, together with consideration of potential indirect effects from areas of mainline widening or other cutting that have the potential to intercept groundwater from **Table 10-13**. The magnitude and significance of impact for each area is based on combined consideration of the potential direct and indirect effects where relevant, together with assessment of the potential drawdown at the receptor against the intervening topography and the nature of the likely local water supply mechanisms to the habitat being assessed.
- 10.4.51 Based on these aspects and the criteria in **Table 10-5**, the magnitude of potential impacts on the individual GWDTE (**medium to very high** sensitivity) are assessed to vary from **negligible to major** across the Proposed Scheme; with direct loss and/ or drawdown effects throughout, but mainly where the value of the individual areas would either not be affected, or would be, but not to a major degree. For the 345 GWDTE assessed, this results in potential impacts ranging from **Neutral to Slight** significance for 203 habitat areas (59%), **Slight/ Moderate to Moderate** significance for 71 habitat areas (21%), **Moderate/ Large to Large** significance for 54 habitat areas (16%) and **Large/ Very Large to Very Large** significance for 17 habitat areas (5%).
- 10.4.52 The impacts identified are predominantly in relation to habitat mosaics considered to have only a low dependence on groundwater throughout the Proposed Scheme. However, several areas with a dominant or sub-dominant cover of wet heath (NVC M15 and M16), mire (NVC M6), soakaway (NVC M29), calcifugous and mesotrophic grasslands (NVC U6, MG9, MG10, CG10) or containing flushes and springs assessed to have a moderate or high groundwater dependence will also be affected. Partial and locally complete permanent loss of some areas is therefore anticipated due to the Proposed Scheme footprint, while disturbance within the land made available during construction may result in temporary, but in many cases reversible, effects.
- 10.4.53 With the exception of some that are locally present in habitat mosaics around Dalnaspidal and through the Pass of Drumochter, known flush (NVC M15a, M10, M11) and spring (NVC M32) features within the east of the study area are predominantly avoided. However, a number of soligenous and base-rich flushes are present within and at the margins of the Drumochter Hills SAC to the east of the northern extents, where overland flow from or associated with these or similar features is diffuse. The access track proposed on the alignment of the existing BDL track bisects moderate and highly groundwater dependent areas (**high to very high** sensitivity) in this area; running perpendicular to the flow direction across sloping ground.
- 10.4.54 Barrier effects to this flow are presently evident in the area, with frequent ponding and gathering of water on the upslope side of the track. However, as proposed track upgrades include up-gradient ditches for the interception of the flow and transmittal of this via check-dams, then cross-track culverts to the down-gradient side; this barrier effect will be removed. Based on

Table 10-5; the magnitude of impact is therefore considered to be **negligible to minor**, resulting in beneficial impacts of **Neutral/ Slight to Moderate/ Large** significance.

- 10.4.55 The ecological importance of the habitats in the study area are outlined in **Chapter 12**, with regards conservation interest, environmental designations and the significance of ecological loss or disturbance of these. This identifies that the majority of impacts occur within or along the edge of more extensive habitat mosaics, within or adjacent to the existing A9 corridor, and where vegetation composition, structures and processes are already affected by land management, drainage or infrastructure. Several are therefore not considered to represent the best habitat examples, with **Table 12-28** in **Chapter 12** noting that ecological losses and disturbance may only be locally potentially significant in relation to wet heath and blanket mire types.

Groundwater Effects on Surface Water

- 10.4.56 Lowering of groundwater levels or dewatering in excavations can affect nearby surface water features that interact with groundwater, by altering their baseflow component.
- 10.4.57 There are several minor watercourses along and adjacent to the Proposed Scheme, with the majority described in **Chapter 11** as being little more than road drainage or ephemeral channels. Although their narrow size and low flow make them vulnerable to reductions in baseflow and they are likely to be locally important for cross-carriageway hydrology; these are identified in **Appendix 11.1 (Volume 2)** to have minimal hydrological importance to sensitive ecosystems and are therefore considered to be of **low** sensitivity. The majority of these will also be replaced or diverted by the drainage network planned for the Proposed Scheme, with excavations considered unlikely to have significant dewatering effects. This is also considered to be applicable to excavations for culverts and watercourse diversions.
- 10.4.58 For other minor and major watercourses however, an assessment of potential impacts as a result of interaction with widenings and cuttings anticipated to intercept groundwater is summarised in **Table 10-15**. Surface watercourses are identified as per the feature referencing in **Chapter 11** and are illustrated in **Drawings 11.1 to 11.7 (Volume 3)**.
- 10.4.59 Where groundwater is not anticipated to be encountered in areas of excavation from **Table 10-13**, the potential impact is assigned as being of **negligible** magnitude and **Neutral** significance. Otherwise, the magnitude of impact is based on consideration of potential drawdown at the receptor against the intervening topography, size of the feature and its ecological sensitivity.

Table 10-15: Potential Impacts on Surface Water Features due to Interaction with Widening/Cuttings

Surface Water Feature Ref.	Surface Water Feature Name	Chainage (approx.)	Nearest Earthworks Ref.	Sensitivity	Magnitude	Significance
MW 7.2	Allt Dubhaig	ch. 400 to ch. 2,950	P7-MC-07	Very High	Negligible	Neutral
MW 7.2	Allt Dubhaig	ch. 400 to ch. 2,950	P7-MC-08	Very High	Negligible	Neutral
MW 7.2	Allt Dubhaig	ch. 400 to ch. 2,950	P7-MC-09	Very High	Negligible	Neutral
MW 7.2	Allt Dubhaig	ch. 400 to ch. 2,950	P7-MC-10	Very High	Negligible	Neutral
MW 7.2	Allt Dubhaig	ch. 400 to ch. 2,950	P7-MC-11	Very High	Negligible	Neutral
MW 7.2	Allt Dubhaig	ch. 400 to ch. 2,950	P7-MC-12	Very High	Negligible	Neutral
MW 7.2	Allt Dubhaig	ch. 400 to ch. 2,950	SuDS 020	Very High	Negligible	Neutral
MW 7.3	Allt Coire Mhic Sith	ch. 500	P7-DJ-01	High	Moderate	Moderate/ Large
MW 7.3	Allt Coire Mhic Sith	ch. 500	P7-DJ-02	High	Moderate	Moderate/ Large
MW 7.3	Allt Coire Mhic Sith	ch. 500	P7-MC-04	High	Negligible	Neutral
MW 7.4	Allt Ruigh nan Sgoilearan	ch. 1,400	P7-MC-06	High	Moderate	Moderate/ Large
MW 7.5	Unnamed (tributary of Allt Dubhaig)	ch. 1,900	P7-MC-07	Low	Moderate	Slight
MW 7.5	Unnamed (tributary of Allt Dubhaig)	ch. 1,900	P7-NCN-02	Low	Negligible	Neutral
MW 7.5	Unnamed (tributary of Allt Dubhaig)	ch. 1,900	SuDS 020	Low	Negligible	Neutral
MW 7.6	Allt Fuar Bheann	ch. 2,000	SuDS 020	High	Negligible	Neutral
MW 7.9	Allt a' Chaorainn	ch. 3,000	P7-MC-13	Very High	Negligible	Neutral
MW 7.9	Allt a' Chaorainn	ch. 3,000	P7-UP-01	Very High	Minor	Moderate/ Large
MW 7.11	Allt an Creagach	ch. 3,770	P7-MC-17	Very High	Negligible	Neutral
MW 7.11	Allt an Creagach	ch. 3,770	P7-MC-18	Very High	Negligible	Neutral
MW 7.18	Allt Coire Chaorainn	ch. 6,950	P7-BJ-01	Very High	Minor	Moderate/ Large
MW 7.20	Unnamed (tributary of River Truim)	ch. 7,250	P07-BJ-01	High	Negligible	Neutral
MW 7.23	Allt Coire Bhotie	ch. 9,300	P7-MC-39	High	Minor	Slight/ Moderate
MW 7.23	Allt Coire Bhotie	ch. 9,300	SuDS 092	High	Negligible	Neutral
MW 7.23	Allt Coire Bhotie	ch. 9,300	CSA-092	High	Negligible	Neutral
MW 7.25	Unnamed (tributary of Allt Chaorach Beag)	ch. -350	P7-MC-01	Low	Negligible	Neutral
MW 7.25	Unnamed (tributary of Allt Chaorach Beag)	ch. -350	P7-MC-02	Low	Negligible	Neutral

Surface Water Feature Ref.	Surface Water Feature Name	Chainage (approx.)	Nearest Earthworks Ref.	Sensitivity	Magnitude	Significance
MW 7.25	Unnamed (tributary of Allt Chaorach Beag)	ch. -350	SuDS 000	Low	Negligible	Neutral
MW 8.1	River Truim	ch. 3,750 to ch. 9,741	P7-MC-32	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 3,750 to ch. 9,741	P7-MC-33	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 3,750 to ch. 9,741	P7-MC-34	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 3,750 to ch. 9,741	P7-NCN-07	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 3,750 to ch. 9,741	P7-MC-35	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 3,750 to ch. 9,741	P7-MC-36	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 3,750 to ch. 9,741	P7-BJ-01	Very High	Minor	Moderate/ Large
MW 8.1	River Truim	ch. 3,750 to ch. 9,741	P7-MC-39	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 3,750 to ch. 9,741	SuDS 069	Very High	Minor	Moderate/ Large
MW 8.1	River Truim	ch. 3,750 to ch. 9,741	SuDS 077	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 3,750 to ch. 9,741	SuDS 083	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 3,750 to ch. 9,741	SuDS 092	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 3,750 to ch. 9,741	CSA-041	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 3,750 to ch. 9,741	CSA-046	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 3,750 to ch. 9,741	CSA-064	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 3,750 to ch. 9,741	CSA-069	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 3,750 to ch. 9,741	CSA-071	Very High	Negligible	Neutral
W 7.5	Unnamed (tributary of Allt Dubhaig)	ch. 2,450	P7-MC-09	High	Negligible	Neutral
W 7.5	Unnamed (tributary of Allt Dubhaig)	ch. 2,450	P7-MC-10	High	Negligible	Neutral
W 7.5	Unnamed (tributary of Allt Dubhaig)	ch. 2,450	P7-MC-11	High	Minor	Slight/ Moderate
W 7.9	Unnamed (tributary of River Truim)	ch. 5,500	P7-MC-30	High	Minor	Slight/ Moderate
W 7.15	Unnamed (tributary of River Truim)	ch. 7,000	SuDS 069	High	Negligible	Neutral
W 7.16	Unnamed (tributary of River Truim)	ch. 7,300	P07-BJ-01	Very High	Moderate	Large/ Very Large
W 7.19	Unnamed (tributary of River Truim)	ch. 8,200	SuDS 083	Low	Negligible	Neutral
W 7.23	Unnamed (tributary of Allt Coire Bhotie)	ch. 9,270	P7-MC-39	High	Minor	Slight/ Moderate
W 7.23	Unnamed (tributary of Allt Coire Bhotie)	ch. 9,270	SuDS 092	High	Negligible	Neutral
W 7.23	Unnamed (tributary of Allt Coire Bhotie)	ch. 9,270	CSA-092	High	Negligible	Neutral

Surface Water Feature Ref.	Surface Water Feature Name	Chainage (approx.)	Nearest Earthworks Ref.	Sensitivity	Magnitude	Significance
W 7.25	Unnamed (tributary of River Truim)	ch. 9,250	SuDS 092	Low	Negligible	Neutral
W 7.31	Unnamed (tributary of River Garry)	ch. -480	P7-MC-01	Low	Negligible	Neutral
W 7.31	Unnamed (tributary of River Garry)	ch. -480	P7-MC-02	Low	Minor	Neutral
W 7.43	Unnamed (tributary of Allt Dubhaig)	ch. 790	P7-DJ-02	Low	Major	Slight
W 7.43	Unnamed (tributary of Allt Dubhaig)	ch. 790	P7-NCN-01	Low	Major	Slight/ Moderate
W 7.50	Unnamed (tributary of Allt Dubhaig)	ch. 970	P7-DJ-02	Low	Minor	Neutral
W 7.50	Unnamed (tributary of Allt Dubhaig)	ch. 970	P7-DJ-03	Low	Major	Slight/ Moderate
W 7.50	Unnamed (tributary of Allt Dubhaig)	ch. 970	P7-MC-05	Low	Major	Slight/ Moderate
W 7.54	Unnamed (tributary of Allt Dubhaig)	ch. 1,250	P7-MC-05	Low	Moderate	Slight
W 7.54	Unnamed (tributary of Allt Dubhaig)	ch. 1,250	P7-MC-06	Low	Major	Slight/ Moderate
W 7.60	Unnamed (tributary of Allt Dubhaig)	ch. 1,680	P7-MC-07	Low	Major	Slight/ Moderate
W 7.60	Unnamed (tributary of Allt Dubhaig)	ch. 1,680	P7-NCN-02	Low	Negligible	Neutral
W 7.78	Unnamed (tributary of Allt a'Chaorainn)	ch. 2,850	P7-MC-12	Low	Negligible	Neutral
W 7.78	Unnamed (tributary of Allt a'Chaorainn)	ch. 2,850	P7-MC-13	Low	Negligible	Neutral
W 7.84	Unnamed (tributary of Allt Dubhaig)	ch. 3,435	P7-MC-16	Low	Negligible	Neutral
W 7.89	Unnamed (tributary of River Truim)	ch. 3,670	P7-MC-16	Low	Negligible	Neutral
W 7.89	Unnamed (tributary of River Truim)	ch. 3,670	P7-MC-17	Low	Negligible	Neutral
W 7.93	Unnamed (tributary of River Truim)	ch. 3,850	P7-MC-18	Very High	Negligible	Neutral
W 7.101	Unnamed (tributary of River Truim)	ch. 4,250	P7-MC-21	Low	Moderate	Slight
W 7.101	Unnamed (tributary of River Truim)	ch. 4,250	SuDS 042	Low	Negligible	Neutral
W 7.108	Unnamed (tributary of River Truim)	ch. 4,555	CSA-046	Low	Negligible	Neutral
W 7.109	Unnamed (tributary of River Truim)	ch. 4,690	P7-MC-22	Low	Major	Slight/ Moderate
W 7.115	Unnamed (tributary of River Truim)	ch. 4,955	P7-MC-23	Low	Negligible	Neutral
W 7.115	Unnamed (tributary of River Truim)	ch. 4,955	P7-MC-25	Low	Negligible	Neutral
W 7.134	Unnamed (tributary of River Truim)	ch. 6,270	P7-MC-33	High	Negligible	Neutral
W 7.134	Unnamed (tributary of River Truim)	ch. 6,270	P7-MC-34	High	Negligible	Neutral
W 7.134	Unnamed (tributary of River Truim)	ch. 6,270	SuDS 063	High	Negligible	Neutral
W 7.137	Unnamed (tributary of River Truim)	ch. 6,470	P7-MC-34	Low	Negligible	Neutral

Surface Water Feature Ref.	Surface Water Feature Name	Chainage (approx.)	Nearest Earthworks Ref.	Sensitivity	Magnitude	Significance
W 7.137	Unnamed (tributary of River Truim)	ch. 6,470	P7-MC-35	Low	Negligible	Neutral
W 7.137	Unnamed (tributary of River Truim)	ch. 6,470	P7-NCN-06	Low	Minor	Neutral
W 7.137	Unnamed (tributary of River Truim)	ch. 6,470	SuDS 065	Low	Negligible	Neutral
W 7.146	Unnamed (tributary of River Truim)	ch. 6,620	P7-MC-35	Low	Negligible	Neutral
W 7.146	Unnamed (tributary of River Truim)	ch. 6,620	P7-NCN-07	Low	Negligible	Neutral
W 7.146	Unnamed (tributary of River Truim)	ch. 6,620	SuDS 065	Low	Negligible	Neutral
W 7.146	Unnamed (tributary of River Truim)	ch. 6,620	CSA-066	Low	Negligible	Neutral
W 7.147	Unnamed (tributary of River Truim)	ch. 6,745	P7-MC-35	Low	Negligible	Neutral
W 7.147	Unnamed (tributary of River Truim)	ch. 6,745	P7-MC-36	Low	Major	Slight/ Moderate
W 7.147	Unnamed (tributary of River Truim)	ch. 6,745	P7-NCN-07	Low	Negligible	Neutral
W 7.150	Unnamed (tributary of River Truim)	ch. 6,820	SuDS 069	Low	Negligible	Neutral
W 7.152	Unnamed (tributary of River Truim)	ch. 6,870	SuDS 069	Low	Minor	Neutral
W 7.157	Unnamed (tributary of River Truim)	ch. 7,630	P7-BJ-01	Low	Major	Slight/ Moderate

Groundwater Abstractions and Private Water Supplies

- 10.4.60 Given its distance from the Proposed Scheme, intervening topography and proximity to the nearest areas of excavation considered likely to intercept groundwater; no potential impacts on quality or yield of the Balsporran Cottage PWS (ABS 7.2) (**high** sensitivity) are anticipated. This is also considered to be the case for the Drumochter Lodge PWS spring (ABS 7.3) (**high** sensitivity), as the source is located 500m up and cross-gradient outwith the estimated zone of dewatering influence from P7-BJ-01, and no works appear likely to intercept the supply network.
- 10.4.61 The PWS features for Dalnaspidal Lodge (ABS 7.4) (**high** sensitivity) and the Old Schoolhouse/ Station Cottages (ABS 7.5) (**high** sensitivity) are sourced from the Allt Coire Mhic Sith surface watercourse, with intakes on the eastern side of the A9 feeding holding tanks, then crossing the carriageway to supply the properties via a pipe network. The tanks and pipe network appear likely to be intercepted by cuttings P7-DJ-01, P7-DJ-02 and the footprint of Dalnaspidal Junction, while the supply quality may also be vulnerable to pollution incidents due to construction works in the vicinity of the surface water source. Based on **Table 10-5**, this is considered to equate to a potential impact of **major** magnitude and **Large/ Very Large** significance.
- 10.4.62 The response zone of the PWS borehole at Dalnaspidal Lodge (ABS 7.6) (**high** sensitivity) has not been confirmed, but this is considered likely to be within the alluvial/ weathered bedrock aquifer in the area. Potential impacts on the yield therefore cannot be ruled out, due to the depth of the borehole (15m), upgradient cuttings P7-DJ-01, P7-DJ-02 and P7-DJ-03 intercepting groundwater and the possibility of rock blasting being required for these. The quality of this supply may also be impacted by any contamination entering shallow groundwater during construction activities, particularly given the indications that a nearby well feature (ABS 7.7) represents a former supply to the same properties and thus, may be connected to the same aquifer as the current borehole (ABS 7.6). Based on **Table 10-5**, potential impacts are therefore assessed to be of **major** magnitude and **Large/ Very Large** significance.
- 10.4.63 The well feature itself (ABS 7.7) (**high** sensitivity) is also likely to be intercepted by the footprint of the Dalnaspidal Junction and SuDS 001, equating to a potential impact of **major** magnitude and **Large/ Very Large** significance.

Potential Contamination

- 10.4.64 A number of potential contamination sources have been identified in the study area, as shown in **Drawing 10.31 to 10.37 (Volume 3)**. An assessment of each source is presented in **Appendix 10.4 (Volume 2)** within the context of a preliminary CSM and with reference to the pollutant linkages identified in **Table 10-7**. Based on the criteria in **Table 10-8 to Table 10-10**, the CSM evaluates the level of potential risk (significance) that may be present in relation to impacts from each source, as a direct result of construction or operation activities associated with the Proposed Scheme.
- 10.4.65 In this respect, there are considered to be two potential ways in which the Proposed Scheme may interact with potential contamination, as follows:
- direct disturbance of potential contamination sources (i.e. those within the Proposed Scheme footprint or permanent and temporary works boundaries)
 - indirect disturbance of nearby potential contamination sources as a result of construction of the Proposed Scheme (i.e. interception within areas of excavation).

- 10.4.66 Direct interaction may occur with potential sources including the existing A9 carriageway (GGD-01), former electricity pylons (GGD-03), the former telephone exchange and tanks (GGD-05 and GGD-06), buildings/ properties at Dalnaspidal and Drumochter Lodge, including septic tanks (GGD-07, GGD-12, GGD-18 and GGD-20), occurrences of made ground (GGD-21 to GGD-74) with one instance of detected asbestos (GGD-73), potential radon hazard areas (GGD-09) and raised levels of ground gas (GGD-75). Based on the CSM assessment, this interaction is considered likely to occur for these sources and may affect human receptors during construction (PL1 to PL4), with **minor** to **medium** consequence and potential impacts of **Low** to **Moderate** significance. Interaction with the same sources may also occur during operation (PL13 to PL16) with similar consequence, but lower likelihood and **Very Low** to **Moderate/ Low** significance.
- 10.4.67 Where made ground material is excavated and temporarily stored during construction (including materials from demolished structures), this may additionally represent potential risks to human receptors (PL1 and PL3), the water environment and ecological receptors such as groundwater, surface water, GWDTE and livestock (PL5 to PL9 and PL11) or property receptors such as PWS (PL7), buried concrete and services (PL12). In the absence of mitigation, the potential of this occurring has been assessed as likely, and of **mild** to **medium** consequence during construction. Potential risks to the same receptors during operation are possible (PL13, PL15, PL17 to PL21, and PL23 to PL24) if the materials were re-used, and are assessed to be of similar consequence, but lower likelihood. Potential impacts are therefore identified to be of **Moderate/ Low** to **Moderate** significance during construction and **Very Low** to **Moderate/ Low** significance during operation.
- 10.4.68 Indirect impacts may occur where areas of widening and cutting intercept groundwater during construction, as they could draw local potential contaminated groundwater towards them or mobilise potential contaminated water within or adjacent to the footprint. This may then impact human health (PL1 and PL13), surface water, GWDTE or PWS receptors through migration (PL7) and require discharge during construction and operation (PL10 and PL22). Potential sources in relation to this principally include the HML railway (GGD-02), former pylons (GGD-03), existing BDL Power Line (GGD-04), former telephone exchange and tanks (GGD-05 and GGD-06), former Dalnaspidal Station (GGD-08), septic tanks at Dalnaspidal (GGD-18) and Drumochter Lodge (GGD-20), and localised inorganics and organics recorded in groundwater chemical testing results.
- 10.4.69 Dewatering effects from excavations for the Proposed Scheme are likely to be predominantly localised and greatest during construction, with longer-term interception of water managed by the detailed design of the excavation areas. The CSM assessment for the source areas, based on the potential for excavations in proximity to draw in or mobilise contaminated groundwater is presented in **Appendix 10.4 (Volume 2)**. During construction, the potential impacts are assessed to be of **Very Low** to **Moderate/ Low** significance, but with some source areas (including GGD-05, GG-06, GGD-08, GGD-10, GGD-18 and GGD-20) identified to have potential impacts of **Moderate** significance, based on potential for contamination presence and the proximity of sensitive receptors. Similar potential impacts during operation are proportional in terms of consequence, but one level lower in terms of likelihood. As such, impacts of between **Very Low** and **Moderate/ Low** significance are expected.

10.5 Mitigation

- 10.5.1 Based on the impact assessment, Standard Mitigation measures for the Proposed Scheme followed by Project Specific Mitigation considerations are detailed in **Table 10-16**. These measures take into account best practice, current legislation and guidance to further avoid, reduce or off-set the potential impacts identified where possible.

- 10.5.2 The Standard Mitigation measures are based upon those being applied across the A9 Dualling Programme and will be developed by the Contractor alongside the Project Specific Mitigation and relevant management systems to structure, monitor, control and communicate implementation, including a Construction Environmental Management Plan (CEMP).

Table 10-16: Standard and Project Specific Mitigation Commitments – Geology, Soils and Groundwater

Mitigation Item	Approximate Chainage/ Location	Timing of Measure	Description	Mitigation Purpose/Objective	Specific Consultation or Approval Required
Standard A9 Mitigation					
SMC-G1	Throughout Proposed Scheme	Pre-Construction	Prior to construction, consultation will be undertaken with the relevant local authorities and SEPA regarding works in relation to land affected by contamination to support the obligations set out in 'Planning Advice Note 33: Development of Contaminated Land' (Scottish Government, 2000). Any remedial action undertaken in relation to land affected by contamination will be carried out under the appropriate remediation licencing.	To reduce impacts from contaminated land sources.	Consultation with P&KC (and SEPA as required).
SMC-G2	Throughout Proposed Scheme	Pre-Construction	Prior to construction and where potential contamination has been identified, further site investigations sufficient to determine the extent and type of contaminants present will be undertaken as necessary to inform identification of appropriate construction methods and any additional mitigation.	To determine the extent and type of contaminants present and to inform identification of appropriate construction methods and any additional mitigation.	None required
SMC-G3	Throughout Proposed Scheme	Pre-Construction & Construction	Prior to construction, appropriate health and safety and waste management procedures for working with potentially contaminated soils will be established. Waste management procedures will take account of inter alia: Waste Management Licence (Scotland) Regulations 2011 (as amended by the Waste Management Licensing (Scotland) Amendment Regulations 2016), HSE Guidance Note MS31 (HSE, 2012) and the Health and Safety Commission Approved Code of Practice and Guidance Note. These procedures will be implemented as appropriate during construction.	To ensure appropriate health and safety and waste management procedures for working with potentially contaminated soils are followed.	None required
SMC-G4	Throughout Proposed Scheme	Construction & Post-Construction/Operation	Risks to construction and maintenance staff working with/ near contaminated land will be mitigated by the implementation of Mitigation Item SMC-G3 in combination with the adoption of appropriate systems of work, including personal protective equipment (PPE) as a last resort. In the event that unrecorded contamination is encountered, works should be stopped and the working procedures reassessed to confirm the working methods remain appropriate. Construction staff will be trained to identify asbestos containing material.	To reduce impacts from contaminated land sources and confirm the safety of construction and maintenance staff.	None required
SMC-G5	Throughout Proposed Scheme	Construction	Appropriate training will be provided for personnel involved in earthworks activities to enable implementation of a watching brief to identify presence of previously unidentified contamination.	To identify potential presence of previously unidentified contamination.	None required
SMC-G6	Throughout Proposed Scheme	Pre-Construction & Construction	Where required, landowner consultation and site visits will be undertaken to confirm the location of septic tanks and associated infrastructure. Where septic tanks are located within the LMA they will be relocated subject to discussion and agreement with the affected landowner(s).	To mitigate the loss of any septic tanks.	Approval from landowners
SMC-G7	Throughout Proposed Scheme	Construction	To prevent cross contamination and pollution from piling works undertaken in areas of land affected by contamination, the Contractor will undertake a Piling Risk Assessment and adhere to appropriate guidance including the 'Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention, National Groundwater and Contaminated Land Centre Report NC/99/77'.	To prevent cross contamination and pollution from piling works undertaken in areas of land affected by contamination.	None required

Mitigation Item	Approximate Chainage/ Location	Timing of Measure	Description	Mitigation Purpose/Objective	Specific Consultation or Approval Required
SMC-G8	Throughout Proposed Scheme	Construction	Excavated soils deemed unsuitable for reuse will be assessed in line with the 'Waste Classification: Guidance on the Classification and Assessment of Waste' (Technical Guidance WM3) (Natural Resources Wales, SEPA, Northern Ireland Environment Agency, Environment Agency, May 2015) to determine whether they are hazardous or non-hazardous. This will establish the most appropriate and cost effective waste stream for the waste materials.	To determine whether soils are hazardous or non-hazardous.	None required
SMC-G9	Throughout Proposed Scheme	Pre-Construction	To maximise the reuse of site-won materials on-site (and minimise the need for disposal of waste in line with the principles of the "Waste Hierarchy") whilst ensuring that no risks are posed to human health nor the water environment a soil reuse assessment will be undertaken prior to construction. The soil reuse assessment will identify any potential risks posed to both human health and the water environment from potentially contaminated soils reused throughout the Proposed Scheme.	To identify any potential risks posed to human health and the water environment. In addition, this mitigation item would maximise re-use of site-won materials on-site and minimise the need for disposal of waste in line with the principles of the "Waste Hierarchy" through re-use of excavation arisings (refer to Mitigation item SMC-M3 in Chapter 18).	None required
SMC-G10	Throughout Proposed Scheme	Construction	Where peat is encountered during construction, it will be excavated, stored and re-used if possible, taking cognisance of 'Development on Peatland: Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste' (Scottish Renewables and SEPA, 2012) and 'The Waste Management Licensing (Scotland) Regulations 2011'. This will be captured in a Peat Management Plan that will be developed by the Contractor.	To comply with relevant waste management practices under The Waste Management Licensing (Scotland) Regulations 2011 and reduce impacts on peatlands.	Consultation with SEPA
SMC-G11	Throughout Proposed Scheme	Pre-Construction & Construction	Does not apply to Project 7, more specific mitigation required for this Scheme. Where concrete materials are proposed to be used, appropriate guidance such as 'Building Research Establishment (BRE) SD1:2005' and 'British Standard (BS) BS8500' should be followed to ensure that ground conditions are appropriate for the use of concrete at each given location.	To ensure that ground conditions are appropriate for the use of concrete at each given location.	None required
SMC-G12	Contamination sources: GGD-09, GGD-75 and GGD-21 to GGD-74	Pre-Construction, Construction & Post-Construction/Operation	Where potential pollutant pathways for ground gas have been identified, a ground gas monitoring programme will be developed prior to construction in adherence to 'BS 8485:2015 - Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings'. This will include an assessment of gassing issues following receipt of additional ground gas monitoring results at selected boreholes. Appropriate working methods will be developed and adopted during below ground site construction works (including piling works and excavations). This should include as a minimum, gas monitoring undertaken prior to any entry into excavations, confined spaces or below ground structures and use of PPE as a last resort. If ground gas issues are identified during construction, further post construction monitoring will be undertaken and/ or appropriate gas protection measures will be incorporated into the final design.	To mitigate against potential impacts on human health during construction and Off Site Receptors (Local residents, transient traffic (foot, road and rail traffic) in the surrounding area) due to ground gas.	None required

Mitigation Item	Approximate Chainage/ Location	Timing of Measure	Description	Mitigation Purpose/Objective	Specific Consultation or Approval Required
SMC-G13	Throughout Proposed Scheme	Construction	Unless it can be demonstrated by the Contractor via a Quantitative Risk Assessment that no water quality impacts will occur due to leaching from SuDS retention ponds and detention basins, operational SuDS features will be lined.	To mitigate against potential impacts on water quality due to leaching from SuDS features.	SEPA
SMC-G14	Throughout Proposed Scheme	Construction	Storage of excavated soils and made ground will be minimised on site (spatially and in duration) and storage areas will be appropriately lined, with adequate drainage management in place.	To ensure that no polluted water percolates into the ground or contaminated runoff is generated.	None required
SMC-G15	Throughout Proposed Scheme	Pre-Construction	Risk assessments will be undertaken before explosives can be used on site.	To minimise or control the impact of blasting on bedrock geology.	None required
n/a (note)	n/a	n/a	<i>Further to the above, the implementation of Mitigation Items detailed in Chapter 11 (Road Drainage and the Water Environment) and the measures detailed in Chapter 16 (Air Quality).</i>	<i>To mitigate the water pollution risk to groundwater and avoid the creation of a statutory nuisance associated with dust and air pollution when working with contaminated land.</i>	n/a
Project Specific Mitigation					
P07-G1	Throughout Proposed Scheme	Pre-Construction & Construction	Prior to construction, a suitably qualified (or team of suitably qualified) and experienced Environmental Clerk of Works (EnvCoW) shall be appointed by the Contractor to oversee implementation of mitigation and monitoring relating to soils, potential contamination, groundwater, PWS and the management of waste materials. A suitably qualified and experienced Ecological Clerk of Works (ECoW) shall also be appointed prior to construction, to oversee and provide specific inputs to the implementation of proposed mitigation and monitoring relating to peat and GWDTE. Naturalistic rock cutting may be possible in areas of widening and cutting identified as being likely to intercept bedrock, the extent of which shall be determined during the detailed design by the Contractor, following risk assessment (Mitigation Item SMC-G15).	To oversee implementation of mitigation and monitoring relating to soils, potential contamination, groundwater, PWS, the management of waste materials, peat and GWDTE.	None required
P07-G2	ch. 400 to ch. 625 ch. 625 to ch. 975 ch. 1,500 to ch. 1,850 ch. 5,200 to ch. 5,750	Design, Pre-Construction & Construction	During construction, rock mapping and inspections shall be undertaken by a suitably qualified and experienced engineering geologist appointed by the Contractor in those areas determined, with the cuts being profiled to be as natural as possible with no visible engineered elements.	To review stability and minimise the requirement for meshing or other stabilisation measures within final rock cut profiles.	None required
P07-G3	ch. -900 to ch. 650 ch. 1,900 ch. 3,300 to ch. 4,800 ch. 5,400 to ch. 5,900 ch. 6,100 to ch. 6,600	Construction	Soil logging with photographs shall be undertaken and documented by a suitably qualified and experienced engineering geologist appointed by the Contractor during earthworks which disturb marginal moraine ridges and/ or mounds associated with the wider Drumochter Hummocky Moraines landform assemblage.	To compensate for partial or total feature losses, by recording the stratigraphy within examples of these landforms and gaining an insight into former glacier dynamics	Consultation with SNH

Mitigation Item	Approximate Chainage/ Location	Timing of Measure	Description	Mitigation Purpose/Objective	Specific Consultation or Approval Required
P07-G4	ch. 7,200 to ch. 9,741	Construction & Operation	During construction or delivery of upgrades to the existing BDL track, the Contractor shall minimise disturbance of the natural soil profile and landform across the area of Allt Coire Chuirn as far as is practicable. Damage to partial alluvial fan exposure areas at bar locations on Allt Coire Chuirn shall be avoided through set-backs as required and appropriate working procedures shall be adopted as per Mitigation Items SMC-W1 to SMC-W5 and SMC-W13 to SMC-W17 in Chapter 11 in relation to in-channel works and hydromorphology.	To minimise additional potential disturbance to soils and landform across the area, partial exposures and active channel morphology	Consultation with SNH
P07-G5	Mainline ch. 3,400 to ch. 4,600 ch. 3,950 to ch. 4,300 ch. 7,100 to ch. 7,200 NCN7 ch. 3,850 to ch. 4,100	Design, Pre-Construction & Construction	Where peat conditions and depths permit, the Contractor shall design and include measures (such as floated access tracks and piled or bridged solutions for embankments or structures) to avoid or minimise peat excavation and disturbance. This shall take account of the unique peat characteristics, and follow guidance on the design, duration and timing of construction, the sequencing of construction and hydrology considerations in 'Floating Roads on Peat: A Report into Good Practice in Design, Construction and Use of Floating Roads on Peat with particular reference to Wind Farm Developments in Scotland' (SNH/ FCS, 2010) and others, as necessary. Additional site surveys comprising peat probing, core sampling, soil logging with photographs, and pollen count laboratory analysis shall be completed and documented by the Contractor prior to and during construction works within the Pollen Record Site in the Pass of Drumochter.	To reduce peaty soil and peat disturbance and resultant excavation volumes	None required
P07-G6	Mainline ch. 3,400 to ch. 4,600 ch. 3,950 to ch. 4,300 ch. 7,100 to ch. 7,200 NCN7 ch. 3,850 to ch. 4,100	Design, Pre-Construction & Construction		To compensate for partial disturbance and loss of sediment and vegetational records	Consultation with SNH
P07-G7	Throughout Proposed Scheme	Pre-Construction & Construction	The Contractor shall develop a Soil Management Plan prior to construction, for implementation during construction, with cognance of the requirements identified in relation to peaty soils and peat (Mitigation Item P07-G8) and adopting principles from the 'Scottish Soil Framework' (Scottish Government, 2009) and other voluntary or industry regulated Codes of Practice, including 'Promoting the Sustainable Reuse of Greenfield Soils in Construction' (SEPA, 2010) and the 'Construction Code of Practice for the Sustainable Use of Soils on Construction Sites' (DEFRA, 2009).	To document and ensure that soil resources and soils of conservation value are excavated, managed, re-used and replaced sustainably and appropriately	Consultation with SEPA
P07-G8	Throughout Proposed Scheme	Pre-Construction, Construction & Post-Construction	Prior to construction, the Contractor shall refine the OPMP (Appendix 10.6 (Volume 2)) of the ES) for implementation prior to, during and following construction as the Construction stage Peat Management Plan (PMP). The Construction stage PMP shall adopt the principles and best practice measures detailed in the OPMP, with refinements made by the Contractor to include the establishment of detailed site-specific method statements related to construction techniques and locations, estimated excavation volumes, excavation procedures, temporary works activities, temporary storage, transportation, handling, proposed peat re-use areas and activities within those. Monitoring requirements and timescales for prior to, during and following construction, particularly with regards re-use and restoration works, shall be established and implemented by the Contractor as necessary, with all refinements made taking cognance of best practice in 'Development on Peatland: Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste' (Scottish Renewables and SEPA, 2012) and others, as necessary.	To comply with relevant waste management practices under The Waste Management Licensing (Scotland) Regulations 2011 and manage, reduce and monitor impacts on peat and peaty soils	Consultation with SNH, SEPA and CNPA required to agree on the Construction stage Peat Management Plan (PMP) and any proposed peat re-use

Mitigation Item	Approximate Chainage/ Location	Timing of Measure	Description	Mitigation Purpose/ Objective	Specific Consultation or Approval Required
P07-G9	Throughout Proposed Scheme	Pre-Construction, Post-Construction	Through adoption and refinement of the OPMP, the Contractor shall identify and propose environmentally beneficial re-uses of peat that is excavated during construction. Provisional candidate areas for this have been identified as detailed in the OPMP (Appendix 10.6 (Volume 2)) of the ES) and illustrated in Drawings 10.38 to 10.44 (Volume 3) , though the Contractor may identify additional areas to this within the LMA or elsewhere, by agreement prior to or during construction. Following re-use, dedicated monitoring of water table and vegetation in the re-use areas adopted shall be undertaken by the Contractor (Mitigation Item P07-G8) and the requirements for additional treatment work such as but not limited to, seeding, compaction, tapering, removal of invasive species and fencing, established on an ongoing basis in consultation with SEPA, SNH and CNPA.	To provide mitigation for peat excavation and disturbance	See Mitigation Item P07-G8
P07-G10	Throughout Proposed Scheme	Design, Pre-Construction & Construction	Temporary storage of excavated peat shall be avoided wherever possible by transporting it to identified re-use locations as soon as is practicable, and the time spent in storage shall be kept to a minimum where possible. Where this is not possible during construction, the Contractor shall take account of the Preliminary Peat Landslide Risk Assessment findings (Appendix 10.5 (Volume 2)) of the ES), undertake additional quantitative assessment where necessary and identify appropriate storage areas for excavated peat, including, varying or additional to those provisionally highlighted in Drawings 10.38 to 10.44 (Volume 3) .	To minimise peat volumes in storage and the likelihood of drying.	See Mitigation Item P07-G8
P07-G11	Throughout Proposed Scheme	Pre-Construction & Construction	Where excavated peat does require temporary storage, the areas for this shall avoid being near watercourses through appropriate set backs. Areas of GWDTE habitat assessed as likely moderate and/ or highly dependent on groundwater in Appendix 10.2 (Volume 2) of the ES shall also be avoided where possible – particularly areas of or containing discrete M6, M10, M11 and M15a flushes and M32 or M37 springs identified on Drawings 10.24 to 10.30 (Volume 3) . Where possible, peat will be extracted and relocated as 300mm to 500mm deep turves. If peat turves need to be stored for any length of time, they will be stored vegetation side up, stacked no more than 1.00m high, and monitored during all weather conditions and kept wet as necessary to prevent them from drying out.	To minimise peat volumes in storage, the likelihood of drying and potential effects on GWDTE	See Mitigation Item P07-G8
P07-G12	Throughout Proposed Scheme	Construction & Post-Construction	For temporary construction-stage SuDS and related drainage, the Contractor shall avoid areas of peat and avoid areas of GWDTE habitat assessed as being likely moderate and/ or highly dependent on groundwater in Appendix 10.2 (Volume 2) of the ES. This shall be achieved through micro-siting during detailed design and the use of above-ground solutions requiring no or limited excavation, such as siltbusters, where possible, during construction. Areas of peat or GWDTE habitat which are unavoidable and in which excavation is required for temporary construction-stage SuDS and drainage shall be re-instated by the Contractor as soon as possible following the completion of construction works. Such re-instatement shall return the areas to their former habitat type as far as is practicable using species appropriate to the environment and of local provenance.	To reduce peaty soil and peat disturbance, resultant excavation volumes and re-instate those areas which are temporarily disturbed	See Mitigation Item P07-G8

Mitigation Item	Approximate Chaining/ Location	Timing of Measure	Description	Mitigation Purpose/ Objective	Specific Consultation or Approval Required
P07-G13	Throughout Proposed Scheme	Design, Pre-Construction & Post-Construction	For temporary haul roads or access tracks required during construction, the Contractor shall avoid areas of peat and areas of GWDTE habitat assessed as being likely moderate and/ or highly dependent on groundwater in Appendix 10.2 (Volume 2) of the ES. Where unavoidable, floated track construction shall be considered where conditions and depths permit, with guidance from 'Floating Roads on Peat: A Report into Good Practice in Design, Construction and Use of Floating Roads on Peat with particular reference to Wind Farm Developments in Scotland' (SNH/ FCS, 2010) and others, as necessary. All temporary haul roads and access tracks created during construction shall be fully re-instated by the Contractor following construction.	To reduce peaty soil and peat disturbance, resultant excavation volumes and re-instate those areas which are temporarily disturbed	See Mitigation Item P07-G8
P07-G14	Throughout Proposed Scheme	Design, Pre-Construction & Construction	Where potential peat landslide or bog burst risks have been identified in the Preliminary Peat Landslide Risk Assessment and Preliminary Risk Register in Appendix 10.5 (Volume 2) of the ES, the Contractor shall undertake additional quantitative assessment of these prior to construction and follow guidance within 'Peat Landslide Hazard and Risk Assessments: Best Practice for Proposed Electricity Generation Developments' (Scottish Executive, 2006) for the implementation of additional micro-siting of Proposed Scheme elements during detailed design, and to determine and implement any required mitigation such as catch ditches, fences, walkovers and inspections during and following construction.	To identify and mitigate against potential peat landslide or bog burst risks	Consultation with SNH, SEPA and CNPA
P07-G15	Throughout Proposed Scheme	Pre-Construction	A number of widening or other cuttings have been identified as having the potential to intercept groundwater. Volumes of groundwater drainage will need to be considered in the context of potential groundwater abstraction CAR licenses prior to construction works commencing.	To comply with CAR license requirements and protect the water environment	Consultation with and approval from SEPA
P07-G16	Throughout Proposed Scheme	Design, Pre-Construction & Construction	A detailed assessment will be undertaken for areas of widening or cutting anticipated to result in groundwater-related impacts on GWDTE and surface water receptors. This shall be completed prior to construction using all available GI data, including additional monitoring and testing data from the Preliminary GI and Detailed GI. If impacts are confirmed as significant, a specific GWDTE monitoring and mitigation plan will be developed, with drainage designs, groundwater exclusion, containment or other control measures determined by the Contractor during detailed design and implemented during construction to reduce drawdown at sensitive receptors where appropriate and practicable. Drainage and pumping from excavations will be carefully monitored during construction, with additional mitigation such as redirecting abstracted water to affected receptors implemented as necessary.	To determine GWDTE risks, assess changes in groundwater level and ensure that GWDTE are protected	Consultation with SEPA
P07-G17	Throughout Proposed Scheme	Design, Pre-Construction & Construction	A differential settlement assessment shall be undertaken by the Contractor prior to construction in excavation areas that have the potential to intercept groundwater and which are located in proximity to existing infrastructure. This shall be completed using all available GI data, including additional monitoring data from the Preliminary GI and Detailed GI. Should potential settlement risks be identified, mitigation measures shall be implemented by the Contractor during construction where necessary and may include monitoring of groundwater level variations, implementation of condition surveys and monitoring of infrastructure.	To determine if adjacent or surrounding structures or infrastructure are at risk of settlement and implement mitigation where required	None required

Mitigation Item	Approximate Chainage/ Location	Timing of Measure	Description	Mitigation Purpose/Objective	Specific Consultation or Approval Required
P07-G18	Throughout Proposed Scheme	Pre-Construction & Construction	The Contractor shall review areas of groundwater likely to be intercepted by excavations and implement treatment as required prior to discharge. This shall be completed using all available GI data, including additional monitoring and testing data from the Preliminary GI and Detailed GI; in the preparation of discharge licensing considerations. Containment facilities and discharge locations for abstracted groundwater during construction shall be defined by the Contractor taking water quality characteristics into account.	To determine treatment and discharge requirements for intercepted groundwater	Consultation with SEPA
P07-G19	Throughout Proposed Scheme	Construction	Any excavations within or alongside areas of deep peat or blanket bog habitat should be bunded with sheets of plastic or metal sheet piling to assist retaining water and preventing local drainage of the adjacent or surrounding peat mass margins where practicable.	To minimise dewatering of areas of peat	See Mitigation Item P07-G8
P07-G20	Throughout Proposed Scheme	Pre-Construction, Construction & Post-Construction	A groundwater monitoring network shall be established within and adjacent to areas of GWDTE identified to be at potential risk of impact, with monitoring completed in accordance with 'LUPS-GU31 Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems, Version 2' (SEPA, 2014). Such monitoring shall involve groundwater level and quality readings, as well as repeated NVC surveys based on the GWDTE monitoring and mitigation plan developed in Mitigation Item P07-G16 .	To determine GWDTE risks, assess changes in groundwater level and quality and ensure that GWDTE are protected	Consultation with SEPA
P07-G21	Throughout Proposed Scheme	Pre-Construction, Construction & Post-Construction	The Contractor shall establish a Groundwater and Surface Water Management Plan with associated monitoring programme prior to construction, to be adhered to during construction, and post construction, as required by the relevant regulatory bodies. This shall be prepared with cognisance of Mitigation Items SMC-W1 to SMC-W17 detailed in Chapter 11 and monitoring requirements related to GWDTE where necessary (Mitigation Item P07-G20).	To document and ensure mitigation and monitoring measures are in place to protect the water environment	Consultation with SEPA
P07-G22	Throughout Proposed Scheme	Design, Pre-Construction & Construction	To maintain hydrological connectivity between and within wetland habitats, particularly springs, flushes and GWDTE assessed as likely moderate and/or highly dependent on groundwater in Appendix 10.2 (Volume 2) of the ES; works around areas containing discrete M6, M10, M11 and M15a flushes and M32 or M37 springs identified on Drawings 10.24 to 10.30 (Volume 3) , shall be carried out carefully by the Contractor, with a buffer zone of at least 10m from the features marked out on the ground and as far as possible, additional works micro-siting during detailed design and construction to avoid them. Any works within the buffer zone shall be supervised by a suitably qualified and experienced ECoW appointed by the Contractor and shall be planned to maintain unpolluted water flows.	To mitigate and control potential effects on GWDTE during construction	Consultation with SEPA

Mitigation Item	Approximate Chaining/ Location	Timing of Measure	Description	Mitigation Purpose/Objective	Specific Consultation or Approval Required
P07-G23	Drumochter Estate Access Track (former BDL track)	Design, Construction & Post-Construction	For construction and delivery of upgrades to the former BDL track at Drumochter, trackside drainage will include a lateral channel cut along the uphill side of the track to intercept natural run-off and shallow flush and groundwater flow. This shall be conducted under the track at regular intervals through cross-drains. Within the LMA, the trackside drain shall be broad and shallow with moderate gradients to prevent scouring, and flows from this drainage will be treated and controlled by filtration through check dams and dispersal trenches. During operation, drains associated with the track shall be inspected periodically and cleaned out as necessary.	To maintain hydrological connectivity between up-gradient and down-gradient GWDTE and prevent/ alleviate overland water flow disruptions	None required
P07-G24	Private Water Supplies: ABS 7.4 (Dalnaspidal Lodge) and ABS 7.5 (Old Schoolhouse/ Station Cottages)	Pre-Construction & Construction	Additional surveys shall be undertaken by the Contractor prior to construction, to confirm the exact location and extent of the Allt Coire Mhic-Siùth surface water supply source and network within the LMA for Dalnaspidal Lodge (ABS 7.4) and the Old Schoolhouse/ Station Cottage (ABS 7.5) properties. If impacts to the supply source and/ or network are confirmed, the Contractor shall incorporate protective measures during construction to protect the supply source and network. If protection is not possible in the context of the works, a replacement/ diverted network shall be put in place or temporary or long-term alternative source of water provided as necessary. Specific monitoring and mitigation requirements for the supply will be determined by the Contractor in consultation with landowners, residents, P&KC and SEPA.	To protect PWS and provide an alternative, replacement or diverted supply network as necessary	Liaison with landowner and residents, and consultation with P&KC and SEPA
P07-G25	Private Water Supplies: ABS 7.6 (Dalnaspidal Lodge)	Construction	The borehole water supply source for properties at Dalnaspidal (ABS 7.6) shall be monitored for yield and quality. If significant adverse impacts on these are identified, corrective actions will be undertaken and could include the provision of a temporary or long-term alternative source of water. Specific monitoring and mitigation requirements for the supply will be determined by the Contractor in consultation with landowners, residents, P&KC and SEPA.	To monitor yield/ quality of PWS and provide an alternative, replacement or diverted supply network as necessary	Liaison with landowner and residents, and consultation with P&KC and SEPA
P07-G26	Private Water Supplies: ABS 7.7 (Possible Well)	Pre-Construction & Construction	Additional surveys shall be undertaken by the Contractor prior to construction, to confirm the location, status, depth and use of the possible well feature at Dalnaspidal (ABS 7.7) and any associated pipe network. If this remains to be utilised as a water source and significant adverse impacts are confirmed, an alternative source of water and replacement/ diverted network shall be put in place. If the well is confirmed as redundant or inoperable, decommissioning shall be undertaken by the Contractor during construction in accordance with 'Good Practice for Decommissioning Redundant Boreholes and Wells' (SEPA, 2010) and others, as necessary.	To protect PWS and provide an alternative, replacement or decommission as necessary	Liaison with landowner and residents, and consultation with P&KC and SEPA
n/a (note)	n/a	n/a	Further to the above, Mitigation Items P07-E7, P07-E8, P07-E11, P07-E14, P07-E15 and P07-E25 detailed in Chapter 12 will be implemented in relation to temporary works and sensitive peatland and GWDTE habitats, and habitat re-instatement and restoration works within the Outline Habitat Management Plan (OHMP) in Appendix 12.11 (Volume 2) of the ES. The implementation of Mitigation Items detailed in Chapter 11 will also mitigate water pollution-related risks to groundwater, GWDTE and PWS.	To reduce temporary impacts on peatland or GWDTE habitats and deliver specific mitigation measures to re-instate and restore notable habitats that are impacted	n/a

Monitoring Requirements

- 10.5.3 Standard and Project Specific Mitigation commitments will be monitored prior to, during and following construction via the CEMP (**Mitigation Item SMC-S1 in Chapter 21**) and additional plans as required. This shall include all aspects related to soil, geodiversity, groundwater, GWDTE, surface water and PWS as necessary and outlined in **Table 10-16**.
- 10.5.4 Aspects related to peat stability shall be subject to monitoring during and following construction, as identified by the Preliminary Peat Landslide Risk Assessment in **Appendix 10.5 (Volume 2)** and requirements will be further defined by the Contractor following additional quantitative assessment prior to construction commencing. Peat re-use and potential habitat re-instatement, restoration or creation activities shall also be monitored during and following construction in accordance with recommendations in the OPMP and OHMP in **Appendix 10.6 and 12.11 (Volume 2)**; both of which shall be further developed by the Contractor prior to construction in consultation and agreement with SEPA, SNH and CNPA.
- 10.5.5 Suitably qualified and experienced EnvCoWs and ECoWs will be appointed to oversee mitigation and monitoring implementation, as well as emerging issues during construction (**Mitigation Item P07-G1**). Monitoring details, frequencies and reporting requirements for all aspects will be agreed with SEPA, SNH, CNPA and others as required, and will be tailored by the Contractor to provide meaningful indications of the ongoing works, impacts and mitigation implementation.

10.6 Residual Impacts

- 10.6.1 Following implementation of mitigation and associated monitoring; potential impacts in relation to geology, soils and groundwater for the Proposed Scheme will be avoided, reduced or off-set as far as is practicable. Residual impacts are those that remain once the measures have been implemented, and are summarised in **Table 10-17** with reference to the Standard and/ or Project Specific Mitigation proposed for them from **Table 10-16**.
- 10.6.2 No residual impacts are expected in relation to the Drumochter Debris Cones or hillsides of Drumochter Pass, PWS features at Balsporran Cottages (ABS 7.2) or Drumochter Lodge (ABS 7.3), while potential impacts on superficial geology, solid geology, mineral extraction, some individual GWDTE and surface water features are expected to remain as Neutral, with no specific mitigation considered necessary. These aspects are therefore excluded from **Table 10-17** for clarity, while mitigation requirements for indirect impacts and residual effects in relation to hydromorphology within the Allt Dubhaig GCR catchment are described, where necessary, in **Chapter 11**.

Table 10-17: Residual Impacts – Geology, Soils and Groundwater

Receptor/ Aspect	Sensitivity	Pre-Mitigation Impact Significance	Mitigation	Post-Mitigation Residual Impact Significance
Designated Geological Receptors and Features of Geodiversity Interest				
Drumochter Hummocky Moraines	Medium	Slight/ Moderate	Impacts in relation to the Drumochter Moraines landform assemblage and setting are likely to be reduced slightly through slope treatment and landform design of the Proposed Scheme, together with landscape integration of planting, as identified in Chapter 13 (Mitigation Items P07-LV1, P07-LV2, P07-LV7 and P07-LV25) . The location of Type A lay-bys through the Pass of Drumochter (Mitigation Items P07-LV3 in Chapter 13), may also locally improve visibility of and access to the wider landform assemblage. Combined with soil logging as marginal ridges and mounds are disturbed during construction (Mitigation Item P07-G3), residual impacts are therefore expected to be of Slight significance; with this offering a potential beneficial opportunity to provide scientific information and records of local insights into marginal former glacier dynamics that could contribute to an active field of research.	Slight
Allt Coire Chuirn Alluvial Fan	Medium	Slight/ Moderate	Residual impacts on the Allt Coire Chuirn alluvial fan geodiversity interest are likely to be Slight through minimisation of disturbance to the natural soil profile and landform as far as practicable, avoidance of damage to partial fan exposure areas through appropriate set-backs and working procedures identified in Chapter 11 (Mitigation Items SMC-W3 to SMC-W13) (Mitigation Item P07-G4) .	Slight
Pass of Drumochter Pollen Record Site	Low	Slight/ Moderate to Moderate	Through the design and implementation of piled solutions for mainline embankments and floating of the NCN7 access track re-alignment (Mitigation Item P07-G5), excavation and disturbance within the Pass of Drumochter Pollen Record Site would be expected to be minimised and reduce impacts on the area to be of Slight/ Moderate significance. Additional site surveys through core sampling, soil logging and pollen count analysis will also be undertaken prior to and during construction in consultation with SNH (Mitigation Item P07-G6) to provide compensation for partial disturbance of sediment and vegetation records.	Slight/ Moderate
Rock Exposures	Negligible	Slight	Loss of existing partial rock exposures has the potential to be off-set by the provision of new ones in areas of widening and cutting identified as being likely to intercept bedrock. The extent of this will be determined during the detailed design and a requirement will be placed on the Contractor for a suitably qualified and experienced engineering geologist to be on site while rock is cut for the Proposed Scheme, to conduct logging and inspections, and to ensure rock cuts are profiled to be as natural as possible with no visible engineered elements (Mitigation Item P07-G2).	Neutral/ Slight
Soils				
Soil Conservation	Medium to High	Slight/ Moderate to Moderate	The establishment of a Soil Management Plan (Mitigation Item P07-G4) for implementation during construction, combined with standard measures in relation to materials management (Mitigation Items SMC-G9 and SMC-M3 (Chapter 18)), will ensure that soil resources, soils of conservation interest or low agricultural productivity are excavated, managed, re-used and re-instated sustainably and appropriately; with residual impacts of Neutral to Slight significance.	Slight
Agricultural Soil Productivity	Low	Neutral/ Slight	It would also be anticipated that the Soil Management Plan will be linked directly to landscape and ecology mitigation proposals regarding habitat re-instatement, restoration and creation outlined in Appendix 12.11 (Volume 2) and illustrated in Drawings 6.1 to 6.12 (Volume 3) , with consideration of the soil-base for certain habitats within these (i.e. dry heath, wet heath, acid or species-rich grasslands) being important.	Neutral

Receptor/ Aspect	Sensitivity	Pre-Mitigation Impact Significance	Mitigation	Post-Mitigation Residual Impact Significance
Peat	Medium to High	Slight/ Moderate/ Large	The OPMP in Appendix 10.6 (Volume 2) demonstrates how unnecessary disturbance of peaty soils and peat has been minimised through design development and that there are ways in which these may be beneficially re-instated or re-used as part of the Proposed Scheme. This includes re-use as part of the landscaping strategy, re-use in candidate habitat re-instatement, restoration and creation areas (Drawings 10.38 to 10.44 (Volume 3)) or selected SuDS basins and compensatory flood storage areas, all of which offer opportunities for the extent of peatland habitats within the locality to be maintained, re-instated, or locally improved. This will be subject to refinement by the Contractor and agreement in consultation with SEPA, SNH and CNPA. However, together with construction methods to further avoid or limit impacts where possible (Mitigation Items P07-G5), and other mitigation and monitoring related to peat stability and dewatering (Mitigation Items P07-G6 to P07-G12 and P07-G19), residual impacts are expected to be Slight/ Moderate in the short-term and Slight to Slight/ Moderate in the longer term. This is expected to reduce further and deliver ecological benefits once habitat re-instatement, restoration and creation measures through appropriate re-use of peat become established.	Slight to Slight/ Moderate
Groundwater				
Groundwater Levels and Flow	Low to High	Slight to Moderate	Mitigation for potential impacts on groundwater levels and flow includes provision of appropriate construction and operation-stage drainage, combined with control measures and monitoring prior to and during construction (Mitigation Items P07-G15 to P07-G18). Optimising the drainage design and the adoption of these measures where possible may reduce impacts slightly. However, local scale residual impacts of Slight/ Moderate significance are expected to remain in the vicinity of cuttings P7-DJ-01, P7-DJ-02, P7-DJ-03, P7-BJ-01 and retaining walls through the Pass of Drumochter.	Neutral/ Slight to Slight/ Moderate
Groundwater Quality	Low to High	Moderate to Moderate/ Large	Residual impacts with regards groundwater quality are expected to be Slight during construction and Neutral during operation due to pollution prevention mitigation (Mitigation Items SMC-W1 to SMC-W17 in Chapter 11); including adherence to SEPA Pollution Prevention Guidelines and otherwise, provision of appropriate construction and operation-stage drainage. These would also mitigate against pollution risks to groundwater and associated receptors, through reducing the potential for pollutant release and preventing run-off from entering groundwater.	Neutral to Slight
GWDTE	Low to Very High	Neutral/ Slight to Very Large	Embedded mitigation has minimised encroachment into notable habitats such as GWDTE. However, the Proposed Scheme infrastructure will result in some permanent and irreversible habitat loss, while construction activities will result in unavoidable, but in many cases reversible impacts to surface vegetation, soils and local groundwater levels and flows. The OHMP in Appendix 12.11 (Volume 2) and Drawings 6.1 to 6.12 (Volume 3) detail outline measures and proposals to re-instate and restore GWDTE habitat types such as wet heaths, mires and grasslands, as well as local wet/ riparian woodland proposals. These measures are anticipated to provide some compensation for habitat losses, together with re-instatement and restoration of areas temporarily affected as far as practicable following construction (Mitigation Items P07-G12 and P07-G13). The OPMP in Appendix 10.6 (Volume 2) also outlines candidate areas for peat re-use in the re-instatement, restoration or creation of wet heath and mire type habitats, as well as opportunities for the creation of wetland-based habitat in SuDS basins and compensatory flood storage areas (Mitigation Item P07-G8). A detailed assessment will be undertaken for areas of widening or cutting anticipated to result in indirect groundwater-related impacts on GWDTE (Mitigation Item P07-G16). If impacts are confirmed as significant, groundwater exclusion, containment or other control measures will be considered and implemented during construction to reduce drawdown at receptors and to maintain natural groundwater flows where possible. This will be further supplemented by a specific GWDTE monitoring and mitigation plan (Mitigation Item P07-G20 and P07-G21), with additional micro-siting during detailed design and construction also recommended where possible (Mitigation Item P07-G22). At this stage, residual impacts on individual areas expected to be variable, but of Neutral/ Slight to Slight/ Moderate significance in several instances due to the majority of direct disturbance being compensated for, re-instated or restored. Residual indirect hydrogeological effects may vary between Slight and Moderate, with locally Neutral/ Slight to Moderate/ Large beneficial effects to some habitats associated with drainage upgrades for the BDL access track.	Neutral/ Slight to Very Large

Receptor/ Aspect	Sensitivity	Pre-Mitigation Impact Significance	Mitigation	Post-Mitigation Residual Impact Significance
Surface Water	Low to Very High	Slight to Large/ Very Large	<p>Groundwater intercepted via road cuttings and widenings will be returned to the same down-gradient catchments during the operational phase through appropriate drainage design and via the retention of existing watercourse crossings. This is expected to compensate for some indirect losses of, or alterations in, groundwater baseflow to surface waters, but very local residual impacts of Slight to Slight/ Moderate significance on surface waters including Allt Coire Mhic Sith, Allt a' Chaorainn and some tributaries may remain.</p> <p>A detailed assessment prior to construction will be undertaken of the cuttings predicted to result in indirect groundwater-related impacts on surface water features. If impacts are confirmed, additional mitigation measures may need to be put in place during construction, such as re-directing abstracted groundwater to the surface water receptor or the relevant catchment (Mitigation Item P07-G16).</p>	Slight to Moderate
Groundwater Abstractions and Private Water Supplies				
Dalnaspidal Lodge PWS (ABS 7.4)	High	Large/ Very Large	If impacts to the supply source and/ or network of PWS ABS 7.4 are confirmed, protective measures during construction to protect these shall be incorporated, or an alternative source of water and replacement/ diverted network shall be put in place with a specific monitoring and mitigation plan (Mitigation Item P07-G24). After implementation of these measures, residual impacts would be expected to reduce to Neutral.	Neutral
Old Schoolhouse/ Station Cottages PWS (ABS 7.5)	High	Large/ Very Large	If impacts to the supply source and/ or network for PWS ABS 7.5 are confirmed, protective measures during construction to protect these shall be incorporated, or an alternative source of water and replacement/ diverted network shall be put in place with a specific monitoring and mitigation plan (Mitigation Item P07-G24). After implementation of these measures, residual impacts would be expected to reduce to Neutral.	Neutral
Dalnaspidal Lodge PWS (ABS 7.6)	High	Large/ Very Large	With specific monitoring and this informing potential additional corrective actions or provision of an alternative temporary or long-term source of water (Mitigation Item P07-G25), residual impacts on PWS ABS 7.6 would be expected to reduce to Neutral.	Neutral
Possible Well (ABS 7.7)	High	Large/ Very Large	Additional surveys shall be undertaken prior to construction, to confirm the location, status, depth and use of the possible well feature ABS 7.7 at Dalnaspidal and any associated pipe network. If this remains to be utilised as a water source and significant adverse impacts are confirmed, an alternative source of water and replacement/ diverted network shall be put in place (Mitigation Item P07-G26). Alternatively, the well will be decommissioned and residual impacts would be Neutral.	Neutral
Potential Contamination				
Potential Contamination Sources and Ground Gas	N/A	Very Low to Moderate	Following implementation of standard mitigation measures for the A9 Dualling Programme (Mitigation Items SMC-G1 to SMC-G14) in relation to potential contamination sources, residual impacts are expected to reduce to Low during construction and Very Low during operation.	Very Low to Low

- 10.6.3 In summary, with the Proposed Scheme in place and taking the identified mitigation measures into account, the residual impacts in relation to groundwater levels and flows in glacial deposits and bedrock at the Dalnaspidal Junction, through the Pass of Drumochter and at the Balsporran/ Drumochter Lodge Junction are expected to be significant at local scales during construction and operation. These may in turn have similarly local scale residual groundwater-related effects on surface water features in the vicinity.
- 10.6.4 Peat excavation and GWDTE habitat loss or disturbance impacts are also identified to be locally significant. However, the assessment has identified that the vast majority of effects will occur along the edge of more extensive peatland or wetland habitat mosaics through the existing A9 corridor, where areas have already been affected by existing land management, drainage or infrastructure, and the consideration and implementation of appropriate construction methods and control measures is likely to further avoid or minimise effects on areas in better condition. During operation, the residual impacts on these aspects are expected to reduce and be further off-set once measures for and ecological benefits from landscaping, beneficial peat re-use and habitat re-instatement, restoration and creation become firmly established in the longer term. Residual effects in terms of permanent GWDTE habitat loss will be localised and significant only at the local scale, with **Chapter 12** also stating that no significant residual ecological habitat loss or disturbance is expected following the implementation of mitigation.
- 10.6.5 All other residual impacts on geology, soils and groundwater receptors are not predicted to be significant and in some instances, may carry consequential benefits for local geodiversity access/ visibility opportunities, geomorphology and ecology, as summarised in **Table 10-17**.

10.7 Summary of Combined Impacts

- 10.7.1 Some of the geology, soils and groundwater receptors may be subject to residual effects that, in combination with others for different environmental topics, could contribute to cumulative impacts during construction or operation. These include soils of conservation interest, peaty soils and peat (direct and indirect disturbance, habitat fragmentation or loss), geodiversity features (direct disturbance and landscape/ visual effects), GWDTE (groundwater flow impacts, habitat fragmentation or loss and pollution risks), surface water features (dewatering or groundwater flow impact from multiple widenings/ cuttings, geomorphological change, flood risk changes and pollution risks) and properties (private water supplies and land-take, noise or visual effects).
- 10.7.2 Such potential cumulative impacts of the Proposed Scheme for the different environmental topic-specific impacts on single receptors are considered further in **Chapter 20**. However, based on the above assessment and review of the residual impacts and mitigation measures proposed in other Chapters, no significant adverse combined impacts of the Proposed Scheme have been identified in relation to geology, soils and groundwater receptors.

10.8 References

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