10. Geology, Soils and Groundwater

10.1. Introduction

10.1.1. This chapter presents the results of the DMRB Stage 3 assessment of the potential impacts of the Proposed Scheme in relation to geology, soils, groundwater and contaminated land and considers potential impacts upon:

- geodiversity and economic minerals;
- soils, including peat;
- groundwater aquifers, and consequential impacts on groundwater dependent resources including public and private water supplies, groundwater dependent terrestrial ecosystems (GWDTEs) and surface waters (watercourses and ponds); and
- existing contaminated land.

10.1.2. This chapter is accompanied by the following Technical Appendices:

- Appendix 10.1 Geodiversity;
- Appendix 10.2 Peat Stability Assessment;
- Appendix 10.3 Outline Soil and Peat Management Plan;
- Appendix 10.4 Groundwater Assessment;
- Appendix 10.5 Confidential Appendix on Public Water Supplies; and
- Appendix 10.6 Contaminated Land Assessment.

10.1.3. Non groundwater related impacts on surface waters are covered in Chapter 11. Groundwater flooding is assessed as part of the Flood Risk Assessment Technical Appendix 11.3.

10.1.4. It should be noted that consequential impacts on sites designated for their conservation value, groundwater dependent habitats and associated fauna are discussed in Chapter 12: Ecology and Nature Conservation and Technical Appendix 12.2 Designated Sites Ancient Woodland and Habitats. Similarly, the value of the soil resources for agriculture or other potential land uses are discussed in Chapter 8: People and Communities - Community and Private Assets.

10.1.5. No impacts have been scoped out of this assessment.

Study Area

10.1.6. The assessment study area includes the footprint of the Proposed Scheme and a buffer of between 250m and 1.2km. This is in recognition that the potential impacts on geology, soils, contaminated land and in particular groundwater and groundwater dependent terrestrial ecosystems (GWDTEs), may extend some distance from the Proposed Scheme itself, where a 250m buffer is used. A buffer of 850m from the Proposed Scheme footprint for private water supplies and 1.2km for public water supplies has been applied based on the requirements of the Scottish Environment Protection Agency (SEPA) Regulatory Method for Licencing Groundwater Abstractions, including dewatering[i].

10.2. Approach and Methods

10.2.1. The assessment has been carried out in accordance with the guidance contained in the Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 11 Geology and Soils[ii] and DMRB Volume 11, Section 3, Part 10 HD 45/09 Road Drainage and the Water Environment[iii]. An explanation of the methods used is provided below.

Guidance

10.2.2. The following guidance documents have been used to inform the assessment:

- SNH 'A Handbook on Environmental Impact Assessment'[iv];
- A9 Dualling Programme Strategic Environmental Assessment (SEA) Environmental Report[v];
- A9 Dualling Programme SEA Environmental Report Addendum[vi];
- The Scottish Government 'Scottish Soil Framework'[vii];
- The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended) A Practical Guide (Version 8.2)[viii];
- Planning Advice Notice (PAN) 33: Development of Contaminated Land[ix];
- SNIFFER WFD 95: A Functional Wetland Typology for Scotland[x];
- SEPA Regulatory Position Statement – Developments on Peat[xi];
- SEPA/Scottish Renewables Developments on Peatland: Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and Minimisation of Waste[xii];
- SEPA Land Use Planning System (LUPS) Guidance Note 31 – Guidance on Assessing the Impacts of Development on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems[xiii];
- SEPA Regulatory Method WAT-RM-11 – Licensing Groundwater Abstractions including Dewatering[xiv];
- SEPA Regulatory Method (WAT-RM-08) Sustainable Urban Drainage systems[xv]
- Pollution Prevention Guidance (PPGs) and Guidance for Pollution Prevention (GPPs)[xvi];
  - PPG 1: Understanding your environmental responsibilities - good environmental practices;
  - GPP 2: Above ground oil storage tanks;
  - PPG 3: Use and design of oil separators in surface water drainage systems;
  - PPG 4: Treatment and disposal of sewage where no foul sewer is available;
  - GPP 5: Works and maintenance in or near water;
  - PPG 6: Working at construction and demolition sites;
  - PPG 7: Safe storage - The safe operation of refuelling facilities;
  - PPG 8: Safe storage and disposal of used oils;
  - GPP 13: Vehicle washing and cleaning;
  - PPG 18: Managing fire water and major spillages;
  - GPP 20: Dewatering underground ducts and chambers;

  - GPP 21: Pollution incident response planning;
  - PPG 22: Incident response - dealing with spills; and
  - PPG 26: Safe storage - drums and intermediate bulk containers.
- Scottish Government Guidance on Developments on Peat - Site Survey[xvii];
- Scotland's Geodiversity Charter 2018-2023 (2017)[xviii];
- British Geological Survey 'Geodiversity of the Cairngorms National Park[xix];
- Department for Environment, Food and Rural Affairs (DEFRA)/ Environment Agency (EA) Contaminated Land Report (CLR) 11: Model Procedures for the Management of Land Contamination[xx];
- BS 10175:2011+A1:2013. Investigation of potentially contaminated sites. Code of practice. BSI 2011[xxi];
- BS 5930:2015. Code of practice for ground investigations. BSI 2015[xxii];
- Construction Industry Research and Information Association (CIRIA) C753 – The SUDS Manual[xxiii];
- CIRIA report C750 Groundwater Control[xxiv];
- C753 – The SuDS Manual[xxv]
- CIRIA Contaminated Land Risk Assessment: A guide to good practice (C552)[xxvi];
- Environmental Protection Act 1990: Part IIA Contaminated Land – Statutory Guidance: Edition 2[xxvii]; and
- Society of Chief Officers of Transportation for Scotland's (SCOTS) 2009 'SUDS for Roads' Guidance Document[xxviii].

Baseline Data Collection

10.2.3. Baseline conditions have been determined through consultation, desk studies and site surveys.

Desk Studies

10.2.4. The desk studies included a review of the following information:

- A9 Strategic Environmental Assessment (SEA) [v];
- British Geological Survey (BGS) 1:50,000 and 1:10,000 superficial and bedrock geology mapping[xxix];
- BGS Aquifer Productivity Map of Scotland 1:100,000 scale digital version and associated user guide[xxx];
- BGS Groundwater Vulnerability Map of Scotland 1:100 000 scale, digital version and associated user guide[xxxi];
- A9 Perth to Inverness Dualling Geotechnical Preliminary Sources Study Report (PSSR) Kinveachy to Slochd (Rev 3) Jacobs[xxxii];
- A9 Perth to Inverness Dualling Geotechnical Preliminary Sources Study Report (PSSR) Slochd to Moy (Rev 4) Jacobs[xxxiii];
- A9 Dualling Northern Section: Dalraddy to Slochd Geotechnical Preliminary Sources Study Report (PSSR) AMJV[xxxiv];

- Scottish Environment Protection Agency (SEPA) River Basin Management Plan (RBMP) Classification Results[xxxv];
- SEPA RBMP Discover Data - Groundwater Interactive Mapping[xxxvi]
- SEPA Waterbody Classification Data[xxxvii];
- SEPA Wetlands Inventory (2015);
- Macaulay Institute for Soil Research Soil Maps of Scotland (partial coverage) at a scale of 1:250,000[xxxviii];
- Review of Mining Instability in Great Britain[xxxix];
- BGS 'Non-Coal Mining plans' online database [xl];
- Coal Authority online interactive map data[xli];
- BGS 'Directory of Mines and Quarries'[xlii];
- Private water supply data (The Highland Council);
- Public water supply data (Scottish Water);
- Ordnance Survey (OS) raster mapping on 1:10k, 1:25k, 1:50k, 1:250k scale[xliii];
- Scotland's Environment Water Framework Directive (WFD) Groundwater body status[xliv];
- Scottish Natural Heritage (SNH) Carbon-rich soil, deep peat and priority peatland habitat map[xlv];
- JNCC National Vegetation Classification (NVC) Users Handbook (2006)[xlvi]
- SNH data on designated environmental and geological sites;
- SNH NVC data for designated sites within the study area;
- Atkins Mouchel Joint Venture (AMJV) Phase 1 habitat mapping;
- RCAHMS Pastmap[xlvii]; and
- UK Maps of Radon[xlviii].

Field Surveys

10.2.5. Geotechnical site walkovers were carried out in June 2015 and August 2017 to assess the site area for drilling and peat probing within the Proposed Scheme corridor.

10.2.6. A Stage 2 Preliminary Ground Investigation (GI) commenced in February 2017 over a 10 week period, with the completion of 104 boreholes and 87 trial pits. This also included in-situ testing, obtaining televiewer pictures of the holes, the installation of gas and groundwater monitoring instruments, laboratory tests on samples and continued gas and groundwater monitoring for the following 12 months. At the time of writing, the Stage 3 Preliminary Ground Investigation works had commenced in December 2017 for a planned duration of four and a half months.

10.2.7. Peat probing was carried out in December 2015 across seven areas where the potential for peat had been identified during the desk studies. A total of 582 probing points were measured as part of the peat probing survey. Peat probing was carried out using a Van Walt peat probe to measure total peat depth, and a Macintosh probe to determine peat geotechnical properties.

10.2.8. Further peat probing was carried out in March 2017 based on the preferred route option from the Stage 2 Assessment. A total of 209 probing points and 4 peat cores were sampled over 8 areas.

10.2.9. Following Phase 1 habitat surveys carried out as part of the A9 SEA, National Vegetation Classification (NVC) surveys were carried out in May 2017 in areas identified at DMRB Stage 2 as potential GWDTEs within a 250m distance of the Proposed Scheme.

10.2.10. A hydrogeological/hydrological walkover was undertaken in the area of the Granish Junction along the Allt na Criche Burn during June 2017. Additional site visits were carried out in August and October 2017 to collect flow data from the Allt na Criche.

10.2.11. A survey of properties fed by private water supplies was conducted in June 2017 to gather further information on the type of supply, source location and number of properties served by each supply. Where residents were not available, further surveys were conducted in August and September 2017 at the remaining properties.

Consultation

10.2.12. Feedback from the Stage 2 assessment was received from statutory consultees (SEPA, SNH and The Highland Council) in relation to the scheme route options assessed as part of the DMRB Stage 2 design process.

10.2.13. Consultation was undertaken with Scottish Water in relation to public water supply boreholes. Further information can be found in Appendix 10.5 Confidential Appendix on Public Water Supplies.

10.2.14. For economic minerals, no specific consultations other than with the Mineral Valuation Office was undertaken to gather information on the economic mineral deposits within the study area.

10.2.15. Consultation feedback from the landowners following Stage 3 Public Exhibitions was also reviewed as part of the Geology, Soils and Groundwater assessment. At the time of writing, no feedback had been received on geodiversity. With regards to private water supplies, letters with questionnaires were sent out and phone calls were made systematically to landowners identified as potentially having private water supplies. Responses to this initial contact were received and were subsequently followed up with site visits.

Assessment of Impacts

Loss of Geodiversity

10.2.16. The assessment of the potential loss of rock exposures has involved:

- identification of Geological Conservation Review (GCR) sites, Sites of Special Scientific Interest (SSSIs, including Candidate SSSIs), and Local Geodiversity Sites (LGS) designated for geological interest, identification of existing road cuttings and outcrops in the vicinity of the Proposed Scheme, and evaluation of the sensitivity/importance of the rock exposures;
- review of the Proposed Scheme to determine where existing cuttings or outcrops will be modified, quantification of the length of each cutting modified, or outcrop intersected for the Proposed Scheme and qualitative evaluation of the potential impact on the rock exposures;

- assessment of the significance of the impacts with consideration of potential mitigation; and
- Further details on the geodiversity assessment method, interpretation and results are provided in Appendix 10.1.

Loss of Mineral Deposits, Soils and Peat

10.2.17. The loss of mineral deposits, soils and peat have been assessed through quantification of the area of each lost under the footprint of the Proposed Scheme.

10.2.18. The areas of mineral deposits were identified through review of geological mapping, searches of the Coal Authority online gazetteer, BGS Mining Plan Portal mapping, BGS Directory of Mines and Quarries[xlii], Review of Mining Instability in Great Britain[xxxix] and discussions with the Mineral Valuation Office, while the variety of soil types within the study area were determined from the Soil Survey of Scotland[xxxviii] mapping.

10.2.19. The area of loss of mineral deposits is calculated based on the footprint of the Proposed Scheme in areas of superficial deposits, including area loss for existing or proposed quarries, with impacts assessed qualitatively.

10.2.20. Areas of peat, including priority peatland, were identified through comparison and collation of data from the superficial geology mapping, soils mapping, SNH priority peatland mapping, site walkovers and Ground Investigation (GI) data including peat probing surveys.

10.2.21. As part of the Outline Soil and Peat Management Plan, the volume of soil and peat loss underneath the Proposed Scheme has been quantified. Peat depths gained from peat probing surveys and GI information were compiled and analysed to produce a peat depth model (using a raster interpolation method). Volumes of soil and peat to be excavated from under the Proposed Scheme footprint were then calculated from the raster output.

10.2.22. The excavated volumes are broken down into the following categories:

- Soil (including peaty soils); and
- Peat – broken down further into acrotelmic, catotelmic (fibrous) and catotelmic (amorphous) peat.

10.2.23. Further information is provided in Technical Appendix 10.3 Outline Soil and Peat Management Plan.

10.2.24. Impacts on indirect loss of peat as a result of hydrological changes are assessed qualitatively.

10.2.25. The sensitivity or importance of the mineral deposits, soils and peat areas has been evaluated qualitatively, as has the magnitude of impact, using the criteria set out in Table 10.5 and Table 10.7 below.

Peat Stability and Landslide Hazard Risk Assessment

10.2.26. Due to the presence of areas of peat within the study area and historic landslides, a peat stability and landslide hazard assessment has been undertaken. This assessment used peat probing depth data in combination with slope information to initially determine risk of peat instability, based primarily on factor of safety slope stability calculations in combination with consequence (receptor) evaluation. Specific areas identified at the initial stage that were considered at an initial risk level greater than low were then

evaluated further, using site-specific geotechnical information and interpretation of aerial photography to refine the initial desktop assessment for each location. The additional site information enabled evaluation of the potential extent and identification of appropriate mitigation measures to reduce the revised risk level.

10.2.27. Further details on the peat stability and landslide hazard risk assessment method, interpretation and results are provided in Appendix 10.2.

10.2.28. The sensitivity of peat is outlined within loss of mineral deposits. The sensitivity of downstream surface water receptors is based on the sensitivity provided in Chapter 11: Road Drainage and the Water Environment, which also covers the classification of magnitude of any impact on surface water receptors.

Construction Pollution

10.2.29. Accidental spillage during construction has the potential to allow pollutants to migrate through the unsaturated zone to aquifers. Excavation of the overlying material, particularly where cuttings are proposed in areas of permeable drift deposits with shallow groundwater, could increase the vulnerability of localised aquifers to contaminants. DMRB Volume 11, Section 3, Part 10, HD 45/09 – Road Drainage and the Water Environment, specifies procedures for the assessment of pollution impacts from accidental spillages on groundwater, known as 'Method D'[ii]. Further information on this assessment methodology is detailed in Section 11.2 of Chapter 11 Road Drainage and the Water Environment.

10.2.30. The sensitivity of the groundwater has been evaluated based on the aquifer productivity classification, the magnitude of impact has been evaluated qualitatively based on a review of groundwater vulnerability mapping and current design plans which identify areas where construction activities and cuttings are proposed.

Pollution of Groundwater from Routine Runoff

10.2.31. A summary of the drainage design for the Proposed Scheme is provided in Chapter 5, which includes seven groundwater discharges, discharging via ten infiltration basins (with network C9(A) featuring a cascade of four basins). DMRB Volume 11, Section 3, Part 10, HD 45/09 – Road Drainage and the Water Environment, specifies procedures for the assessment of pollution impacts from routine runoff on groundwater, known as 'Method C'[ii].

10.2.32. The Method C assessment of potential routine runoff impacts on groundwater takes the form of a risk assessment using the Source-Pathway-Receptor (S-P-R) model utilised in contaminated land investigations. Seven parameters relating to source and pathway are considered in turn and assigned a risk category as detailed in Table 10.1.

10.2.33. The risk of adverse impact at each proposed groundwater discharge is determined by multiplying the risk factor attributed to each parameter by the weighting factor and adding the resultant scores to establish the overall risk score for each discharge. This is evaluated against the following risk ratings (based on DMRB 45/09 Method C method):

- Overall risk score < 150 – Low Risk of Impact;
- Overall risk score 150-250 – Medium Risk of Impact;
- Overall risk score > 250 – High Risk of Impact.

Table 10.1: Routine Runoff Groundwater Assessment Parameters

S-P	Weighting	Parameter	Low Risk (1)	Medium Risk (2)	High Risk (3)
Source	15	Traffic density	< 50,000 AADT	50,000 to <100,000 AADT	> 100,000 AADT
	15	Annual average rainfall	< 740mm rainfall	740 – 1060 mm rainfall	> 1060 mm rainfall
Pathway	15	Soakaway geometry	Continuous linear (e.g. ditch, grassed channel)	Single point, or shallow soakaway (e.g. lagoon) serving low road area	Single point, deep serving high road area (>5,000m2)
	20	Unsaturated zone	Depth to water table >15m and unproductive strata	Depth to water table 5-15m	Depth to water table <5m
	20	Flow type	Unconsolidated or non-fractured consolidated deposits (i.e. dominantly intergranular flow)	Consolidated deposits (i.e. mixed fracture and intergranular flow)	Heavily consolidated sedimentary deposits, igneous and metamorphic rocks (dominated by fracture porosity)
	7.5	Effective grain size	Fine sand and below	Coarse sand	Very coarse sand and above
	7.5	Lithology	>15% clay minerals	1-5% clay minerals	<1% clay minerals

Table Source: DMRB, Volume 11, Section 3, Part 10, HD 45/09 – Road Drainage and the Water Environment[ii].

10.2.34. Available ground investigation data (from the Preliminary Stage 2 GI) has been used to determine the groundwater table and aquifer properties in the vicinity of the proposed groundwater discharges, where appropriate.

10.2.35. The sensitivity of groundwater aquifers have been identified and their sensitivity evaluated through review of BGS superficial and bedrock geology[xxix], aquifer productivity[xxx], groundwater vulnerability mapping[xxxi] and review of the WFD groundwater body status[xxxvii].

Loss or Change to Groundwater Aquifers and Supported Water Supplies

10.2.36. The location, area and depth of each cutting has been quantified in relation to bedrock and superficial aquifers, and water supplies within close proximity. Hydraulic conductivity values have been derived for each superficial geology unit based on permeability test results from the GI or from literature values. Groundwater levels have been determined by interpolating or extrapolating local GI data, where available. For each cutting that is likely to intercept groundwater, a radius of drawdown influence has been determined following methods detailed in CIRIA report C750 Groundwater Control[xxiv].

10.2.37. Controlled Activities Regulations (CAR) abstraction licences are also considered within this chapter. Other than the confidential Scottish Water public supply boreholes there are no other CAR licenced groundwater abstractions listed within the study area. The other CAR licences are detailed further in Chapter 11: Road Drainage and the Water Environment.

10.2.38. As part of the cutting assessment, a qualitative assessment has been undertaken of the impact on all groundwater dependent receptors, with further information detailed in Appendix 10.4. Groundwater dependent receptors include:

- Superficial and bedrock aquifers, based on groundwater vulnerability and aquifer productivity;
- Public and Private water supplies from groundwater sources;
- Surface water receptors; and
- GWDTEs.

Loss or Change to Surface Water Receptors

10.2.39. Surface water bodies such as streams, lakes and wetlands are receptors that can exchange water with groundwater bodies. Any changes to groundwater as a result of dewatering may indirectly impact surface water bodies and result in changes to surface water flow.

10.2.40. For the Proposed Scheme, the impact on surface water receptors has been assessed qualitatively based on the location and distance from each cutting as part of the cutting assessment detailed within Appendix 10.4 Groundwater Assessment.

10.2.41. Further investigation of the Granish Junction was required as the Allt na Criche Burn flows in close proximity to the junction. This investigation involved a desktop review of current available data on the hydrogeology of the area surrounding the junction. To support this review, site visits were conducted in August and October 2017 and flow monitoring data of the Allt na Criche Burn was collected. The results are detailed in Appendix 10.4

10.2.42. Further baseline information on each surface waterbody is provided in Chapter 11: Road Drainage and the Water Environment.

Loss or Change to Groundwater Dependent Terrestrial Ecosystems (GWDTEs)

10.2.43. The impact of groundwater changes related to the Proposed Scheme on GWDTEs has been assessed in line with SEPA LUPS Guidance Note 31. The assessment process has involved:

- National Vegetation Community (NVC) surveys were carried out in May, April and July 2017 for all areas within 250m of the Proposed Scheme. This NVC survey information is presented in Chapter 12: Ecology and Nature Conservation and associated appendices and figures;
- A screening exercise was carried out to screen out NVC communities within the study area where there was a lack of hydrogeological connectivity between the NVC community and the Proposed Scheme, or where groundwater or ground condition data indicated groundwater interactions with the vegetation were highly unlikely;
- The baseline groundwater dependency of each of the remaining GWDTE habitat polygons was reviewed and revised, based on qualitative assessment of the local ecology, topography, hydrology and hydrogeology. The sensitivity of each GWDTE habitat was assigned based on the revised groundwater dependency;
- During the revision of the groundwater dependency, a confidence value was added to each polygon based on the available information to undertake the assessment. Confidence ranks High, Medium or Low depending on the groundwater levels, geology, hydrogeology and site information available.

- Those NVC communities considered to have a dependency on groundwater were progressed to impact assessment. The impact assessment considered direct loss under the footprint of the scheme, indirect loss due to groundwater drawdown in the vicinity of proposed road cuttings and indirect impacts to GWDTEs downgradient of the Proposed Scheme due to changes in subsurface flows. Where there is uncertainty regarding the confidence of drawdown influence/prediction from cuttings, on any GWDTE, this also contributes to the assignment of a confidence rank already described;
- Where significant impacts are predicted, outline mitigation measures have been proposed. The residual impact on each GWDTE habitat has been evaluated taking this mitigation into consideration; and
- Finally, the individual impact assessment results have been summarised and aggregated, with a qualitative assessment undertaken of the overall impact of the Proposed Scheme on GWDTEs within the study area as a whole.

10.2.44. Appendix 10.4 provides further details on the assessment methodology, including screening, baseline groundwater dependency assessment and impact assessment methods.

Mobilisation of Historic Contaminants

10.2.45. For contaminated land, the Scottish Government considers the 'suitable for use' approach as the most appropriate to deal with historical land contamination. A contaminated land Phase 1 Preliminary Risk Assessment (PRA) has been undertaken as part of this assessment, and is reported within the Geotechnical PSSR[xxxiv]. Further relevant details from the PSSR are included in Appendix 10.6.

10.2.46. The aims of the PRA are to identify sites of potential historic contamination within the Proposed Scheme study area and to assess the potential risks posed to human health and the wider environment in the context of the proposed land use, in line with the requirements of PAN 33: Development of Contaminated Land[ix], CLR11[xx] and the Scottish Government's statutory guidance on Part IIA of the Environmental Protection Act 1990 [xlix].

10.2.47. As part of the DMRB Stage 2, the risk assessment methodology involved the initial development of a Preliminary Conceptual Site Model (CSM) for the site as part of the PRA. The CSM represents a network of relationships between potential sources of contamination and different receptors through different potential pollution pathways. The receptors can include humans, i.e. local residents, drivers and non-motorised users (NMUs) of the road, construction workers, the water environment, statutory designated ecological systems (SSSIs, SPAs etc.) or property such as buildings/structures, crops, livestock and domestic pets. Potential pollutant pathways may include: direct contact with contaminated soils, ingestion/inhalation of soil, dust, vapour or gas; and the leaching and migration of contaminants, including gas through the ground. The potential receptors and pathways have been compiled based on the definitions used in Part IIA of the Environmental Protection Act 1990, as provided in the Scottish Government's Statutory Guidance[xlix]. Where a source, pathway and receptor combination exists this is referred to as a complete pollutant linkage.

10.2.48. For the purposes of this assessment, some of the potentially contaminated sites under and immediately adjacent to the footprint have been investigated as part of the Stage 2 GI. The remaining are being investigated as part of the Stage 3 GI. Contamination testing was carried out as part of this GI and the chemical analysis scheduled as part of this investigation has allowed potential pollutant pathways to be investigated and the preliminary CSM to be refined.

10.2.49. A generic quantitative risk assessment has been undertaken in accordance with CLR11 and this includes an update of the preliminary CSM in accordance with CIRIA C552 [xxv]. The risk is evaluated based on the probability or likelihood of risk being realised as shown in Table 10.2 and the consequence of risk being realised as shown in Table 10.3. The risk evaluation is then derived from the matrix shown in Table 10.4.

Table 10.2: Criteria used to Estimate the Likelihood of Contamination

Likelihood	Description
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 Source: CIRIA. (2001). Contaminated Land Risk Assessment: A guide to good practice, CIRIA Publication C552.

Table 10.3: Criteria used to Estimate the Consequence of an Impact of Contamination

Consequence	Description
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/ Scheduled Ancient Monument (SAM).
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/ SAM.
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/SAM/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 reparable damage to buildings, structures, SAM and services.

Table Source: CIRIA. (2001). Contaminated Land Risk Assessment: A guide to good practice, CIRIA Publication C552.

Table 10.4: Contaminated Land Potential Pollutant Linkage Risk Evaluation Matrix

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

Table Source: CIRIA. (2001). Contaminated Land Risk Assessment: A guide to good practice, CIRIA Publication C552.

10.2.50. The contaminated land assessment has been carried out using a consequence/likelihood risk based methodology as per accepted industry practice referenced above. This approach does not easily translate into the sensitivity/magnitude/ significance approach of EIA. However, a methodology has been devised to assign significance to the identified levels of risk and this is detailed in Table 10.11. The assessment of impact significance will be undertaken by comparing the current baseline risks with the construction / operation (without mitigation and subsequently with mitigation) phase risks and assessing any change in risk.

10.2.51. The approach can be considered an amalgamation of the Contaminated Land and EIA assessment methods.

Impact Assessment Criteria

10.2.52. The assessment of significance of impacts in relation to geology, soils, and groundwater has been based on the guidance provided in the DMRB, Volume 11, Section 3, Part 10, HD 45/09 Road Drainage and the Water Environment[ii]. It should be noted that DMRB, Volume 11, Section 3, Part 11 Geology and Soils[iii] does not provide any specific guidance on the evaluation of sensitivity, magnitude and significance.

Value / Sensitivity

10.2.53. Application of the DMRB/EIA guidance has involved consideration of the importance/sensitivity of relevant attributes of the geology, soils and groundwater receptors and evaluation of the magnitude of the impact. Importance/sensitivity has been evaluated taking into account quality, rarity, scale and substitutability in keeping with the principles of DMRB guidance and using the criteria shown in Table 10.5.

Table 10.5: Criteria Used to Estimate the Sensitivity of Geology and Soil Receptors

Sensitivity	Description
High	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. Presence of extensive areas of economically important minerals valuable as a national resource. Presence of high quality topsoil or soils (typically indicated by Land Capability for Agriculture Class 1 and Class 2). Areas of peatland within designated sites such as SSSI, SAC or 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

Sensitivity	Description
	carbon-rich and peaty soils, deep peat and priority peatland habitat likely to be of potentially high conservation value and restoration potential).
Medium	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. Presence of areas of economically important minerals of regional value. Presence of medium quality topsoil or soils (typically indicated by Land Capability for Agriculture Class 3 and Class 4). 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).
Low	Sites and geological features not currently identified as SSSI, GCR or LGS/ RIGS but that may require protection in the future. Presence of mineral areas or resource of local importance only. Presence of low quality topsoil or soils (typically indicated by Land Capability for Agriculture Class 5 and Class 6). 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).
Negligible	Geological features not currently protected and unlikely to require protection in the future. No exploitable minerals or geological resources. Presence of very low quality topsoil or soils (typically indicated by Land Capability for Agriculture Class 7). 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)).

Table 10.6: Criteria Used to Estimate the Sensitivity of Groundwater Receptors

Sensitivity	Description
Very High	Groundwater aquifer(s) with very high productivity or WFD good groundwater quality and quantity status. Exploitation of groundwater resource is extensive for public, private domestic and/ or agricultural use (i.e. supplying 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 supplying 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.

Sensitivity	Description
	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.
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.

Magnitude of Impact

10.2.54. Magnitude of impact has been determined by taking into account the extent of loss and impacts on integrity of an attribute in keeping with the DMRB guidance and using the criteria shown in Table 10.7 and Table 10.8.

Table 10.7: Criteria Used to Estimate the Magnitude of Impact on Geology and Soil Receptors

Magnitude	Description
Major	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. Major or total loss of topsoil, soils or peatland, or where the value of the area would be severely affected.
Moderate	Loss of part of a geological/ geodiversity site or mineral deposit, major severance, major impacts to the setting, or disturbance such that the value of the site would be affected, but not to a major degree. Partial loss of topsoil, soils or peatland, or where the value of the area would be affected, but not to a major degree.
Minor	Small impact on a geological/ geodiversity site or mineral deposit (up to 15%) or a medium impact on its setting, or where there would be a minor severance or disturbance such that the value of the site would not be affected. Partial loss of topsoil, soils or peatland, or where soils will be disturbed but the value of the area would not be affected.
Negligible	Very slight change from geological, mineral and soil baseline conditions.

Table 10.8: Criteria Used to Estimate the Magnitude of Impact on Groundwater Receptors

Magnitude	Description
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.

Magnitude	Description
	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. Dewatering impacts create significant differential settlement impacts on existing infrastructure and buildings. Potential high risk of pollution to groundwater from routine runoff – risk score >250 (Method C).
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. Dewatering impacts create moderate differential settlement impacts on existing infrastructure and buildings. Potential medium risk of pollution to groundwater from routine runoff – risk score 150-250.
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). Dewatering impacts create minor differential settlement impacts on existing infrastructure and buildings. Potential low risk of pollution to groundwater from routine runoff – risk score <150. Minor impacts on groundwater supported wetlands
Negligible	Very slight change from groundwater baseline conditions, approximating to 'no change' conditions. Dewatering impacts create no or no noticeable differential settlement impacts on existing infrastructure and buildings. No measurable impact upon an aquifer from pollution.

Significance of Impact

10.2.55. The evaluation of significance has been derived by combining the sensitivity of the affected attributes and the magnitude of the impacts using the matrix recommended in the DMRB HD 45/09 guidance[ii], which is replicated in Tables 10.9 and 10.10. Where

the significance is shown as being one of two alternatives, a single description is provided based on reasoned judgement.

Table 10.9: Significance Criteria for Geology and Soil Impacts

Value or 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

10.2.56. The evaluation of significance looks at the potential magnitude of a negative impact, however, as the major value of a geological feature relies upon the state of the rock exposure there can also be major beneficial impacts to geology/geodiversity sites as any excavation may provide new exposures for study.

Table 10.10: Significance Criteria for Groundwater Impacts

Value or 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

10.2.57. As noted above, the contaminated land assessment does not easily translate into the sensitivity / magnitude / significance approach of EIA. Table 10.11 provides details of the criteria that have been derived to assign significance to the identified levels of risk associated with contaminated land.

Table 10.11: Significance Criteria for Contamination Impacts

Significance Criteria	Definition
Major adverse impact	An increase in contamination risk from the existing baseline conditions of 4 or 5 risk levels in the risk matrix, e.g. land that has a very low contamination risk in the baseline becomes a high or very high risk. A high or very high risk of pollution to an aquifer. Land that does not meet the statutory definition of Contaminated Land in the existing baseline becomes capable of being determined under Part IIA.
Moderate adverse impact	An increase in contamination risk from the existing baseline conditions of 2 or 3 risk levels in the risk matrix, e.g. land that has a low contamination risk in the baseline becomes a moderate or high risk. A moderate or moderate-high risk of pollution to an aquifer.
Minor adverse impact	Limited risk of pollution to an aquifer. An increase in contamination risk from the existing baseline conditions of 1 risk level in the risk matrix, e.g. land that has a low contamination risk in the baseline becoming a moderate / low risk.
Neutral	No measurable risk of pollution to an aquifer. No change in contaminated land risks.

Significance Criteria	Definition
Minor beneficial impact	Reduction in existing risks to an aquifer and increased water quality. A reduction in contamination risk from the existing baseline conditions of 1 risk level in the risk matrix, e.g. land that has a moderate / low contamination risk in the baseline becomes a low risk.
Moderate beneficial impact	Reduction in existing risks to an aquifer and increased water quality. A reduction in contamination risk from the existing baseline conditions of 2 or 3 risk levels in the risk matrix, e.g. land that has a high contamination risk in the baseline becomes a moderate / low or low risk.
Major beneficial impact	Significant reduction of impact to groundwater quality. A reduction in contamination risk from the existing baseline conditions of 4 or 5 risk levels in the risk matrix, e.g. land that has a very high contamination risk in the baseline becomes low or very low risk. Land that meets the statutory definition of Contaminated Land in the existing baseline is no longer capable of being determined under Part IIA.

Limitations of the Assessment

10.2.58. All existing GI data has been used where available, however as Stage 3 GI works have not been completed, parts of the assessment has relied on available historic GI data, supplemented with other desk based information.

10.2.59. A total of 104 boreholes were drilled as part of the stage 2 GI, of which 70 boreholes have installations for groundwater and gas monitoring. Fourteen boreholes did not encounter groundwater, and a further 12 boreholes that did encounter water either initially recorded a depth to water but successive monitoring rounds have reported as dry or the boreholes have been predominantly dry with one or two occasional dip readings recorded. The groundwater boreholes have been monitored/dipped on a monthly basis since installation. Many cuttings do not have boreholes within their immediate vicinity and so there is little groundwater level data for these areas. These areas have been targeted as part of the stage 3 GI.

10.2.60. Permeability testing was undertaken during the stage 2 GI, with additional testing conducted in August 2017. Tests were conducted in boreholes screened through different superficial deposits (as identified by the BGS)[I] and through the weathered bedrock. The returned results from the Stage 2 GI are lower than expected for the described superficial strata (based on conservative literature values taken from CIRIA C750). To assess whether the lower values were due to the testing methodology, three boreholes were retested in August using a different test method (solid cylinder slug test) which produced very similar results in one borehole and slightly higher but not significantly different results in the other boreholes. The difference in permeability values is likely due to the density of the deposits at the tested boreholes. The borehole logs record “CPT values of >50” and describe superficial strata as medium dense to very dense with occasional pockets of clay. It is worth noting that rising and falling head tests can be greatly affected by very local conditions and the condition of the gravel pack surrounding the borehole, therefore it can be difficult to extrapolate these values over a large area. There are also drilling effects that can influence permeability test results such as smearing along the borehole wall and the mudcake (depending on flush used).

10.2.61. Despite limitations, permeability testing is still valuable as it gives an indication of the local hydraulic properties. This initial testing has shown that the superficial deposits (River Terrace and Glaciofluvial Deposits) have locally varying permeability with values that are often lower than would be expected based on the lithological description. Additional testing as part of the stage 3 detailed GI will further clarify the nature of the

superficial deposits, but due to the programme, results will not be available in time for inclusion in the ES.

10.2.62. Consequently, there is limited site specific information available on the groundwater table and aquifer properties in the vicinity of the proposed road cuttings. Conservative assumptions of hydraulic conductivity values have therefore been made for the majority of the cuttings, based on the available mapping data for the study area. Additionally, the number and location of the monitored boreholes does not allow for a reliable interpolation of the recorded groundwater levels. Where possible groundwater levels have been taken from the closest borehole in the same geological unit. In the case where there is no nearby monitoring location a groundwater contour plot was created and used to estimate the groundwater levels. There are a number of limitations to the use of this plot which are discussed further in Appendix 10.4. The groundwater monitoring data used for the assessment was collected from November 2017 this was the most conservative dataset available at the time of undertaking the assessment, representing the highest recorded groundwater levels over the monitoring period.

10.2.63. There are additional limitations surrounding the cuttings assessment methodology itself. There is no published methodology for calculating the radius of influence from linear features such as road cuttings, therefore the method used to estimate the radius of influence for individual cuttings has been based on an empirical formula widely used for calculating the radius of influence of groundwater abstractions. This calculation does not account for the direction of each cutting relative to the groundwater flow direction. The calculations also utilise an empirical constant which may overestimate the radius of influence, as detailed in Appendix 10.4.

10.2.64. This assessment has relied upon the accuracy and level of detail of the documented data sources. For instance, identification of potential contaminated land and historical quarry sites have been identified through desk study review of historical maps. It is possible that potentially contaminating land use or quarry excavation and backfilling could have taken place between recorded years of mapping and have therefore not been identified. It is also possible given the rural nature of the Proposed Scheme that unrecorded farmers' tips may be present along the scheme.

10.2.65. The scale of various mapping datasets, such as groundwater vulnerability and soils mapping, is such that only broad characterisation of these attributes and high level assessment of potential impacts has been possible where there is no GI data available. Both the aquifer productivity and groundwater vulnerability data only provide a guide to aquifer conditions at a 1:100,000 scale.

10.2.66. The private water supply data was provided by The Highland Council. The quality of the private water supply data provided was variable, with grid references and type of supply (i.e. surface water or groundwater source) missing for some supplies. Additionally, it was not always clear whether the grid references provided were for the source or the property supplied. This dataset was subsequently updated for the majority of the identified supplies with accurate grid references and additional information following private water supply surveys carried out in June 2017, August 2017 and September 2017. The sensitivity of the water supplies has been evaluated based on current use of supply and the population supplied.

10.2.67. In relation to private water supplies, whilst full landowner consultation has been carried out, the exact locations of associated pipework and septic tanks were not included as part of this assessment and will be covered in the pre-construction phases.

10.2.68. In relation to the peat investigations the probing surveys carried out provide total soil depths at a specified location, but do not detail the extent of different soil layers (e.g.

peat, clay, gravel). Any estimates of peat depths between probe locations have been extrapolated from surrounding data points and topography.

10.2.69. In relation to GWDTEs, in a small number of cases, where NVC data has not been available within the study area, GWDTEs are assumed to be groundwater dependent for the purposes of the assessment.

10.2.70. A number of areas (41 areas) were unable to be surveyed or classified from aerial imagery. For the purpose of the assessment, these communities have been considered during the baseline assessment as having a Moderate groundwater dependency.

10.2.71. The limited coverage of monitoring wells across the scheme does not provide enough information to determine whether these areas are solely groundwater-fed at the present time. It is proposed that further groundwater monitoring is carried out at a representative sample of these areas during the detailed design phase to determine whether they are true GWDTEs; this has been included as a mitigation commitment in Section 10.5. The areas of potential Moderate groundwater dependency are currently considered to be of High sensitivity, while Low dependency areas are considered of Medium sensitivity.

10.2.72. The contaminated land assessment has been based on desk study data and available ground investigation data derived from the Stage 2 GI. The potential pollution pathway linkages have been identified and risk assessed based on the available data. It should be noted that not all potential sources of contamination have been targeted by ground investigation; therefore, the presence, nature, extent and severity of all potential pollutant linkages cannot be confirmed at this stage. However, a more detailed Stage 3 GI is currently underway and this will further investigate the identified potential pollutant linkages. As the Stage 3 GI is incomplete the related information is not available and cannot be considered within the contaminated land assessment within the environmental statement.

10.2.73. Much of the desk study information has been sourced from third parties which cannot be fully verified and, as such, no guarantees can be given in relation to its accuracy. Whilst every reasonable attempt has been made to identify all relevant information needed to inform the assessment, the accessed information is not necessarily exhaustive and further desk study information relevant to the study area may be available from other sources.

10.2.74. With regards to the contaminated land assessment, borehole installations generally did not target the made ground where this was present. Response zones were generally screened across the underlying natural deposits so monitoring results are likely to be reflective of conditions within the natural deposits rather than the made ground. As ground gas is generally associated with made ground rather than natural deposits, the gas levels identified within the monitored natural may not reflect the gas concentrations that may be present in the shallower deposits. However, only limited enclosed spaces are anticipated within the proposed scheme and only very occasional, localised made ground deposits have been identified within the study area and therefore there will be limited potential for gas to build up and to affect receptors. Therefore, contamination pathways relating to gas are not considered to be particularly relevant to the proposed scheme.

10.3. Baseline Conditions

Geology

Bedrock Geology

10.3.1. The BGS mapping indicates that much of the Proposed Scheme is underlain by Psammitic metasedimentary rocks:

10.3.2. The southern section of the Proposed Scheme between Alvie and Granish is underlain by the Loch Laggan Psammite Formation, the Pityoulish Formation and the Nethybridge Psammite Formation. East of the existing A9 carriageway between Granish and Avielochan is underlain by the Grampian Group.

10.3.3. The northern section of the site is underlain by the Dava Subgroup, the Central Highlands Migmatite Complex and the Slochd Psammite Formation. Approximately 1.7km north-west of Slochd along the A9 carriageway, the psammites and semipelites of the Dalradian Supergroup, Creag Buidhe Psammite Formation and Beinn Bhreac Psammite Formation can be found in thin north-south trending fault bound strips. The Dava Subgroup is separated from the Pityoulish Formation and Grampian Group bedrock in the south by a south west to north east trending fault.

10.3.4. These bedrock units consist of psammite and semipelite with some quartzite and are often reported as being micaceous with a gneissic texture.

10.3.5. The Monadhliath Pluton (Phases 1 to 4) is an igneous intrusion that underlies the study area towards the south of the Proposed Scheme, west of the A9 carriageway. The geology of the pluton generally consists of granite or microgranite.

10.3.6. The Boat of Garten Pluton underlies the study area in the area of Loch Vaa and Kinveachy (NGR NH 2910 8179). This igneous intrusion comprises tonalite and granodiorite.

10.3.7. Minor intrusions belonging to the North Britain Siluro-Devonian Calc-Alkaline Dyke Suite are found beneath the Proposed Scheme at several locations as shown on Figure 10.1.

10.3.8. Historical exploratory boreholes in the area were rarely in excess of 5m bgl, however bedrock was encountered in two holes at depths of 6.50m and 9.50m bgl. These were in the northern section of the site, east of Slochd at grid reference NGR NH 2857 8238 Bedrock here was reported as granite.

10.3.9. Of the 104 exploratory boreholes from the preliminary Stage 2 GI, 36 encountered bedrock. Bedrock was found at depths ranging from 0.1-12.5 m bgl. Many exploratory locations did not encounter bedrock, recording superficial deposits to depths in excess of 15 m bgl. Bedrock directly underlies made ground or top soil with a thickness of less than 1 m in 8 boreholes. Psammite is the most common rock type, and is encountered throughout the Proposed Scheme. Pelites were also logged at depths ranging from 1.50-12.50 m bgl, however, their identification was not independently verified. The psammites predominantly have a gneissose texture, and were often reported as weak with weathering throughout. Recovery was frequently recorded as cobbles and boulders. Between two and five fracture sets could be identified including a closely spaced sub horizontal set, a set at 45-50 degrees and a widely spaced sub vertical set. Quartz rich granitic veins (50-400mm) were common throughout the recovered bedrock.

10.3.10. South of Aviemore, quartzite (NGR NH 2891 8114) and granite (NGR NH 2893 8139 were identified during the GI at depths of 10.10 m bgl and 12.10 m bgl, respectively.

10.3.11. The sensitivity of each bedrock unit is listed in Table 10.12 below. Some of the formations have a sensitivity of Negligible as they are not protected, occur widely throughout the region, and would be exploited on a local scale only. The Slochd Psammite Formation in the northern section of the Proposed Scheme, cuts through part of the Slochd GCR site, also considered to be a candidate SSSI, therefore the sensitivity is considered to be High. The geodiversity assessment (Appendix 10.1) has highlighted the importance of the contact between the non gneissose metamorphic rocks (part of the Dalradian Supergroup) and gneissose metamorphic rock. Therefore, in addition to the Slochd Psammite, other gneissose rocks at Slochd (Dava Subgroup, Creag Buidhe Psammite and Beinn Bhreac Psammite Formations) also have notable geodiversity value and consequently are classed as High sensitivity. The Boat of Garten outcrops are considered to be of Low sensitivity due to their identified geodiversity interest but lack of an existing geological conservation designation.

Table 10.12: Sensitivity of each Bedrock Geological Formation within the Study Area

BGS Geological Unit	Sensitivity
Igneous Geological Units:	
Siluro-Devonian Calc-Alkaline Dyke Suite	Negligible
Monadhliath Pluton	
Boat of Garten Pluton	Low
Metasedimentary Geological Units:	
Loch Laggan Psammite Formation	Negligible
Pityoulish Formation	
Nethybridge Psammite Formation	
Grampian Group	
Central Highland Migmatite Complex	
Dalradian Supergroup - Psammite Semipelite and Calcsilicate	
Slochd Psammite Formation	High
Dava Subgroup – Psammite, Gneissose	
Creag Buidhe Psammite Formation	
Beinn Bhreac Psammite	

Table Source: British Geological Survey (BGS). (2015). Superficial and Bedrock Geology mapping 1:50,000.

Superficial Geology

10.3.12. BGS mapping indicates the most prevalent superficial deposits underlying the study area comprise glacial deposits including the poorly sorted Devensian Glacial Till, Hummocky (Morainic) Glacial Deposits and the better sorted Glaciofluvial Sheet and Ice Contact Deposits comprising typically fining upwards sand and gravel deposits with lenses of silt and clay. Localised areas of Alluvium and River Terrace deposits correspond to watercourses within the study area and isolated areas of peat have been mapped throughout. The superficial deposits are discussed in more detail below and their distribution is shown on Figure 10.2.

10.3.13. Devensian Glacial Till (Diamicton), described as firm-stiff sandy silty gravelly clay and very compact clay silty gravelly sand, is typically shown in the central and northern section of the study area and specifically beneath the Proposed Scheme around NGR NH 290343 821721 between Crannaich and Ellan Wood, to the south of the A9 carriageway at Black Mount (NGR NH 2881 8239) and north of the carriageway at

Slochd Summit (NGR NH 2836 8256). Intermittent deposits beneath the Proposed Scheme are also shown at Avielochan (NGR NH 2902 8162) and at Kinveachy (NGR NH 2910 8187).

10.3.14. Hummocky (Morainic) Glacial Deposits consisting of poorly sorted and consolidated deposits of boulders, gravel, sand and sandy diamicton forming boulder strewn mounds are located in the north of the study area. Intermittent hummocky (moundy/morainic) glacial deposits are also located west of the A9 carriageway from roughly NGR NH 2889 8123 to NGR NH2905 8172, between Aviemore and Avielochan

10.3.15. Glaciofluvial Sheet and Ice Contact Deposits, comprising terrace spreads of dense cobbles, gravel and sand with silts and boulders, with moundy boulder strewn spreads of sand and gravel, including esker ridges formed of cobble gravel and cross bedded fan/delta deposits, underlie most of the ground between the existing A9 and the River Spey between Aviemore and Kinveachy.

10.3.16. Alluvium deposits of river floodplains (typically described as soft to firm consolidated compressible silty clay with silt, sand and peat) and River Terrace deposits (sand and gravel with lenses of silt, clay or peat) are indicated on the geological map in the most southern extent of the study area, surrounding Loch Alvie. Extensive alluvial deposits are associated with the River Spey, east of the A9, south of Aviemore, and in the northern section where the Proposed Scheme crosses the River Dulnain.

10.3.17. Deposits encountered in the exploratory holes drilled as part of the Stage 2 GI, across the proposed Scheme and surrounding study area, predominantly comprised poorly sorted fluvial and glacial deposits. The deposits were described as silty, gravelly fine to coarse sand; silty fine to coarse sand and gravel; or silty, sandy gravel. It is noted that deposits were dense to very dense. Frequently, within less sorted deposits, sub-rounded to angular cobbles and boulders of mixed lithology (including psammite, pelites and granite) were present. Often pockets/bands of silty sand, clayey sand, laminated clays and silts, gravels, and cobbles and boulders of mixed lithology were present throughout the superficial deposits. These features may indicate a fluvial or glaciofluvial depositional history.

10.3.18. Thickness of superficial deposits regularly exceeds 15m bgl, with the thickest of superficial deposits found at NGR NH 2861 8099 at the southern end of the Proposed Scheme. Thicknesses here exceeded 20m bgl, which is the depth at which the borehole was terminated, and so the full thickness was not proven. These deposits are marked on the map as Hummocky Glacial and Glaciofluvial Sheet deposits, and were described as silty sands and gravels with pockets of cobbles and boulders along with sandy, gravelly clay.

10.3.19. Geological mapping also indicates a number of peat deposits along the Proposed Scheme, which are discussed within the soils section below. The sensitivity of each superficial formation(s) is listed in Table 10.13 below.

Table 10.13: Sensitivity of Superficial Deposits within Study Area

BGS Geological Unit	Sensitivity
Peat	n/a – refer to Peat Baseline section
Devensian Till	Negligible
Glaciofluvial Sheet Deposits	Low
Glaciofluvial Ice Contact Deposits	Low
Hummocky (Morainic) Glacial Deposits	Low

BGS Geological Unit	Sensitivity
Alluvium	Low
Undifferentiated River Terrace Deposits	Low

Designated Geological Sites

10.3.20. The term 'Geodiversity' refers to the variety of rocks, minerals, fossils, landforms sediments and soils in an area, together with natural processes, such as erosion and landslips that may still be active[li]. Sites of geodiversity interest within the study area are shown on Figure A10.1.3.

10.3.21. There are no Geological SSSIs within the study area; however, there is one Geological Candidate Review (GCR) site which SNH advises should be considered a Candidate SSSI. This has been given GCR Number 3318 and is referred to as The Slochd[lii,liii].

10.3.22. The Slochd GCR covers an area of approximately 110 ha and the GCR record gives the following grid references: NGR NH 2836 8257, NGR NH 2833 8240, and NGR NH 2842 8240. The Proposed Scheme enters the GCR site at NGR NH 2838 8252 in the southeast and at NGR 2835 8255 in the northwest and the existing rock cutting adjacent to the southbound carriageway forms part of the site. The extents of the GCR are shown on Figure A10.1.3. It is noted that only a small proportion of the GCR is in close proximity to the existing A9 and thus to the Proposed Scheme. The GCR will be directly impacted due to the southbound widening of the scheme, the existing rock cut that forms part of the GCR will be lost. However, this has been viewed positively as there is an opportunity to view fresh exposures, allowing for further study of the geology.

10.3.23. The GCR belongs to the "Precambrian – Dalradian" GCR block and is considered to be of national importance for the study of Precambrian metamorphism and the tectonic history of the Highlands of Scotland. A 2010 site condition survey published by SNH[liv] recorded the GCR site condition to be "favourable". In this report, two areas within the GCR boundary (A and B) were identified as "crucial areas of interest", on the basis that important features of the rocks are best exposed in these localities, these areas are crucial to the understanding of the scientific interest of the GCR. The northernmost of these areas (area A) includes the rock cutting adjacent to the southbound carriageway as well as the rock cuttings adjacent to the railway line and the northbound carriageway. It is noted that SNH extend Area A beyond the boundary of the GCR. The southernmost crucial area (Area B) is within the GCR boundary but beyond the extents of the Proposed Scheme.

10.3.24. A second GCR site, Allt na Feithe Sheilich (GCR number 924) is also present within 1km of the carriageway (Figure A10.1.3). At its closest point, it is 895m northeast of NGR NH 2839 8251 (south of Slochd Summit). Given its distance from the carriageway it has not been considered further as part of this assessment as the Proposed Scheme will have no impact upon it.

10.3.25. There are no Local Geodiversity Sites (LGS) within the study area. The 2011 geodiversity audit of the Cairngorms National Park completed by the BGS identified two further sites within the study area that are of geodiversity interest but which have not been designated as LGSs. These are: Boat of Garten / Tore Hill and Slocht Mor (it is noted that Slochd appears to have been misspelled and this location will be referred to as Slochd Mor herein). The BGS Geodiversity Audit proposed the addition of Boat of Garten/Tore Hill and Slochd Mor as geodiversity sites.

10.3.26. Boat of Garten / Tore Hill were identified as possible geodiversity locations for their outcrops of the Boat of Garten and Tore Hill igneous intrusions. Of relevance to the

Proposed Scheme, are the extents of the Boat of Garten Pluton which are shown on Figure A10.1.1. As discussed in the sections above, the Boat of Garten Pluton underlies the Proposed Scheme from NGR NH 2904 8169 to NGR NH 2909 8177 and is considered to be of potential geodiversity interest, along with the Tore Hill intrusions, these may be the only representatives of the Argyll-Northern Highlands Sub suite in the Cairngorms National Park. A former quarry face is exposed at NGR NH 2906 8172 in the area shown to be underlain by the Boat of Garten Pluton otherwise bedrock exposures along the existing A9 are limited with much of the landforms dominated by superficial deposits.

10.3.27. A small but distinct valley can be found west of Slochd Summit, centred at NGR NH 8341 2541. The approximate location is shown on Figure A10.1.3. This is of geodiversity interest as it is a significant meltwater channel landform associated with past glaciations in the area.

10.3.28. An additional feature falls within the study area that has not been designated or suggested as a geodiversity site but is known to be a feature of local interest. A rock feature within the Slochd Mor rock slopes near Slochd Summit (NGR NH 2841 8251) is locally referred to as the German Soldier and it is thought to resemble a human head wearing a helmet. This feature is also known by a number of other names such as the Soldier's Head, hereafter this feature will be referred to as the Soldier's Head. Anecdotal reports suggest that this feature was either hand carved or formed as a result of nearby blasting during the construction of the existing A9; however, it is most likely a natural feature in the rock face.

10.3.29. A number of cuttings have been formed in rock to accommodate the existing A9 between Dalraddy and Slochd. The majority of these cuttings, listed below, are considered to have little geodiversity interest unless stated otherwise:

- NGR NH 2836 8254, southbound lane: part of The Slochd GCR;
- NGR NH 2838 8253, northbound lane: part of The Slochd GCR;
- NGR NH 2842 8247, southbound lane;
- NGR NH 2849 8239, northbound and southbound lanes. The cutting adjacent to the southbound lane is noted to be substantially larger than the one adjacent to the northbound lane;
- NGR NH 2851 8238, northbound lane;
- NGR NH 2908 8204, northbound lane;
- NGR NH 2895 8144, northbound lane;
- NGR NH 2891 8131, northbound lane;
- NGR NH 2891 8116, southbound lane;
- NGR NH 2890 8111, northbound and southbound lanes. The cutting adjacent to the northbound lane is noted to be substantially longer and deeper than adjacent to the southbound lane. This feature is illuminated as a feature of interest at night; however, the geodiversity interest of this cutting is considered to be low; and,
- NGR NH 2886 8107, northbound lane.

10.3.30. The sensitivity of most of the rock exposures and outcrops within the study area is considered to be Low with the exception of The Slochd GCR which should be treated as a Candidate SSSI and is therefore considered to be of High sensitivity. In addition, other gneissose metamorphic formations at Slochd (Dava Subgroup, Creag Buidhe and Beinn Bhreac) are also recognised as having great geodiversity value, therefore these formations are also of High sensitivity. The Boat of Garten / Tore Hill and Slochd Mor

outcrops are considered to be of Low sensitivity due to their identified geodiversity interest as detailed below in Table 10.14. These features are not currently identified as an SSSI, GCR or LGS but have been proposed by the BGS as sites of Geodiversity therefore may require protection in the future. The 'Soldier's Head' is a local undesignated feature that would be deemed negligible based on the definition in the assessment criteria. However, this is a unique feature of notable local interest.

Table 10.14: Sensitivity of Geodiversity

Sites of Geodiversity Interest	Sensitivity
The Slochd	High
Gneissose Metamorphic Formations (Dava Subgroup, Creag Buidhe and Beinn Bhreac)	High
Boat of Garten / Tore Hill	Low
Slochd Mor	Low
'Soldier's Head'	Low

Economic Minerals

10.3.31. A search of the Review of Mining Instability in Great Britain, data from the Mineral Valuation Unit and the BGS Mining Plan Portal mapping information confirmed that the Proposed Scheme is not located within any areas affected by present or past mining activities.

10.3.32. The BGS Directory of Mines and Quarries[lv] and the BGS Onshore GeoIndex online portal indicate that there is one registered active quarry within the study area. This is Granish Quarry (NGR NH 2905 8153), north of Aviemore, and approximately 160m east of the existing A9. This quarry is operated by David Ritchie & Sons Ltd and the commodity is given as sand and gravel.

10.3.33. Historical maps identify a number of pits and quarries within the study area. These are summarised in Table 10.15 below and illustrated on Figure 10.4.

Table 10.15: Quarries and Pits within the Study Area

Location	Map Description	Comments
NGR 2864 8103	Disused pit	-
NGR 2871 8103	Disused gravel pit	Stockpiled materials observed during the PSSR walkover. No evidence of current extraction.
NGR 2873 8098	Disused sand pit	-
NGR 2883 8100	Disused pit	-
NGR 2885 8108	Quarry	Former commodity – rock.
NGR 2892 8116	Disused sand pit	-
NGR 2894 8138	Quarry	-
NGR 2896 8145	Quarry	At the time of the PSSR walkover this was used as an industrial yard. No evidence of current extraction.
NGR 2906 8172	Former quarry	Former commodity – rock.
NGR 2910 8196	Disused pit	-
NGR 2911 8198	Disused pit	-

Location	Map Description	Comments
NGR 2859 8243	Gravel pit	-
NGR 2848 8238	Disused quarry	-
NGR 2848 8239	Former quarry	Rock was extracted from this location at the time of the original A9 construction.
NGR 2825 8260	Disused pit	-
NGR 2824 8261	Disused sand pit	-

Table Source: A9 Dualling Northern Section: Dalraddy to Slochd Geotechnical Preliminary Sources Study Report.

10.3.34. Given their location and the underlying geology it is assumed that the majority of these former pits and quarries were used for the extraction of sand and gravel. It is noted that a number of former quarries were used for the extraction of rock (igneous or metamorphic) possibly for building stone supply or for the provision of material for the construction of the existing A9.

10.3.35. Granish Quarry is considered a locally important source of sand and gravel and has therefore been assigned a sensitivity of Medium. The sand and gravel resource elsewhere in the study area has been worked historically but is not currently being extracted. Given the widespread distribution of superficial deposits that consist largely of sand and gravel the sensitivity of this resource is considered to be Low. The location of Granish Quarry is shown on Figure 10.4.

10.3.36. Rock is not currently being quarried within the study area but has been extracted historically. Bedrock is at or near the ground surface across large sections of the study area; therefore, the sensitivity of this resource is considered to be Low.

Soils

10.3.37. The soil units present on site are summarised from the 1:250,000 Soil Map of Scotland by the James Hutton Institute[xxxviii].

10.3.38. The distribution of soils within the study area is dependent on the geology, topography and drainage regime of the area. The study area soils consist of various soil units belonging to the Arkaig, Corby, Countesswell, Aberlour and Dulsie Associations, derived from Moine Series metamorphic rocks, fluvioglacial sands and gravels and granites respectively. The main soil types within the study area are:

- Gleys: naturally poorly drained soils that develop under conditions of intermittent or permanent waterlogging. Soils are typically greyish or blue-grey with orange mottling. Peaty gleys have a peat-rich surface horizon; noncalcareous gleys have a low lime content; humic gleys include a humus-rich surface layer;
- Podzols: typically free-draining acid soils developed under aerobic conditions. Podzols are generally nutrient-deficient and heavily leached in the upper horizons, with an accumulation of iron/aluminium oxides (‘ironpan’) or organic material at lower levels within the soil profile. Peaty podzols have a peat-rich surface horizon; humus-iron podzols have a more humus-rich surface layer and a higher concentration of iron oxides within the soil profile. In areas with low slope angles, waterlogging may occur above the ironpan; this can produce a soil intermediate between a podzol and a gley;
- Rankers: predominant in mountain or hilly terrain or on glacially eroded rocky terrain with underlying solid or fragmented non-calcareous rocks within 30cm depth. An organic or organo-mineral surface horizon present but generally lacks subsoil; and
- Peat: accumulations of organic material that have remained wet to the surface; often dominated by sphagnum mosses.

10.3.39. Sixteen soil units are found within the study area, summarised in Table 10.16, and shown in Figure 10.5. Each soil unit consists of varying proportions of the soil types discussed above, with the proportion of each soil type within a soil unit dictated by the local climatic, topographical and drainage conditions.

Table 10.16: Soils within the Study Area

Soil Association	Soil Unit	Component Soils	Landforms	Typical Associated Vegetation	Study Area Presence .
Alluvial Soils	1	Alluvial soils	Flood plains, river terraces and former lake beds	Arable and permanent pastures, rush pastures and sedge mires, broadleaved woodland	Along the valley of River Spey upstream of Loch Alvie and south of Aviemore
Organic Soils	3	Basin and valley peats	Basins and valleys	Blanket and flying bent bog, swamp, rush pastures and sedge mires	Large open areas both south and east of Black Mount, and north of Slochd summit
Aberlour	9	Peaty podzols, peat, peaty gleys	Hummocky moraine with strong, non-rocky or slightly rocky complex slopes.	Moist boreal heather moor and blanket bog	North of Slochd along steep rocky slopes
	10	Peaty podzols, humus-iron podzols, peaty gleys and rankers	Hills and valley sides with strong to moderately rocky slopes	Moist and dry boreal heath moors and white bent-tussock grass grassland	East of Slochd across existing A9 route
	15	Rankers, lithosols and some alpine soils	Mountain summits with strong to very steep and very rocky slopes	Blaeberry heath, bog whortleberry heath, alpine azalea-lichen heath and stiff sedge-fescue grasslands	Area around settlement of Slochd and surrounding valley
Arkaig	22	Peaty podsols, peat, some peaty gleys and humus-iron podzols	Hills and valley sides with strong slopes, non-rocky	Moist boreal heather moor, blanket and upland blanket bog, bog heather moor	Small upland area north of Slochd
	28	Peaty podzols, humus-iron podzols; some peaty gleys and rankers	Hills and undulating lowlands with gentle and strong slopes: moderately rocky	Boreal and Atlantic heath moors, heath rush-fescue grasslands and rich bent-fescue grassland	Lower lying woodland west of Crannaich, west of the Proposed Scheme
	30	Rankers, peaty podzols; some humus-iron podzols and peaty gleys	Rugged hills with strong and steep slopes; very rocky	Dry and moist boreal heather moor, bog heather moor, blaeberry heath	Large area west of Proposed Scheme from Aviemore to north of Kinveachy, upper slopes west of Slochd summit
Corby	98	Humus-iron podzols, alluvial soils	Valley floors, terraces and mounds with gentle and strong slopes	Coniferous woodland, and natural oak and birch woodlands	Valley of River Dulnain at Carrbridge

Soil Association	Soil Unit	Component Soils	Landforms	Typical Associated Vegetation	Study Area Presence .
	100	Humus-iron podzols, some peaty gleys and humic gleys	Mounds and ridges with gentle to steep slopes	Atlantic and boreal heather moors, and acid bent-fescue grassland	Valley floor around Loch Alvie, large area east of Proposed Scheme extending north from Aviemore to Kinveachy
	101	Peaty podzols, some humus-iron podzols and peat	Located on both steep sided mounds and flat areas	Moorland communities dominate peaty podzols whereas blanket bogs typify peat filled depressions	South of Slochd Mhor and west of the existing A9 route
Countesswells	126	Peaty podzols, humus-iron podzols, some peaty gleys and rankers	Hill and valley sides with strong to very steep, moderately rocky slopes	Boreal heath moors, flying bent grassland and boreal juniper scrub	Small area west of Ballinluig on upper slopes of Creag Ghleannain
	127	Peaty podzols, peat; some peaty podzols and peaty rankers	Hills and undulating lowlands with gentle and strong slopes: moderately rocky	Moist boreal and Atlantic heather moor, bog heather moor, blanket, lowland and upland blanket bog	Small uphill area, on lower slopes of An Leth-chreag, west of Granish
Dulsie	172	Humus-iron podzols; some gleys and peaty podzols	Undulating lowlands and hills with gentle and strong slopes	Scots pine, with areas of crops based on grass.	Woodland area around Crannaich, south of Carrbridge
	173	Peaty podzols, peat; some peaty gleys and humus-iron podzols	Hills and valley sides with strong and steep slopes	Scots pine	Large area around Black Mount and Baddengorm Woods
Organic Soils	606	Peat	Blanket Peat		Small area located east of Slochd summit, on slopes of Carn nam Bain-tighearna

Table Source: Soils Scotland[xxxviii].

10.3.40. Information on the potential use and quality of the soils has been derived from the Land Capability for Agriculture mapping, produced by The James Hutton Institute[xxxviii]. The land capability classes present within the study area are listed in order of prevalence within Table 10.17 below.

Table 10.17: Land Capability for Agriculture Classes within the Study Area

Class	Description	Study Area Presence
4_2	Land capable of producing a narrow range of crops. Primarily grassland with some limited potential for other crops. Grass yields can be high but difficulties of conservation or utilisation may be severe, especially in areas of poor climate or on very wet soils.	Extensive area of Proposed Scheme from land around Loch Alvie, along existing A9 through Aviemore, Kinveachy and Carrbridge to Black Mount. Corresponds mainly to soil unit 100, but also with soil units 98 and 173.
6_3	Land capable of use only as rough grazings. The vegetation is dominated by plant communities with low grazing values, particularly heather moor, bog heather moor and blanket bog.	Primarily along steeper slopes and higher ground west of existing A9 west of Lynwilg, Aviemore and Kinveachy, also the area around Slochd. Corresponds with a number of soil units including 3, 9, 10, 15, 30 and 126.
5_2	Land capable of use as improved grassland. Sward establishment presents no difficulties but moderate to low trafficability, patterned land and/or strong slopes cause maintenance problems. Growth rates are high and despite some problems of poaching satisfactory stocking rates are achievable.	Woodland around Avielochan, north of Kinveachy and west of Slochd Mor. Corresponds with soil units 30, 100 and 172.
3_2	Land capable of producing a moderate range of crops. Suited to an average production but high yields of barley, oats and grass. Grass leys are common and reflect increasing growth limitations for arable crops and degree or risk involved in production.	Base of the Spey valley at Aviemore and along River Dulnain valley west of Carrbridge. Broadly correlates with soil units 1 and 100.
6_2	Land capable of only rough grazing due to intractable physical limitations, the semi-natural vegetation provides grazing of moderate value. This land is either steep, very poorly drained, has very acid or shallow soils and occurs in wet cool or cold climate zones.	Woodland south and east of Loch Alvie. Broadly correlates with soils units 1 and 22.
5_3	Land capable of use as improved grassland. Similar to class 5_2, sward establishment may be easy although deterioration in quality is often rapid. Patterns of soil, slope or wetness may seriously interfere with establishment, land cannot support high stock densities.	Large areas south of Black Mount and east of Slochd, with a small area west of Sluggangranish. Corresponds with soils 3, 22 and 127.

Table Source: Soils Scotland[xxxviii].

10.3.41. Given the distribution of the soils in the study area, the vast majority of the study area is underlain by land capability Class 4 and Class 5 soils, where the soils are of medium quality and therefore of Medium sensitivity.

10.3.42. Areas towards the south end of the study area feature land capability Class 3 soils, where the soils are of high quality and therefore considered to be of High sensitivity.

10.3.43. The outlying areas of the study area are generally on higher ground with poorer quality soils (land capability Class 6) where the soils are of low quality and therefore are considered to be of Low sensitivity.

Peat

10.3.44. Peat is a soft to very soft, highly compressible, highly porous organic material which can consist of up to 90% water by volume. Unmodified blanket peat typically has two layers, a surface layer or acrotelm which is usually 0.1 to 0.3 m thick, highly permeable and receptive to rainfall. The acrotelm layer generally has a high proportion of fibrous material and often forms a crust under dry conditions. The second layer, or catotelm, lies beneath the acrotelm and forms a stable colloidal substance which is generally impermeable. As a result, the catotelm usually remains saturated with little groundwater flow. Peat is thixotrophic, meaning that its viscosity decreases under applied stress. This property may be considered less important where the peat has been modified through artificial drainage and is drier, but becomes an important factor when the peat body is saturated.

10.3.45. A variety of desk study data sources provide information on the presence of peat deposits within the study area, in particular the superficial geology mapping and the soils mapping. However, there are conflicts between the datasets, partly due to the different scales of mapping, but also due to differences in the definition of what constitutes peat and the criteria used in mapping it.

10.3.46. SNH published a national map of 'carbon-rich soil, deep peat and priority peatland', in July 2016[xlv]. This map draws on a number of national datasets including those mentioned above to identify peat and peat soils and classify them by 'importance'. This mapping is presented in Figure 10.6. A summary description of the Carbon and Peatland 'importance' classes present within the study area is provided in Table 10.18, listed in order of prevalence within the study area.

Table 10.18: Summary of Carbon and Peatland Classes Present Listed in Order of Prevalence within the Study Area

Class	Description	Study Area Presence	Area (ha) within Study Area	Percentage of Study Area
Class 0	Mineral Soils. Peatland habitats are not typically found on such soils.	Predominant classification, present across most of the study area	1097.05	60.3
Class 4	Area unlikely to be associated with peatland habitats or wet and acidic soils. Area unlikely to include carbon-rich soils.	West of existing A9 at Kinakyle, large area of Craigellachie National Nature Reserve, and at Aviemore. Large area north of Sluggangranish at Cairn Beinn Ghuilbin, area west of Dalrachney Beag (north of Carrbridge) and west of Slochd at Torr Mor.	496.13	25.8

Class	Description	Study Area Presence	Area (ha) within Study Area	Percentage of Study Area
Class 5	Soil information takes precedence over vegetation data. No peatland habitat recorded. May also show bare soil. All soils are carbon-rich soil and deep peat.	Extensive area in the very gently sloping valley of Allt Ruaidh located north west of Dalrachney Beag and south of Black Mount, and large area in the vicinity of Slochd summit, on both sides of the current A9	183.57	10.1
Class 3	Dominant vegetation cover does not indicate priority peatland habitat, but is associated with wet and acidic type. Occasional peatland habitats can be found. Most of the soils are carbon-rich soil, with some areas of deep peat.	Number of small areas of peat north-west of Dalrachney Beag, west of Baddengorm Woods along A938, and north of the railway at Black Mount.	10.14	0.6
Class -2	Non-soil i.e. loch, built up area, rock, scree	Lochs and larger watercourses throughout the study area.	35.59	2.0
Class 1	All vegetation cover is priority peatland habitats. All soils are carbon-rich soils and deep peat	Extensive peatland south of Black Mount in the very gently sloping valley of the Allt Ruaidh, west of the railway at Slochd Summit and a small isolated area north of Sluggangranish along the Allt na Criche (north). Isolated areas to the west of Baddengorm Woods north of the A938.	25.04	1.4
Class -1	Unknown soil type	None within study area	0	0
Total			1820.53	100

Table Source: SNH[xlv].

10.3.47. Based on the information presented in Table 10.18 the Class 1 and Class 3 peat within the study area are considered of High and Medium sensitivity, respectively. The Class 5

areas are considered of Low sensitivity and Class 4 and Class 0 areas are considered Negligible.

10.3.48. The SNH mapping has been supplemented with data from historical boreholes, the results of the Stage 2 GI and a number of peat probing surveys. The survey carried out at Stage 2 assisted in defining the extent and depth of the peat within the study area. Further surveys provided additional data in areas of peat for the Proposed Scheme. The results of the peat probing surveys and peat contours based on these results are presented in Figure 10.6.

10.3.49. The vast majority of the study area was found to have peaty soils of less than 0.5m depth, however, a number of defined areas with peat or peaty soil depths greater than 0.5m were identified immediately adjacent to or under the footprint of the Proposed Scheme. Details are summarised in Table 10.19, with full details provided in Appendix 10.3.

Table 10.19: Areas of Peat Under or Immediately Adjacent to the Proposed Scheme

Area	Location (NGR)	Max peat depth (m) SNH Priority Peatland Class	Peat Volume (m3)	Associated Peat Core ID Von Post Class	Description
P1 Dalraddy (CH200 – 400)	NH 85407 09198	1.2 Class 0	1700	-	This area is located east and downslope of the Proposed Scheme, gently sloping south-east towards Allt an Fhearna, featuring broad-leaved semi natural woodland and improved grassland habitats.
P2 Docharn WD (CH13900 – 13930)	NH 90929 20173	2.5 Class 4	4560	-	The area is located immediately east of the Proposed Scheme, gently sloping towards the Highland Mainline Railway, featuring coniferous plantation woodland.
P3 Feith Mhor (01) (CH14500 – 15100)	NH 90762 20798	6.4 Class 0	21620	-	This area is located immediately east of the Proposed Scheme, on the existing A9 embankment, gently sloping towards the Highland Mainline Railway. The area is in an area of coniferous plantation woodland and unimproved grassland.
P4 Feith Mhor (02) (CH14500 – 15100)	NH 90583 21234	2.7 Class 0 and 5		-	This area is located immediately east of the existing A9, gently sloping east towards Highland Mainline Railway, featuring semi-improved grassland,

Area	Location (NGR)	Max peat depth (m) SNH Priority Peatland Class	Peat Volume (m3)	Associated Peat Core ID Von Post Class	Description
					heath and coniferous plantation woodland.
P5 Feith Mhor (CH14950-15000)	NH 90556 21225	4.3 Class 0	5740	DS-PC-04 H4 to H8 Slightly to very strongly decomposed	This area is located immediately west of the existing A9, at the base of a small hill, featuring a mixture of blanket bog, coniferous plantation woodland and semi-improved acid grassland.
P6 Ellan WD (CH15380)	NH 90420 21608	1.1 Class 0	750	-	Small area of semi-improved grassland located downslope of the existing A9 northbound embankment verge, gently sloping east towards the Highland Mainline Railway.
P7 South of Black Mount Junction (CH18410)	NH 88461 23857	1.1 Class 4	180	-	Small area located immediately south-west of the existing A9, gently sloping south from the carriageway, featuring dense/continuous scrub.
P8 Black Mount Junction (East of CH18800)	NH 88045 24073	2.55 Class 3	2200	DS-PC-03 H2 to H5 Insignificantly to moderately decomposed	The area is located north of the Proposed Scheme, gently sloping north towards the Highland Mainline Railway, featuring a mix of swamp and broad-leaved semi-natural habitat.
P9 Black Mount - Cuttings (CH19100-20100)	NH 87019 24020	0.9 Class 4	930	-	Area immediately north of the Proposed Scheme, sloping north, featuring a range of habitat including coniferous plantation woodland and dry modified bog.
P10 Black Mount – Embank-ment(01) (CH20100-21000)	NH 86255 23893	3.1 Classes 4 and 5	32180	DS-PC-02 H2 to H8 Insignificantly to very strongly decomposed	Area immediately north of the existing A9, gently sloping north, featuring a range of habitats including marshy grassland and blanket bog.

Area	Location (NGR)	Max peat depth (m) SNH Priority Peatland Class	Peat Volume (m3)	Associated Peat Core ID Von Post Class	Description
P11 Black Mount – Embank-ment(02) (CH20100-21000)	NH 86363 23827	4.6 Classes 4 and 5		DS-PC-01 H2 to H4 Insignificantly to slightly decomposed	Area immediately south of the existing A9, gently sloping south, featuring a range of habitats including unimproved acid grassland, blanket bog and heath.
P12 Black Mount – Embank-ment(03) (CH20100-21000)	NH 86254 23892	3.1 Classes 5 and 0		-	Area immediately north of the existing A9, gently sloping north towards secondary road, featuring a range of habitats including basin mire and coniferous plantation woodland.
P13 Slochd (CH24200-24300)	NH 83478 25671	1.5 Class 5	980	-	Small area located north-east of the Proposed Scheme, moderately sloping north-east towards Slochd Summit, featuring unimproved acid grassland.
P14 Slochd (CH24450-25000)	NH 83058 26061	3.1 Class 5	1980	-	This area is located immediately north-east of the existing A9, at the base of the Slochd Summit, featuring unimproved grassland and heath.

Peat Stability and Hazard Ranking Assessment

10.3.50. The Peat Stability Assessment initially highlighted eight areas of initial concern (7 high risk and 1 moderate risk). Detailed assessment of local characteristics at these 8 locations identified that deeper peat and steeper slopes in various areas were generally not coincident, with steep artificial slopes relating to existing A9 and Highland Mainline Railway infrastructure often adjacent to low gradient peat deposits. Deeper peat deposits were often confined to well-defined basins, generally with very shallow gradients and adjacent to existing infrastructure, with soil exposures providing evidence of glacial till and peaty soils. A number of peat cores were collected at identified areas of peat across the scheme to refine the assessment process.

10.3.51. Peat characteristics were subsequently used to provide more accurate information in Factor of Safety (FoS) slope calculations for individual points and grid cell values. No evidence of peat instability was recorded during the site visits. The methodology, peat core data and detailed assessment datasheets are provided in Technical Appendix 10.2, Peat Stability Assessment.

10.3.52. Taking account of the local characteristics, application of general good practice and appropriate site-specific mitigation, all of the initially identified risk areas are considered to have a revised risk level of low. Therefore, this has been scoped out of the impact assessment.

Groundwater

Hydrogeology

10.3.53. Most of the igneous and metasedimentary bedrock in the study area is described on the BGS Bedrock Aquifer Productivity mapping as very low productivity aquifers[xxix]. Within these very low permeability rocks groundwater storage and flow is limited to the near surface weathered zone and secondary features such as fractures. Sustainable yields of less than 0.1 litres per second (l/s) are typical in suitably sited boreholes. The direction of groundwater flow in the bedrock is not known.

10.3.54. There are two areas of the Pityoulish Formation at Kinakyle and at Granish, which feature low productivity aquifers and where groundwater storage and flow is also limited to fractures. Sustainable yields are typically around 0.1 to 1l/s in suitably sited boreholes.

10.3.55. The BGS Superficial Aquifer Productivity mapping[xxix] (Figure 10.7) indicates that the glaciofluvial sheet and ice contact deposits comprising gravel, sand and silt are considered to be high productivity intergranular flow aquifers. Typical sustainable borehole yields are expected to be greater than 10l/s. These aquifer types are located around Lynwilg, Aviemore, Kinveachy and west of Slochd.

10.3.56. The river terrace and alluvial deposits within the study area are described as intergranular flow aquifers with moderate to high productivity, i.e. sustainable yields of between 1 and 10l/s are typical. These aquifer types are located at Dalraddy, south of Lynwilg, along the River Dulnain at Carrbridge, along the valley of the Allt nan Ceatharnach to the west of Baddengorm Woods and along the valley bottom of the Allt Slochd Mhuic near Slochd settlement. There are small areas described as intergranular flow aquifers with low to moderate productivity and yields of 0.1 to 10l/s, which correspond to talus deposits near Slochd Mor.

10.3.57. The Devensian Till, Hummocky (moundy/morainic) deposits and Peat deposits are not considered significant aquifers, with typical sustainable yields of less than 0.1l/s. These form large areas of the scheme west of the existing A9 north of Aviemore, and along the sections of the Study Area at Docharn Wood, Ellan Wood, Baddengorm Woods, Black Mount and north of the existing A9 at Slochd Summit.

10.3.58. Groundwater flow within the superficial deposits is expected to follow surface topography, draining towards local surface watercourses[xxxii].

10.3.59. Based on the information presented above, both the ‘moderate to high’ and ‘high’ productivity classes are considered of High sensitivity in relation to groundwater quality. The remaining aquifers are considered of Low sensitivity. Sensitivity classifications are summarised below in Table 10.21.

Groundwater Observations

10.3.60. Groundwater levels have been monitored both during and after the Stage 2 GI across 71 boreholes within the Proposed Scheme corridor between February 2017 and June 2018. Where detected, the water table varied across the existing boreholes, measuring between 433.27 m AOD at BHDS2041 (March 2017) in the north of the area,

approximately 385m south west of Slochd summit (NGR NH 2838 8255) to 208.33 m AOD at BHDS2011 (June 2018) in the south of the area (NGR NH 2892 8118). The depth to the water table varied between 0.18 m bgl at BHDS2043 (NGR NH 2880 8240, March 2017) in the north of the area, to 25.60 m bgl at BHDS2042 (NGR NH2837 8256, March 2018) also in the north of the area.

10.3.61. Based on the above groundwater monitoring it is anticipated that groundwater levels will be variable, but with the potential to be found at shallow depths across the study area.

10.3.62. Many of the boreholes were dry when drilled. Depths of the dry boreholes varied, approximately a quarter of the dry boreholes were terminated early (at depths ranging from 3m – 7.9m bgl) due to encountered obstructions (e.g. BH2002, BH2024) but the majority of the boreholes extended beyond depths of 10 m bgl and beyond the base of proposed cuttings (e.g. BHDS2001, BHDS2069). During the monitoring period, 33 boreholes were recorded as dry at least once, and often multiple times. Monitoring of the boreholes has continued on a monthly basis for the majority of installations, however some boreholes only recorded a single water level as a result of unusually dry weather.

10.3.63. Thirteen in situ variable head permeability tests were carried out on boreholes as part of the Stage 2 GI. This round of testing comprised 11 rising head tests and two falling head tests. Tests were carried out in nine boreholes which were screened through superficial deposits of silty Sand and Gravel comprising both River Terrace Deposits and Glaciofluvial deposits, a further three tests were conducted in boreholes screened through weathered psammite bedrock with one test in a borehole screened through fractured and partially weathered granite bedrock.

10.3.64. To corroborate the previously obtained permeability test results undertaken during the Stage 2 GI, five borehole tests were completed using the slug test method. Three boreholes were retested, two of these boreholes (BHDS2005 and BHDS2083) were screened through superficial deposits of gravelly, silty fine to coarse sand with cobbles. These deposits are categorized by the BGS as River Terrace Deposits at BHDS2005 and Glaciofluvial sheet deposits at BHDS2083, with one borehole (BHDS2046A) screened through fractured and partially weathered granite bedrock. Two additional permeability tests were also conducted on boreholes screened through weathered psammite bedrock (BHDS2064 and BHDS2065). The locations of the boreholes are shown on figure 10.8.

10.3.65. The calculated hydraulic conductivity of the superficial deposits ranged from 4.40 x 10-8-9.78 x 10^{-6} m/s.

10.3.66. The calculated hydraulic conductivity of the bedrock ranged from 4.18 x 10^{-9} - 2.21 x 10^{-5} m/s.

10.3.67. The results for the bedrock show a larger range of permeability values than the superficial deposits. The bedrock typically has a lower permeability. The differing permeability values are due to the extent of weathering and/or fracturing within the bedrock. The calculated results for hydraulic conductivity of the superficial deposits (River Terrace and Glaciofluvial ice/sheet Deposits) appear to be low based on the described strata and the typical anticipated values. This may be due to their dense, silty nature.

10.3.68. The permeability results for the study area show notable variation sometimes over relatively short distances. Permeability values are slightly lower than the expected CIRIA C750literature values, reflecting the highly variable nature of the superficial deposits, and should be treated with caution when extrapolating over significant distances. Variable head tests utilise only a small a volume of water and as such the area of the aquifer which responds to the test is relatively small and the variability of

geological conditions over larger areas may not be evident. Groundwater vulnerability is defined as 'the tendency and likelihood for general contaminants to reach the water table within the uppermost aquifer after introduction at the ground surfacelvi. The groundwater vulnerability classifications are derived from datasets for a number of parameters, including the flow type, presence of clay deposits, permeability and thickness of superficial and bedrock deposits, groundwater depth and Hydrology of Soil Type (HOST) class.

10.3.69. The variation of groundwater vulnerability classification is important in identification of the risk posed to groundwater receptors from pollutants, and is considered when assessing potential pollution impacts from construction activities and operational routine runoff and accidental spillages on groundwater bodies[lvii].

10.3.70. Table 10.20 provides information on the groundwater vulnerability classifications.

Table 10.20: Groundwater Vulnerability Classification

Vulnerability Class	Description		Frequency of Activity	Travel Time	Site Presence
5	Vulnerable to most pollutants, with rapid impact in many scenarios		Vulnerable to individual events	Rapid	Large area of exposed rock west of A9 at Kinakyle/Craigellachie, west of A9 at Sluggangranish, around Kinveachy forest and at Slochd/Slochd summit. Generally, corresponds to areas where bedrock is at or near surface.
4	Vulnerable to those pollutants not readily absorbed or transformed	4a May have low permeability soil; less likely to have clay present in superficial deposits			Most of The Proposed Scheme footprint lies within this class, including areas around Aviemore, Kinveachy and Carrbridge.
		4b More likely to have clay present in superficial deposits			Small areas within the woodland area south of Carrbridge, open peatland west of Dalrachney Beag and across to the south of the A9 at Black Mount. Generally, corresponds to peat deposits.
3	Vulnerable to some pollutants; many others significantly attenuated				Small areas around Ballinluig, woodland areas at Craigellachie, woodland west of Granish junction extending north to Avielochan. Broadly corresponds to some hummocky glacial deposits within the study area
2	Vulnerable to some pollutants; but only when they are continuously discharged/leached				Not present within study area.
1	Only vulnerable to conservative pollutants in the long term when continuously and widely discharged/leached		Vulnerable only to persistent activity	Slow	None within study area. Largely corresponds to areas of valley peat.
0	Not sufficient data to classify vulnerability e.g. below lochs, in urban areas where geological and/or soil data is missing, where superficial deposits are mapped but not classified; or in mined (including opencast) and quarried areas.				Areas including Loch Alvie and made ground at Slochd associated with the Highland Mainline railway and current A9, corresponding to waterbodies and built up areas.

Table Source: BGS (2016).

10.3.71. Groundwater vulnerability mapping[lviii] indicates that the majority of the study area falls under Class 4a, featuring a relatively High groundwater vulnerability and Low permeability soils. This mapping is presented in Figure 10.8.

Water Quality & Water Framework Directive (WFD) Status

10.3.72. The bedrock aquifer of the study area is classified under the WFD as part of the Strathnairn, Speyside and Cairngorms Groundwater Body (WFD ID 150709). The high and moderate to high productivity glacial sands and gravels and alluvium deposits of the study area are classified under the WFD as part of the Upper Spey Sand and Gravel Groundwater Body (WFD 150814)[lix].

10.3.73. As of 2015 both water bodies are classified as having an overall status of 'Good' with high confidence, with a 'Good' status for both chemistry and quantitative factors. There are currently no pressures identified on these water bodies. Both waterbodies are also designated as Drinking Water Protected Areas (DWPA) under the Drinking Water Directive, with a current condition parameter (DWPA status) of Pass.

10.3.74. There are four Scottish Water public supply boreholes, further details of which are included in the confidential Appendix 10.5.

10.3.75. Based on the information presented above, the groundwater bodies of the study area are considered to be of High sensitivity in relation to groundwater quality.

10.3.76. Table 10.21 below shows the SEPA and BGS aquifer classifications and implied sensitivity of water quality. The table also categorises the aquifer's potential for sustaining various levels of borehole water supply.

Table 10.21: Sensitivity of Groundwater Aquifers

Geological Unit	Attribute	Classification	Sensitivity
Alluvial Fan Deposits Alluvium Glaciofluvial Sheet Deposits River Terrace Deposits (Undifferentiated)	Water Quality	Moderate to High Productivity WFD Good status - Upper Spey Sand and Gravel	High
	Water Supply, Groundwater Flow	High Productivity (unless specified locally as clay and silt then it will not be a significant aquifer	High
Devensian Till Hummocky Glacial Peat	Water Quality	N/A	Low
	Water Supply, Groundwater Flow	Non-aquifer	Low
Moine Supergroup Bedrock – Psammites & Semipelites	Water Quality	WFD Good status - Strathnairn, Speyside and Cairngorms Groundwater Body	High
	Water Supply, Groundwater Flow	Very Low Productivity	Low
Dalradian Supergroup Bedrock – Psammites & Semipelites	Water Quality	WFD Good status - Strathnairn, Speyside and Cairngorms Groundwater Body	High
	Water Supply, Groundwater Flow	Very Low Productivity	Low

Geological Unit	Attribute	Classification	Sensitivity
Intrusive Igneous Bedrock – Monadhliath Pluton Boat of Garten Pluton	Water Quality	WFD Good status - Strathnairn, Speyside and Cairngorms Groundwater Body	High
	Water Supply, Groundwater Flow	Very Low Productivity	Low

Table Source: BGS (2016) and SEPA (2013).

Public Water Supplies

10.3.77. Public water supply information was provided by Scottish Water. A number of assets were identified in the Aviemore area. This includes the public water supply for the Aviemore area, which is a groundwater source located south of Aviemore adjacent to the River Spey (the precise location of the source is confidential, details are provided in Appendix 10.5).

10.3.78. The main carriageway of the proposed scheme lies approximately 115m uphill of the source, at the nearest point. The carriageway construction requires cutting into the uphill hillside, with the nearest point of cutting lying 130m uphill of the source. The maximum cutting height/depth in this area is approximately 5.1m. Initial dip information for the public supply boreholes shows a range in groundwater depth from 4.6mbgl to 17.60mbgl.

10.3.79. Borehole logs provided by Scottish Water confirm the public supply boreholes are abstracting from the Glaciofluvial Ice Contact and Sheet Deposits at depths of 35 to 55 m bgl. This groundwater source is likely to have a strong hydrological connection to the River Spey. The sensitivity of these Aviemore groundwater source boreholes are considered Very High.

10.3.80. There are also three Scottish Water District Service Reservoirs (DSR) assets which store drinking water for the local area, located at Aviemore, Sluggangranish and Carrbridge. As these are not abstraction locations they are not considered further in this chapter.

10.3.81. Any impacts on public water infrastructure will be covered under the Utilities Section of the DMRB Stage 3 Engineering Assessment.

Private Water Supplies

10.3.82. Groundwater-fed private water supplies identified within the 850m buffer of the private water supply study area are shown on Figure 10.8 and presented in Table 10.22 below. A number of data sources were reviewed for potential private water supplies, including data from The Highland Council, OS mapping, SEPA CAR licence information. Landowner consultations also took place on a systematic basis.

10.3.83. Sensitivity has been evaluated on the basis of the criteria identified in Section 10.2. Those supplies with strong justification for not being considered further in this assessment have been identified as not applicable (‘n/a’) in the supply sensitivity column.

Table 10.22: Private Water Supplies located within 850m of the Proposed Scheme

Source Name Grid Reference	Source Type	Properties Supplied and Estimated no. of Properties Served	Property Grid Reference	Comment and Screening Decision	Screening Result	Sensitivity
Potential PWS Nr Chainage 4600	Spring OS Map	1. Craig Dhu 2.March Cottage	1. NH 891 113 2. NH 891 113	Craig Dhu is approximately 38 m west of the proposed scheme, while March Cottage is located 8m to the west. Landowner consultations confirmed the properties are on the public water mains supply.	Screened Out – no supply	n/a
PWS Rothiemurchus Estate NH 927 114	Spring	1. Rothiemurchus Visitor Centre 2. Rothiemurchus Smoke House 3. Tigh an Druidh 4. Tennis Club	1. NH 896 111 2. NH 900 113 3. NH 898 112 4. NH 900 113	The supply is listed both by The Highland Council and SEPA. There are a number of properties on the estate that are served by a spring fed supply located at Achnahatnich approx. 3km east of these properties. The River Spey is located between the Proposed Scheme and both the supplies and properties. Given their distance and the intervening topography they will be unaffected by the Proposed Scheme.	Screened Out – supply outside of study area	n/a
PWS Wendy Unknown source location Nr Chainage 7400	The Highland Council	1. 7 Dalfaber Place	1. NH 904 139	The property is a residential house in Aviemore and is located approx. 0.99km east of the Proposed Scheme. Consultation with the property owner confirmed this supply does not exist.	Screened Out – no supply	n/a
Potential PWS Unknown source location Near CH17000	SEPA OS Map	1. Lynphail 2. Dalrachney Beag	1. NH 891 227 2. NH 892 226	Due to its rural location this property may have a private water supply to supplement the mains supply. Lynphail is 10 m away from, and Dalrachney Beag is located adjacent to, an access track of the Proposed Scheme. Landowner consultation confirmed both properties are on the public water mains supply.	Screened Out – no supply	n/a
PWS Baddengorm NH 887 243	Borehole	Supplies one property: 1. Baddengorm	1. NH 887 243	The source is located immediately adjacent to the north of the property and 450m north and 10m upslope of the Proposed Scheme. The depth of the PWS Baddengorm's borehole is approximately 20mbgl. Boreholes installed as part of the Proposed Scheme's Stage 2 Geotechnical Investigations (GI) within a 750m radius of the source do not extend to the same depth of the supply's borehole, with the maximum	Screened in	High

Source Name Grid Reference	Source Type	Properties Supplied and Estimated no. of Properties Served	Property Grid Reference	Comment and Screening Decision	Screening Result	Sensitivity
				depth at 10mbgl (borehole reference BHDS2043, 710m south-west of the supply), with fine to coarse sand with cobbles present below 7.3mgbl. The nearest boreholes (installed in Stage 2 GI) shows water levels to be 4.2mbgl (rising to 3.9mbgl in 20 minutes) at borehole reference BHDS2033, 580m south-west of the supply, and 3.20mbgl (rising to 1.90mbgl after 20 minutes) at borehole reference BHDS2043, 710m south-west of the supply. Due to this unknown, the borehole is considered to abstract from either the Ardverikie Till Formation (Diamicton) or Alluvium (Sand, Gravel and Boulders), underlain by Slochd Psammite Formation (Psammite, Quartzose-Gneissose-Migmatitic) or Dava Subgroup (Psammite, Feldspathic-Migmatitic). It is considered that the supply may be impacted by the Proposed Scheme due to its close proximity to the source.		
PWS Slochd 1 NH 850 237	Spring	Supplies one property: 1. 3 Slochd Railway Cottages	1. NH 847 237	The source is located 130m south and upslope of the Proposed Scheme. This source is not currently in use by the property, with the resident stating that the source is in poor condition. As a result, it is not considered as fit for use. The two nearest boreholes with water levels recorded within the borehole logs (installed in Stage 2 GI) show variable water depths: at borehole reference BHDS2059, 190m north-west of the source, groundwater was encountered at a depth of 3.60 m bgl and rose to 3.50 m bgl after 20 minutes and at borehole reference BHDS2035, 320m east of the source, groundwater was encountered at a depth of 20.30 m bgl and rose to 20.10 m bgl after 20 minutes. As a result, the source of the supply is anticipated to emanate from either Devensian Till (Diamicton) or the underlying Slochd Psammite Formation (Psammite, Quartzose-Gneissose-Migmatitic). It is considered that the supply may be impacted by the Proposed Scheme, due to the close proximity.	Screened in	High

Source Name Grid Reference	Source Type	Properties Supplied and Estimated no. of Properties Served	Property Grid Reference	Comment and Screening Decision	Screening Result	Sensitivity
PWS Slochd 2 (known locally as PWS Slochd Mhor Lodge and Cottages) NH 847 238	Borehole	Supplies five properties: 1. Slochd Mhor Lodge 2. 1 Slochd Railway Cottages 3. 2 Slochd Railway Cottages 4. 3 Slochd Railway Cottages 5. 4 Slochd Railway Cottages	1. NH 847 237 2. NH 847 237 3. NH 847 237 4. NH 847 237 5. NH 848 237	The source and properties are 110m south-east and 30m downslope of the Proposed Scheme. As the depth of the borehole is unknown, it will abstract from either alluvium (clay, silt, sand and gravel), Glaciofluvial sheet deposits (gravel, sand and silt), or the underlying Slochd Psammite Formation (Psammite, Quartzose-Gneissose-Migmatitic). No water was found in any boreholes upstream of the supply's source. It is considered that the supply may be impacted by the Proposed Scheme due to being downslope and in close proximity.	Screened in	High
PWS Slochd 3 (known locally as PWS Slochd) NH 847 245	Spring	Supplies two properties: 1. Slochd 2. Doneen	1. NH 848 242 2. NH 848 242	The source is located 310m north and 60m upslope of the properties, and 130m north-east and 50m upslope of the Proposed Scheme. Pipework for these supplies are known to pass under the existing A9 route. The source of the supply emanates from Devensian Till (Diamicton), underlain by Slochd Psammite Formation (Psammite, Quartzose-Gneissose-Migmatitic), 60m upslope of cuttings for the Proposed Scheme on the southern mid-slope of Carn nam Bain-tighearna, at approximately 440m AOD. The nearest boreholes with water levels recorded within the borehole logs (installed in Stage 2 GI) show variable water depths. Groundwater was recorded close to the surface in borehole reference BHDS2084, 190m south-west of the source, groundwater was encountered at a depth of 3.5 m bgl and rose to 3.4 m bgl after 20 minutes, at borehole reference BHDS2083, 230m south-west of the source, groundwater seepage was recorded at 0.7 m bgl. However, 215m west of the source, at borehole reference BHDS2085 groundwater was encountered at a depth of 21 m bgl and rose to 18.4 m bgl after 20 minutes. It is considered that the supply may be impacted by the Proposed Scheme due to its close proximity.	Screened in	High

Table Source: The Highland Council (2015), SEPA (2016), OS Mapping.

Groundwater Dependent Terrestrial Ecosystems (GWDTEs)

10.3.84. GWDTEs are types of wetland which are specifically protected under the WFD and can include fens, springs, flushes, seepages, quaking bog, wet woodland, marshy grassland and some types of wet heath, reedbed and swamp.

10.3.85. NVC surveys were carried out in April 2017, May 2017 and July 2017. Further information on the survey method, baseline information and results are presented in Chapter 12: Ecology and Nature Conservation and Appendix 12.2 Designated Ancient Woodland and Habitats.

10.3.86. The NVC map was reviewed for GWDTEs using SEPA guidance which indicates NVC habitats that are potentially groundwater dependent. Areas which were not likely to be groundwater-fed, or were not hydrogeologically linked to the Proposed Scheme based on the methodology described in Section 10.2 were screened out from the assessment. The groundwater dependency of the remaining NVC habitats has been reviewed and revised as described in Section 10.2. Full descriptions of each habitat and their resulting groundwater dependencies are provided in Appendix 10.4. The resulting GWDTE map is presented in Figure 10.7a-j and summarised in Table 10.23 below.

Table 10.23: Summary of Potential GWDTEs within the Study Area

Groundwater Dependency	Sensitivity	Area (ha)	Number of Polygons
High	Very High	20.74	40
Moderate	High	243.37	312
Low	Medium	19.65	116
Not Groundwater Dependent	Low	18.23	39
Total		302.35	507

Table Source: NVC February 2018 data.

10.3.87. From an original list of 507 potential GWDTE areas, 7.7% of the NVC habitats initially identified using the SEPA criteria are not considered as GWDTEs following review of local characteristics, with the remaining 486 locations considered of potential High, Moderate or Low groundwater dependence, representing 15% of the total study area (based on a 250m buffer zone).

10.3.88. For the purpose of this assessment, NVC communities which are defined as highly dependent are considered to be genuinely groundwater dependent and are considered to be of Very High sensitivity. Areas with potential Moderate groundwater dependency are likely to feature a combination of surface and groundwater dependency. Low groundwater dependency areas are likely to be predominantly fed by surface runoff and direct rainfall, with minimal groundwater contribution.

10.3.89. Areas assessed as having no groundwater dependency, while assessed as having a Low sensitivity, have not been progressed to the impact assessment.

Surface Water Receptors

10.3.90. The study area features a number of watercourses including the River Spey, all of which are expected to be in continuity with groundwater to a greater or lesser extent. The sensitivity of these watercourses ranges from Very High to Low. Further information on surface water receptors is provided in Chapter 11: Road Drainage and the Water Environment.

10.3.91. There are a number of standing waters within the study area, including seven named lochs and a number of unnamed ponds. This includes Loch Beag, Loch Alvie (identified as a SSSI), Brogach, Loch Vaa (identified as an SPA and SSSI) and Loch Roid. These are described further in Table 2.4 within Appendix 11.1. The nature conservation value of the unnamed ponds is judged to be of local importance in Chapter 12 Ecology and Nature Conservation. It is not known whether these waterbodies are fed by surface or groundwater, or a combination of both.

Contaminated Land

Sites of Potential Contamination

10.3.92. The contaminated land assessment should be read in conjunction with Appendix 10.6 which provides further details of the undertaken assessment.

10.3.93. Potentially significant sources of contamination within the study area have been identified using the information sources detailed earlier. These sites of potential contamination are discussed in further detail within the Geotechnical PSSR, and are summarised in Figures 10.10 and Table 10.24 below. Note that the list of relevant contamination sources has been reviewed since DMRB Stage 2 and as a result the source numbering provided in Table 10.24 and Figure 10.10 do not reflect the numbering used within the Stage 2 Scheme Assessment Report and PSSR.

Table 10.24: Contaminated Land Sites Located within the Study Area

Potential Sources	Number on Figure 10.10	Distance to Carriageway (m)	Chainage Link to Carriageway	National Grid Reference
Perth to Inverness Railway Line	1	Adjacent - 250	Throughout Proposed Scheme	Various
Disused pit	2	225	1700	NGR NH 2866 8104
Disused gravel pit. Stockpiled materials observed during the PSSR walkover.	3	~25	2250	NGR NH 2872, 8104
Disused sand pit	4	Adjacent	2400	NGR NH 2873 8098
Disused pit	5	25	3820	NGR NH 2886, 8108
Disused sand pit	6	75	4850	NGR NH 2892, 8116
Unidentified potentially contaminated land (The Highland Council information)	7	225	5100	NGR NH 2895, 8122
Garage	8	250	5200	NGR NH 2895, 8120
Infilled land	9	On site	5400	NGR NH 2891, 8121
Infilled land	10	On site	7150	NGR NH 2893, 8138
Corn and Barley Mill	11	770	7200	NGR NH 2894, 8139
Unidentified potentially contaminated land	12	110	7250	NGRNH 2895, 8139

Potential Sources	Number on Figure 10.10	Distance to Carriageway (m)	Chainage Link to Carriageway	National Grid Reference
(The Highland Council information)				
Historical tank. (contents unknown)	13	70	7260	NGR NH 2893, 8139
Quarry. Currently used as an industrial yard.	14	Adjacent (potentially encroaching on-site)	7800 - 8100	NGR 289675, 814593
Former gravel pit and recycling centre	15	220	Granish Junction (closest chainage 8400)	NGR NH 2904, 8150
Quarry	16	Adjacent	Granish Junction (closest chainage 8700)	NGR NH 2901, 8151
Granish Quarry	17	170	Granish Junction (closest chainage 8800)	NGR NH 2904, 8158
Dairy	18	80	10200	NGR NH 2904, 8167
Former Quarry	19	30	10750	NGR NH 2906, 8172
Infilled water feature	20	Adjacent	10950	NGR NH 2908, 8174
Sawmill	21	200	12100	NGR NH 2913, 8184
Infilled water feature	22	Adjacent	12150	NGR NH 2910, 8184
Disused pit	23	Within alignment	13250	NGR NH 2910, 8196
Disused pit	24	75	13500	NGR NH 2911, 8198
Unidentified potentially contaminated land	25	Within alignment	14650	NGR NH 2908, 8206
Coal yard. Walkover indicated that this now comprises a storage area with stored vehicles, static caravans and metal drums noted	26	~100	16300	NGR NH 2899, 8224
Sawmill/derelict land	27	20	16450	NGR NH 2897, 8224
Depot	28	100	16500	NGR NH 2896, 8225
Printing Works	29	100	16600	NGR NH 2895, 8224

Potential Sources	Number on Figure 10.10	Distance to Carriageway (m)	Chainage Link to Carriageway	National Grid Reference
Unidentified potentially contaminated land	30	50	16750	NGR NH 2896, 8227
Sheep Wash	31	75	17000	NGR NH 2891, 8226
Former quarry	32	Adjacent	21800-22120	NGR NH 2849, 8239
Disused quarry	33	Adjacent	21900	NGR NH 2848, 8239
Former Quarry	34	On site	22900-22970	NGR NH 2843, 8246
Disused pits	35	250	25300	NGR, NH 2825, 8261

10.3.94. The Stage 2 GI investigated the presence of contamination at the location of selected former land uses and also provided an understanding of soil and groundwater contaminant concentrations across the wider study area.

10.3.95. Details of locations where the Stage 2 GI was targeted at former land uses is provided in Appendix 10.6 alongside further information on made ground and visual / olfactory evidence of contamination identified during the Stage 2 GI. The Appendix 10.6 should be read in conjunction with this chapter. Further targeted ground investigation is proposed as part of the Stage 3 GI but the results from this are not available for inclusion in the contaminated land assessment and have not been considered within the Environmental Statement.

10.3.96. Chemical testing suites were specified to take account of likely sources of contamination within the study area and to quantify the concentrations of related contamination within the recovered environmental samples. Further information on the determinands that were included within these suites is also specified in Appendix 10.6.

10.3.97. The available chemical test results were assessed using the methodologies described in Appendix 10.6. The assessment process allowed the level of risk to sensitive receptors identified within the Preliminary Risk Assessment (PRA) to be quantified and the following provides an overview of the assessment results with further details provided in Appendix 10.6.

Human Health Risk Assessment

10.3.98. 111 soil samples taken during the Stage 2 GI underwent chemical testing to provide data for the human health assessment. These were taken at depths of between 0.2 m bgl and 9.5 m bgl and comprised 36 samples of Made Ground, including possible Made Ground, and 75 samples of natural soils although two samples of natural soil exhibited evidence visual or olfactory evidence of hydrocarbon contamination. The human health risk assessment based on the available soils data identified the following exceedances of the selected Generic Assessment Criteria (GAC) which were selected to be protective of human receptors in a commercial end use. These GAC are considered to be the most appropriate for a road development.

Table 10.25: Summary of Human Health Exceedances

Location (Chainage)	Chainage	Exceedance (concentration)	Material Description	Comments
TPDS2065 at 1.0m	3900	Benzo(a)pyrene (24380 µg/kg), Total	Brown/black sandy slightly silty gravel	Location not targeted at former

Location (Chainage)	Chainage	Exceedance (concentration)	Material Description	Comments
		Petroleum Hydrocarbons (TPH) Aliphatic C12-C16 (45 mg/kg), TPH Aromatic TPH C12-C16 (179 mg/kg)	with asphalt and ash material and a strong hydrocarbon odour (MADE GROUND)	land use. Situated approximately 75 m east of a former quarry.
BHDS2070A at 1.0m	4720	Benzo(a)pyrene (20195 µg/kg), TPH Aliphatic C12-C16 (129 mg/kg)	Dark brown sandy slightly silty gravel with fragments of tarmac and a slight hydrocarbon odour (MADE GROUND)	Location not targeted at former land use. Situated approximately 100 m east of a disused sand pit.
BHDS2075 at 1.0m	7260	TPH Aliphatic C12-C16 (150 mg/kg)	Brown very gravelly silty sand (possible MADE GROUND)	Location not targeted at former land use. Situated approximately 50 m east of a former tank of unknown contents.

10.3.99. Concentrations of other contaminants within the soil samples were recorded at concentrations less than the commercial GAC where a GAC was available.

10.3.100. No asbestos fibres were detected in the analysed soil samples. Possible asbestos pipe was noted in the log for TPDS2065 at 1.1 to 1.2m, however the presence of asbestos was not confirmed as the suspected asbestos material was not tested.

Water Environment Risk Assessment – Soil Leachate Results

10.3.101. Soil-leachate analysis was undertaken on 27 soil samples and the exceedances of the relevant GAC are summarised below and in Appendix 10.6. All other results were either below the laboratory method detection limit (MDL) or the GAC. The methodology for the assessment is included in Appendix 10.6.

10.3.102. Assessment of the soil leachate results identified exceedances of groundwater GACs, comprising Resource Protection Values (RPVs) protective of a groundwater receptor, at several locations. Exceedances were identified for cyanide, benzo(a)pyrene, aliphatic TPH C16 – C35 and aromatic TPH C16 – C35 and were predominantly associated with natural materials or reworked natural materials.

10.3.103. Assessment of the soil leachate results identified exceedances of surface water GACs, comprising Environmental Quality Standards (EQS) protective of a surface water receptor, at several locations. Exceedances were identified for cyanide, benzo(a)pyrene, aliphatic TPH C16 – C35 and aromatic TPH C16 – C35. As for the groundwater receptor exceedances, these exceedances were predominantly associated with natural materials or reworked natural materials.

10.3.104. The only soil leachate exceedances associated with made ground showing a presence of anthropogenic materials were associated with materials encountered at BHDS2011, BHDS2070A, TPDS2014, TPDS2022, and TPDS2072. These anthropogenic materials included tarmacadam, wood, plastic, concrete, and brick. These four exploratory holes were located at chainages 4720, 7360, 9510 and 13,940 respectively with no potential contamination sources relating to former land uses noted within 50 m of any of these locations.

10.3.105. All other analysed determinands within the soil leachates were identified at concentrations lower than the appropriate EQS and DWS values.

Water Environment Risk Assessment – Groundwater Results

10.3.106. Analysis was carried out on eighteen groundwater samples collected from various locations throughout the proposed scheme and exceedances of GAC identified within these samples are summarised below and in Appendix 10.6. All other results were either below the MDL or the GAC (RPV and / or EQS).

10.3.107. The groundwater risk assessment indicated that metals and TPH within the assessed groundwater samples potentially posed a risk to both groundwater and surface water receptors. The materials encountered during the drilling of the monitoring wells generally comprised only natural materials or made ground comprising reworked natural material and so it is likely that the identified metals exceedances relate to background concentrations or off-site sources of these substances. Manmade components such as ash, clinker and slag are the common anthropogenic sources of elevated concentrations of metals, however such materials were only identified at one location (TPDS2065 at 0.8 m to 1.7 m) during the Stage 2 GI.

10.3.108. The only sampled monitoring well that exhibited anthropogenic constituents within its screened materials was BHDS2070A where the arisings during drilling were found to contain tarmacadam and a slight hydrocarbon odour. This was one of only two of the sampled monitoring wells where aliphatic TPH was not detected within the groundwater and the concentrations and range of aromatic TPH fractions at BHDS2070A were similar to those identified in groundwater in other boreholes. The highest concentrations of TPH were identified in BHDS2010 where no made ground was identified, and BHDS2043 where only reworked natural materials was identified.

10.3.109. Further discussion on the groundwater risk assessment is included in Appendix 10.6

Water Environment Risk Assessment – Surface Water Results

10.3.110. Assessment of twelve surface water samples collected from within the study area identified EQS exceedances for metals. None of the monitored watercourses were located within 400m of the identified soil leachate exceedances and given this distance there is unlikely to be a significant pathway relating to the migration of leachate to surface water.

Water Environment Risk Assessment – Summary

10.3.111. Only selected metals (cadmium, mercury and iron) and TPH were identified in exceedance of the GACs within both soil leachates and groundwater and / or surface water providing an indication of potential SPR linkage between contamination in the soils within the study area and the water environment.

10.3.112. With regards to the identified elevated concentrations of metals, no obvious visual or olfactory evidence of a source for these such as ash, clinker or slag was identified within any of the tested materials with these materials only identified at one location (TPDS2065 at 0.8 m to 1.7 m). Made Ground at the proposed scheme was generally limited in extent and present only at isolated locations. Where identified, this material was generally considered to be reworked natural, i.e. did not contain obvious anthropogenic constituents and so it is likely that the elevated concentrations of metals identified within groundwater and surface water were reflective of background concentrations, i.e. as a result of metals leaching from natural deposits and rock. The observed exceedances may also be indicative of an off-site source.

10.3.113. Elevated marginal concentrations of TPH within the groundwater were widespread whereas these exceedances were fairly isolated within the soil leachates (only 3 out of 27 samples showed detectable concentrations of TPH). Moreover, visual or olfactory evidence of hydrocarbons was only identified within one of the assessed soil samples (BHDS2070A at 1.0 m bgl) although greater concentrations of TPH were identified at other GI locations where no such similar evidence had been noted. Given the limited number of realistic possible sources for this TPH at the proposed scheme compared to the widespread nature of the TPH contamination identified within the groundwater it is considered likely that an off-site source has contributed to the groundwater quality or the observed testing results are related to natural materials.

Phytotoxicity Assessment

10.3.114. The soil results were also screened with regards to their associated phytotoxic risk.

10.3.115. No exceedances of the screening criteria were identified. The selected screening criteria were based on pH ranges of between pH 5.0 and pH 7 and pH readings of less than pH 5.0 were recorded at nine of the assessed locations at depths of between 0.3m bgl and 2.1 m bgl. As metals are more available in acidic soils it is considered that the screening criteria may not be sufficiently protective at these locations and a phytotoxic risk is possible.

Ground Gas Risk Assessment

10.3.116. The design for the Proposed Scheme does not include enclosed spaces and it is unlikely that the proposed scheme will create any pathways that will allow ground gas to migrate to the isolated residential properties located close to the A9. However, five rounds of gas monitoring were carried out from selected monitoring wells between 31st May 2017 and 3rd September 2017 to provide an understanding of the gassing regime at the proposed scheme.

10.3.117. A maximum carbon dioxide concentration of 17% vol. was recorded in BHDS2032. Methane was only recorded at one location (BHDS2054) with a concentration of 1% vol. being measured. Hydrogen sulphide and carbon monoxide were not recorded in any of the monitoring wells. A maximum flow rate of 26.21 l/hr was identified in BHDS2069.

10.3.118. The recorded concentrations of carbon dioxide were found to correlate with a CS2 low level of risk for carbon dioxide and a CS1 very low level of risk for methane.

Ground Model

10.3.119. Land use within the study area is largely agricultural / forestry land, with the exception of the settlements and commercial premises within Aviemore and Carrbridge and other isolated residential properties.

10.3.120. Several sites of potentially contaminated ground have been identified as detailed in in Table 10.24 and in Figure 10.10 and the GI carried out within the study area identified further made ground and the relevant locations are discussed in Appendix 10.6. The Made Ground has the potential to contain contaminants and to generate ground gas / vapours. In addition, spills and leaks may have occurred at several of the areas and these may have introduced contaminants to the ground. Representative samples of the made ground and natural materials underwent assessment and this process identified localised risks to sensitive receptors.

10.3.121. A large proportion of the superficial deposits within the study area have been classified as highly productive aquifers and are therefore considered to be a potential receptor.

From the southern extent of the proposed scheme to approximate chainage 14500 these highly productive superficial aquifers generally comprise a mixture of Alluvium, Glaciofluvial Deposits and River Terrace Deposits. Glaciofluvial deposits are considered to possess high productivity and the River Terrace Deposits and Alluvium are considered to possess a moderate to high productivity. From chainage 14500 northwards the natural superficial deposits predominantly comprise Devensian Till with localised peat, both of which are considered to be of low productivity. Further localised River Terrace Deposits are also indicated to be present associated with the River Dulnain between approximate chainages 16600 and 17400 and at 22600.

10.3.122. The bedrock across the proposed scheme is considered to be of low productivity and has therefore been ruled out of any further assessment as a realistic receptor is unlikely to be present.

10.3.123. There are several surface water bodies within the study area, with a number of watercourses crossing beneath the existing A9, or flowing in the general vicinity of the A9 and these are detailed in Table 10.26 below. Some of these watercourses have been classified by SEPA as part of the River Basin Management Plan requirements of the Water Framework Directive (WFD) and this classification information has also been provided below.

Table 10.26: Watercourses Located within the Study Area

Watercourse Name	Approximate Distance to Carriageway at Closest Point	Approximate Chainages	WFD Overall Classification (2016)
Allt an Fhearna	0 m	100	Good
Loch Alvie	100 m	800 to 2400	Good
Allt Chriochaidh	0 m	550	N/A
Caochan Ruadh	0 m	1700	N/A
Unnamed	0 m	1900	N/A
Allt na Criche	0 m	3500, 9100	N/A
River Spey (River Feshie to River Nethy)	200 m 0 m	3400 to 3900 16500 and 17400	Moderate
Loch Puladdern	Adjacent	5400	N/A
Aviemore Burn	0 m	7150	N/A
Unnamed	0 m	8400	N/A
Unnamed	0 m	9900	N/A
Allt Cnapach	0 m	12200	N/A
River Dulnain – Feith Mhor	0 m	14400	Good
River Dulnain – Lower Catchment	0 m	16600	Good
River Dulnain – Allt Ruighe Magaig / Allt nan Ceatharnach	0 m	17400	Good
Bogbain Burn	100m	19100 to 19400	N/A
River Dulnain – Allt an Aonaich	100 m	22600	Good

Watercourse Name	Approximate Distance to Carriageway at Closest Point	Approximate Chainages	WFD Overall Classification (2016)
Allt Cosach	0 m	25250	N/A

10.3.124. The following designated ecosystems detailed in Table 10.27 have been identified within the study area, both on and adjacent to the A9 carriageway:

Table 10.27: Designated Ecosystems within the Study Area

Ecosystem	Distance to Carriageway at Closest Point	Approximate Chainages	Associated Species
Cairngorms National Park	On-site	Throughout study area	None specified
Alvie Site of Special Scientific Interest (SSSI);	Adjacent to carriageway	0 to 2800	Goldeneye (Bucephala clangula), breeding, Hydromorphological mire range (wetlands), Invertebrate assemblage, Upland oak woodland
River Spey Special Area of Conservation (SAC) and SSSI;	200 m On-site	3400 to 3900 16500 and 17,400	Atlantic salmon (Salmo salar), Freshwater pearl mussel (Margaritifera margaritifera), Otter (Lutra lutra), Sea lamprey (Petromyzon marinus)
Craigellachie SSSI	Adjacent to carriageway	4500 to 6500	Moth assemblage, Upland birch woodland
Craigellachie National Nature Reserve	Adjacent to carriageway	3500 to 6500	None specified
Kinveachy Forest SPA, SAC, SSSI	50 m	11000 to 13500	Capercaillie (Tetrao urogallus), breeding, Scottish crossbill (Loxia scotica), breeding, Bog woodland, Caledonian forest, Breeding bird assemblage, Native pinewood
Loch Vaa SPA and SSSI	100 m	11000 to 11500	Slavonian grebe (Podiceps auritus), breeding, Beetles, Goldeneye (Bucephala clangula), breeding,
Slochd SAC.	50 m	25200 to 25700	Dry heaths

10.3.125. Residential properties are concentrated in the settlements of Aviemore (close to approximate chainages 4500 and 8000) and Carrbridge (close to approximate chainages 16500 and 17000) although there are also individual properties scattered throughout the study area. There are also several agricultural properties located within the study area. Farming within the study area is largely limited to livestock (sheep) farming, with very limited arable farming.

10.3.126. Table 10.28 details designated built environment receptors e.g. Scheduled Monuments, and Listed Buildings located within the study area.

Table 10.28: Designated Built Environment Receptors within the Study Area

Feature	Distance to Carriageway at Closest Point	Closest Approximate Chainage	Associated Information
Aviemore, Dalfaber Road, Pine Bank (Former Craigellachie House)	225 m	5000	Grade C Listed Building
Avielochan, Tor Beag, Fort	125 m	10750	Scheduled Monument - Prehistoric domestic and defensive: fort (includes hill fort and promontory fort)
Carrbridge Station including platform shelters and footbridge	75 m	16400	Category B Listed Building
Slochd Mhuic Railway Viaduct	240 m	22100	Category B Listed Building

10.3.127. Parts of the A9 alignment are within designated Radon Affected Areas. The presence of radon is noted as a diffuse source/regional constraint to the A9 dualling corridor. However, as there are no buildings as part of the Proposed Scheme, there is unlikely to be an impact from radon.

10.3.128. The Conceptual Site Model (CSM) has been developed for the baseline conditions and comprises a summary of the ground model, un-investigated and investigated potential contamination sources, pathways and receptors as well as an evaluation of the risk associated with plausible pollutant linkages. The CSM is based on the preliminary CSM presented in the Geotechnical PSSR at DMRB Stage 2 which has been updated using additional new GI and desk study information.

Potential and Identified Sources

10.3.129. Sites of potential contamination within the study area were identified in Table 10.24 above. Table 10.29 below provides details of the likely contaminants associated with these potential sources. S1 are on-site potential sources and S2 are off-site potential sources.

Table 10.29: Potential Sources of Contamination

Ref	Primary Source	Relevant Sources (see Figure 10.10 or Table 10.24)	Likely Contaminants
S1	Potentially Contaminated Ground / Waters located within or immediately adjacent to Proposed Scheme – Railway, infilled pits / quarries, agricultural use	1, 4, 9, 10, 14, 16, 20, 22, 23, 25, 32, 33, 34	Heavy metals, asbestos, organic contamination including polycyclic aromatic hydrocarbons (PAHs) and total petroleum hydrocarbons (TPH), inorganic contaminants.
	Contamination identified from ground investigation		organic contamination including polycyclic aromatic hydrocarbons (PAHs) and total petroleum hydrocarbons (TPH), inorganic contaminants.

Ref	Primary Source	Relevant Sources (see Figure 10.10 or Table 10.24)	Likely Contaminants
S2	Potentially Contaminated Ground / Waters located within 250m of Proposed Scheme.	1, 2, 3, 5, 6, 7, 8, 11, 12, 13, 15, 17, 18, 19, 21, 24, 26, 27, 28, 29, 30, 31, 35	As detailed above.

Potential Receptors

10.3.130. A summary of the identified potential receptors is provided in Table 10.30 below.

Table 10.30: Potential Receptors

Ref	Receptor	Description
R1	Aquifer – Superficial Deposits	The underlying superficial deposits are generally classified as highly productivity aquifers, although lower productivity aquifers are present in the northern part of the proposed scheme. Aquifers are likely to be in hydraulic continuity with the surrounding burns and rivers
R2	Surface Water	In general, the waterbodies located within the study area were not designated under WFD. Designated waterbodies included Loch Alvie (good) Allt an Fhearna (Poor), River Spey (Moderate) and River Dulnain (generally good).
R3	Drivers & Non-Motorised Users (NMUs)	Drivers of vehicles using the existing/proposed route, pedestrians and NMUs using the existing/proposed footpaths and cycle paths
R4	Local Residents	Residential properties are concentrated in the settlements of Aviemore and Carrbridge, although there are also individual properties scattered throughout the study area.
R5	Ecosystems	Designated ecosystems are located in, or immediately adjacent to the study area and so have been considered. These include Cairngorms National Park; Alvie Site of Special Scientific Interest (SSSI); River Spey Special Area of Conservation (SAC) and SSSI; Craigellachie National Nature Reserve and SSSI; Kinveachy Forest SAC, SPA, SSSI, Loch Vaa SPA and SSSI and Slochd SAC
R6	Property (buildings and crops)	There are several residential properties and agricultural buildings and limited agricultural fields for arable farming present at various locations within the study area
R7	Property (livestock, Pets, wildlife)	Sheep farming is prevalent throughout the study area. There are likely to be pets associated within various residential properties and game subject to shooting and fishing rights in the study area.
R8	Site Infrastructure	There will be buried services, culverts and structure foundations associated with the Proposed Scheme

10.3.131. Construction and maintenance workers are potential receptors to contamination but are not considered in the CSM. The UK framework for contaminated land assessment is based on potential adverse health effects resulting from long-term chronic exposure to soil contamination. This is because, in the majority of cases, chronic exposure to contamination is more significant than acute exposure, and because the occupational risks are already required to be addressed by the Health and Safety at Work Act 1974 and related legislation.

Potential Pathways

10.3.132. The potential pathways which could expose the potential receptors to the potential sources of contamination are summarised in Table 10.31 below.

Table 10.31: Potential Pathways

Reference	Pathway	Description
P1	Direct contact with soil / soil derived dust and groundwater	Soil and groundwater contaminants could come into direct contact with the skin of site users, buried services, culverts or structure foundations, ecosystems, crops (via plant uptake), pets, livestock.
P2	Ingestion of soil / soil derived dust and groundwater	Soil derived and groundwater contaminants could be ingested by site users and property receptors (livestock / pets / wildlife).
P3	Inhalation of fugitive soil derived dust / fibres	During dry, dusty conditions, contaminated soil dust and asbestos fibres could be inhaled by site users and property receptors (livestock / pets / wildlife).
P4	Inhalation of vapour / soil gas	Site users and property receptors (livestock / pets / wildlife) may inhale vapours and / or soil gas that may be present.
P5	Vertical / lateral migration of contaminants by leaching through superficial deposits, via preferential pathways, via surface water runoff and via baseflow of contaminated groundwater	Contaminants could migrate into the underlying superficial aquifer and adjacent watercourses / bodies potentially subsequently affecting dependant water supplies and ecosystems. Contaminated surface and groundwater could come into contact with property foundations and site infrastructure. Contaminants present in offsite sources could migrate onto the proposed scheme footprint. Contaminated surface water could run off into adjacent watercourses. There could also be migration via preferential pathways such as soakaways and underground services.
P6	Vertical and lateral migration of soil gas	There is the potential that made ground present in the study area could generate soil gas. This gas could potentially migrate into adjacent buildings via preferential pathways and permeable deposits located on-site.

Risk Evaluation – Baseline Conditions

10.3.133. Each plausible pollutant linkage at baseline is identified in the table below. An evaluation of the risk that each pollutant linkage poses, based on the current desk based and ground investigation data, has been undertaken in general accordance with CIRIA guidance document C552, 2001. Risk classification matrices are presented in the methodology for the assessment detailed section 10.2.

Table 10.32: Risk Evaluation of Plausible Pollutant Linkages - Baseline

Hazard Identification	Hazard Assessment		Risk Estimation		Risk Evaluation	Comments
Contaminant Source	Pathway	Receptor	Consequence of Risk being realised	Probability of Risk being realised	Classification	
S1 Potentially on-site contaminated ground / waters located within Proposed Scheme Footprint – Railway, infilled pits / quarries, agricultural use Contamination identified from ground investigation.	P1 – Direct Contact with soil / soil derived dust and groundwater	R3 - Drivers & NMUs	Medium	Unlikely	Low	It is unlikely that these receptors would come into direct contact with soil / soil dust during baseline conditions due to the lack of exposed soil as part of the proposed scheme.
		R4 – Local Residents	Medium	Unlikely	Low	
		R5 – Ecosystems	Medium	Unlikely	Low	
		R6 – Buildings & Crops	Mild	Unlikely	Very Low	
		R7 – Livestock, Pets & Wildlife	Mild	Unlikely	Very Low	
		R8 – Site Infrastructure	Mild	Likely	Moderate / Low	It is possible that retained and proposed site infrastructure could come into direct contact with contaminated soil during baseline conditions.
	P2 – Ingestion of soil / soil derived dust and groundwater	R3 – Drivers & NMUs	Medium	Unlikely	Low	It is unlikely that these receptors would ingest soil / soil dust, inhale fugitive soil dust or inhale vapours / soil gas during baseline conditions due to the lack of exposed soil and the lack of enclosed spaces in the immediate vicinity of the proposed scheme.
		R4 – Local Residents	Medium	Unlikely	Low	
		R5 – Ecosystems	Medium	Unlikely	Low	
		R7 – Livestock, Pets & Wildlife	Mild	Unlikely	Very Low	
	P3 – Inhalation of fugitive soil dust and fibres	R3 – Drivers & NMUs	Medium	Unlikely	Low	
		R4 – Local Residents	Medium	Unlikely	Low	
		R5 – Ecosystems	Medium	Unlikely	Low	
		R7 – Livestock, Pets & Wildlife	Mild	Unlikely	Very Low	
	P4 – Inhalation of vapours / soil gas	R3 – Drivers & NMUs	Medium	Unlikely	Low	
		R4 – Local Residents	Medium	Unlikely	Low	

Hazard Identification	Hazard Assessment		Risk Estimation		Risk Evaluation	Comments
Contaminant Source	Pathway	Receptor	Consequence of Risk being realised	Probability of Risk being realised	Classification	
		R5 - Ecosystems	Mild	Unlikely	Very Low	
		R7 – Livestock, Pets & Wildlife	Mild	Unlikely	Very Low	
	P5 – Leaching and vertical / lateral migration of contaminants	R1 – Superficial Aquifer	Medium	Low	Moderate / Low	It is possible that contaminants present in sources within the proposed scheme footprint could leach and migrate into the underlying superficial aquifer and into adjacent surface waters, subsequently affecting other receptors
		R2 – Surface Water	Medium	Low	Moderate / Low	
		R5 - Ecosystems	Mild	Low	Low	
		R6 – Buildings and Crops	Mild	Low	Low	
		R8 – Site Infrastructure	Mild	Low	Low	
	P6 – Vertical and lateral migration of soil gas	R3 – Drivers & NMUs	Severe	Unlikely	Moderate / Low	It is unlikely that soil gas from sources present within the proposed scheme footprint would migrate the distance required to affect these receptors and as no enclosed spaces are proposed on site it is considered that gas build up and effects on site users are unlikely.
		R4 – Local Residents	Severe	Unlikely	Moderate / Low	
		R6 – Buildings (crops unaffected)	Severe	Unlikely	Moderate / Low	
		R8 – Site Infrastructure	Severe	Unlikely	Moderate / Low	
	P1 – Direct Contact with soil / soil derived dust	R3 - Drivers & NMUs	Medium	Unlikely	Low	Limited potential contamination sources were identified in the surrounding area and it is considered unlikely that dust associated with these will migrate into the proposed scheme.

Hazard Identification	Hazard Assessment		Risk Estimation		Risk Evaluation	Comments
Contaminant Source	Pathway	Receptor	Consequence of Risk being realised	Probability of Risk being realised	Classification	
S2 Potentially Contaminated Ground / Waters located outwith proposed footprint but within 250m of Proposed Footprint	P5 – Leaching and vertical / lateral migration of contaminants	R1 – Superficial Aquifer	Medium	Low	Moderate / Low	Contaminant sources outside the proposed scheme footprint could migrate into the aquifer and surface waters located within the footprint of the proposed scheme.
		R2 – Surface Water	Medium	Low	Moderate / Low	
	P6 – Vertical and lateral migration of soil gas	R3 – Drivers & NMUs	Severe	Unlikely	Moderate / Low	As no enclosed spaces are proposed on site it is considered that gas / vapour build up and effects on site users are unlikely.
		R8 – Site Infrastructure	Severe	Unlikely	Moderate / Low	

Summary of Baseline Receptor Sensitivity

10.3.134. A summary of the sensitivity of each baseline receptor is listed in the table below.

Table 10.33: Sensitivity of Receptors

Sub-topic	Receptor	Attribute	Sensitivity
Bedrock Geology	Igneous bedrock Metasedimentary bedrock	Mineral value	Negligible
Superficial Geology	Devensian Till Alluvial Fan Deposits Alluvium Undifferentiated River Terrace Deposits	Geodiversity Mineral value	Negligible
	Glaciofluvial Sheet Deposits Glaciofluvial Ice Contact Deposits		Low
	Granish Quarry	Mineral Value	Low
Geodiversity	Slochd GCR	Geodiversity	High
	Gneissose Metamorphic Formations (Dava Subgroup, Creag Buidhe and Beinn Bhreac)		High
	Boat of Garten / Tore Hill Slochd Mor		Low
	'Soldier's Head'		Negligible
Soils	LCA Class 3 & 4	Soil Value	Medium
	LCA Class 5 & 6		Low
	SNH Peat Class 1	Biodiversity	High
	SNH Peat Class 3		Medium
	SNH Peat Class 5		Low
Groundwater	Alluvial Fan Deposits Alluvium Glaciofluvial Sheet Deposits Glaciofluvial Ice Contact Deposits Undifferentiated River Terrace Deposits	Water Quality	High
		Water Supply, Groundwater Flow	High
	Devensian Till Hummocky Glacial Peat	Water Quality	Low
		Water Supply, Groundwater Flow	Low
	Moine Supergroup Bedrock – Psammites & Semipelites	Water Quality	High
		Water Supply, Groundwater Flow	Low
	Dalradian Supergroup Bedrock – Psammites & Semipelites	Water Quality	High
		Water Supply, Groundwater Flow	Low
	Intrusive Igneous Bedrock –	Water Quality	High

Sub-topic	Receptor	Attribute	Sensitivity
	Monadhliath Pluton Boat of Garten Pluton	Water Supply, Groundwater Flow	Low
Public Water Supplies	Scottish Water Aviemore Groundwater Public Supply Boreholes	Water Quality & Groundwater Flow	Very High
Private Water Supplies	PWS Baddengorm	Water Supply, Groundwater Flow, Water Quality	High
	PWS Slochd 1		High
	PWS Slochd 2		High
	PWS Slochd 3		High
GWDTEs	GWDTEs with High Groundwater Dependency (dominant and sub-dominant)	Biodiversity	Very High
	GWDTEs with Moderate Groundwater Dependency (dominant and sub-dominant)		High
	GWDTEs with Low Groundwater Dependency (dominant and sub-dominant)		Medium
	Surface Water Receptors	Surface Water Flow	High
Contaminated Land	n/a	n/a	n/a

10.4. Potential Impacts

10.4.1. The potential impacts of the Proposed Scheme discussed in this section are subdivided into construction and operational impacts. For the purposes of this assessment construction impacts are generally considered to be short-term impacts which occur during the construction phase only. Operational impacts are considered to be long-term or permanent impacts affecting receptors after the construction phase is complete. It is recognised that many operational impacts are initiated by construction activities e.g. excavation of cuttings, however, the full effect of the impact may only manifest itself in the long-term.

10.4.2. The potential significant impacts from the Proposed Scheme which are considered within this section are:

- pollution of groundwater aquifers, private and public water supplies during construction due to increased generation and release of sediments and suspended solids, and increased risk of accidental spillage of pollutants such as oil, fuel and concrete associated with construction activities and site storage requirements;
- disturbance of existing contaminated land during construction, resulting in the establishment of potential pollutant linkages, or an increase in the risk associated with existing pollutant linkages with consequential impacts on local receptors;
- loss of geodiversity, particularly within sites of conservation importance, where existing road cuttings are widened/deepened, or new cuttings created;
- loss or sterilisation of economic mineral deposits, soils and peat, beneath the footprint of the Proposed Scheme;
- pollution of groundwater aquifers, private and public water supplies during road operation due to contaminants within routine road runoff. A broad range of potential

pollutants, such as hydrocarbons i.e. fuel and lubricants, fuel additives, metal from corrosion of vehicles, de-icer and gritting material, can accumulate on road surfaces. These can subsequently be washed off the road surface during rainfall events, polluting the receiving groundwater bodies;

- direct loss or changes to groundwater aquifers and groundwater supported public and private water supplies, either below the footprint of the Proposed Scheme, or as a result of changes to groundwater flows and levels associated with the dewatering of deep cuttings and foundation excavations;
- indirect loss of surface water as a result of changes to groundwater aquifers, due to dewatering activities where surface waterbodies are connected to groundwater aquifers;
- loss or changes to Groundwater Dependent Terrestrial Ecosystems (GWDTEs), including peatland habitats, either below the footprint of the Proposed Scheme, as a result of severance of habitat or as a result of changes to groundwater flows and levels associated with dewatering activities;

10.4.3. Each impact is assessed using the methods outlined in Section 10.2. All impact magnitude and significance ratings are adverse unless otherwise stated.

10.4.4. Much of the potential 'mitigation' of geology, soils and groundwater impacts has been realised through the iterative design of the scheme and as such is embedded within the design. The potential impacts have been assessed with the embedded mitigation listed below, but without additional standard or project-specific environmental mitigation and therefore considered a worst-case scenario.

10.4.5. Embedded mitigation included in the design of the Proposed Scheme comprises:

- The avoidance of Class 1 Priority peatland and areas of deep peat under the Proposed Scheme footprint;
- The avoidance of routine runoff discharge to areas with deep peat at Black Mount, by combining networks and discharging further east to the Bogbain Burn;
- All proposed SuDS ponds will be lined to prevent groundwater infiltration and pollution, other than those specifically designed for infiltration discharge. Note filter drains within the proposed mainline networks may be unlined, dependant on ground conditions and specific risks such as drinking water abstraction points;
- Sections of non-mainline road will be constructed as 'floating' track where peat greater than 1m is encountered and engineering conditions permit, thereby reducing the volume of peat to be excavated;
- Minimisation of peat excavation in the construction of the mainline road embankments across the Feith Mhor floodplain and the Black Mount areas, through the use of non-excavation construction techniques (e.g. piling);
- The inclusion of Compact Grade Separated Junctions (CGSJ) to reduce the land-take required, therefore reducing direct loss of soils and peat, also reducing direct loss to GWDTEs; and
- Horizontal and vertical alignments designed to be as close to the existing A9 as possible to minimise resultant earthwork embankments/cuttings and land take.

10.4.6. Standard good practice and specific mitigation measures are detailed in Section 10.5. Residual impacts, post mitigation, are summarised in Section 10.6.

Construction Impacts

Construction Pollution

10.4.7. Accidental spillage during construction has the potential to allow pollutants to migrate through the unsaturated zone to shallow aquifers. Excavation of the overlying material, particularly where cuttings are proposed in areas of permeable drift deposits with shallow groundwater, could increase the vulnerability of localised aquifers to contaminants.

10.4.8. Potential impacts on groundwater quality during construction relate to the removal of surface cover, including soils and superficial deposits, during the creation of cuttings and potential excavation close to or below the groundwater table. Spillages in these areas could introduce pollutants directly into the groundwater aquifers resulting in changes to water quality. These impacts are temporary in nature but may result in long-term changes to water quality.

Loss of Soils

10.4.9. This issue is considered as primarily a longer-term impact, with this assessed in the Operational Impact section.

Loss of Peat

10.4.10. This issue is considered as primarily a longer-term impact, with this assessed in the Operational Impact section.

Groundwater Aquifers

10.4.11. Dewatering activities for road cuttings are regulated as a construction activity under the Controlled Activities Regulations[lx]. The Proposed Scheme includes 369 proposed cuttings (areas of material excavation), of which 183 are likely to intercept groundwater, thereby potentially creating new pathways for the direct introduction of pollutants. The majority of the proposed cuttings which intercept groundwater will have very little impact on the surrounding groundwater levels or flows, due to relatively small radii of influence.

10.4.12. During construction there may also be groundwater impacts as a result of the temporary dewatering of deep foundation excavations related to the larger bridge structures. The effect on groundwater levels at these locations is likely to be temporary and the long-term effects on groundwater flowpaths highly localised.

10.4.13. A groundwater assessment was carried out to assess the potential impact of each cutting on groundwater aquifers. This has been provided in full in Appendix 10.4. Locations of cuttings can be seen on figure A10.4.1. The conclusions of this assessment have been summarised in table 10.34 below.

Table 10.34: Cuttings Assessment Summary

Cutting No.	NGR	Sensitivity	Magnitude		Significance	Comments
1	NH8658810104	H	Major		Large	Large significance Impacts due to the high productivity aquifer beneath the cuttings and >100m large radii of influence calculated. Due to ground conditions during the stage 2 ground investigation limited groundwater monitoring data is available for the southern section of the site. The lack of available data is likely to have led to an over conservative estimate of groundwater levels. Stage 3 GI data should help to reduce the significance of these impacts
2	NH8658810104	H	Major		Large	
3	NH8658810104	H	Major		Large	
5	NH8658810104	H	Major		Large	
6	NH8658810104	H	Major		Large	
10	NH8658810104	H	Major		Large	
11	NH8658810104	M	Major		Large	
12	NH8658810104	M	Major		Large	
15	NH8658810104	M	Major		Large	
18	NH8658810104	M	Major		Large	
19	NH8658810104	M	Major		Large	
27	NH8658810104	M	Major		Large	
93	NH8915911673	H	Major		Large	The cuttings are both small, however there is a borehole located 150m to the south the groundwater level which has been used to inform the assessment suggesting that the groundwater data is more representative. Further investigation is recommended in this area.
95	NH8915911673	H	Major		Large	
100	NH8915911673	H	Major		Large	There is no groundwater data available for these cuttings. A water level of 0.5m bgl has been assumed for the purpose of this assessment. BH2012 is located 0 to 50m from these cuttings and was recorded as dry during all rounds of monitoring. The base of this borehole is
101	NH8915911673	H	Major		Large	
102	NH8915911673	H	Major		Large	
104	NH8915911673	H	Major		Large	

Cutting No.	NGR	Sensitivity	Magnitude		Significance	Comments
105	NH8915911673	H	Major		Large	below the proposed depth of the cuttings and therefore we can assume that these cuttings are unlikely to intercept the groundwater table however further monitoring is recommended.
154	NH8934513957	H	Major		Large	This is a very small cutting associated with a side road where there is little available groundwater data. The size of the cutting suggests that it is unlikely to intercept the groundwater table, however further ground investigation is recommended to gather more groundwater information in this area.
167	NH8934513957	H	Major		Large	The cuttings impact significance is Large due to an underlying high productivity aquifer and the calculated size of the radius of influence. Further groundwater monitoring data is likely to reduce the significance of the impact.
183	NH8934513957	H	Major		Large	Although there are boreholes within close proximity to this cutting, they are not deep enough to provide groundwater level data. This suggests that further GI is needed to gather groundwater level data is requited at this location.
184	NH8934513957	H	Major		Large	The cuttings are located on the B1952 in close proximity to Granish Junction. Boreholes (BHDS2049 and BHDS2016) did not encounter groundwater as they were not drilled to a sufficient depth due to difficult ground conditions. This suggests that further groundwater monitoring data is needed in this area.
186	NH8934513957	H	Major		Large	
332	NH8965322619	M	Major		Large	Large significance due to the size of the estimated drawdown and the radius of influence. This cutting is relatively small and is in an area with very little groundwater data. The size of this cutting suggests it is extremely unlikely that the drawdown will be as large as estimated. Therefore, it is likely that the availability of more groundwater data will reduce the significance of the risk.
373	NH8440824526	H	Major		Large	The cutting is located on the northbound side of the alignment. BHDS2029 lies to the north of cutting, the data from which was

Cutting No.	NGR	Sensitivity	Magnitude		Significance	Comments
						used in the assessment of this cutting. Further groundwater monitoring is recommended in this area.
8	NH8658810104	H	Moderate		Moderate	Cuttings are underlain by a high productivity aquifer and have calculated radii of influence over 50m. Both cuttings are located at the southern extent of the scheme where there is little groundwater level data. Further groundwater data in this area is likely to reduce the significance of the impact.
9	NH8658810104	H	Moderate		Moderate	
17	NH8658810104	H	Moderate		Moderate	Moderate significance due to the calculated size of radius of influence of >50m and underlying Moderate/ high productivity aquifer. The closest borehole (BHDS2004) was not drilled to a sufficient depth to encounter groundwater. Further groundwater monitoring data from the stage three ground investigation is required to refine the assessment of the significance of the impact on groundwater from these cuttings.
20	NH8658810104	M	Moderate		Moderate	
21	NH8658810104	M	Moderate		Moderate	
22	NH8658810104	M	Moderate		Moderate	
23	NH8658810104	M	Moderate		Moderate	
28	NH8658810104	M	Moderate		Moderate	
29	NH8658810104	M	Moderate		Moderate	
30	NH8658810104	M	Moderate		Moderate	
38	NH8658810104	M	Moderate		Moderate	The cuttings are located on a side road where there is limited groundwater data available. Moderate significance of impact given due to the calculated size of radius of influence and moderate productivity aquifer underlying the cuttings. The cuttings are relatively small and therefore it is likely that the size of the drawdown for these cuttings has been overestimated. Availability of the stage 3 GI data is likely to reduce the significance of the impact.
39	NH8719310287	M	Moderate		Moderate	
82	NH8719310287	M	Moderate		Moderate	Moderate significance given due to the calculated size of the radius of influence and moderate productivity aquifer underlying the cutting. The small size of the cutting suggests that the lack of groundwater data has led to an overestimation of the drawdown.

Cutting No.	NGR	Sensitivity	Magnitude		Significance	Comments
						Groundwater data from the stage 3 GI should help to reduce the significance of the impact.
113	NH8837010632	H	Moderate		Moderate	Cuttings are underlain by a high productivity aquifer and the calculated radius of influence is >100m. BHDS2012 is located <50m from the cuttings, this borehole was not dug to a sufficient depth to encounter groundwater however the base of this borehole is below the base of these two cuttings and has been recorded as dry throughout the monitoring rounds. This suggests that the significance of the impact at these cuttings is likely to be reduced once further groundwater data is available.
114	NH8915911673	H	Moderate		Moderate	
136	NH8915911673	H	Moderate		Moderate	Significance of impact of moderate due to high productivity underlying aquifer and the calculated radius of influence >50m. There is limited groundwater data available in the area, therefore it is recommended that more groundwater data is collected.
175	NH8923513736	L	Major		Moderate	Moderate significance due to the calculated radius of influence >50m (175) and >100m (178 and 181). The cuttings are located on a side road near Granish junction. There is little groundwater data available for side roads at present. It is recommended that further groundwater data is collected in this area.
178	NH8934513957	H	Moderate		Moderate	
181	NH8934513957	H	Moderate		Moderate	
185	NH8934513957	H	Minor		Moderate	The cutting is located on the B1952 in close proximity to Granish Junction. Boreholes (BHDS2049 and BHDS2016) did not encounter groundwater as they were not drilled to a sufficient depth due to difficult ground conditions and therefore do not provide groundwater data. This suggests that further groundwater monitoring data is needed in this area.
269	NH8934513957	H	Moderate		Moderate	Moderate significance due to the underlying high productivity aquifer and calculated radius of influence >100m. Groundwater data is not available from boreholes within the same geological unit. Based on groundwater levels in nearby (70m west) alluvial fan deposits groundwater levels are likely to be lower than

Cutting No.	NGR	Sensitivity	Magnitude		Significance	Comments
						estimated. However, it is recommended that more groundwater monitoring data is collected in this area.
321	NH9107918525	H	Moderate		Moderate	Moderate significance due to the calculated radius of influence >100m. There is limited groundwater data available for this groundwater body. Further monitoring is recommended for this location.
322	NH9075220888	L	Major		Moderate	
323	NH9075220888	L	Major		Moderate	
364	NH9075220888	L	Major		Moderate	Moderate significance due to the size of the radius of influence and drawdown. Both large cuttings are on the southbound side of the alignment at Slochd.
365	NH8440824526	L	Major		Moderate	
369	NH8440824526	L	Major		Moderate	There is a pond on the northbound side of alignment. There is limited data available for the southbound side of the alignment at Slochd. Further data collection is recommended in this area.
372	NH8440824526	M	Moderate		Moderate	Cuttings are located on the northbound side of the alignment. BHDS2029 lies to the north of these cuttings, however the size of the drawdown suggests that the groundwater level has been overestimated. Further groundwater monitoring should help to reduce the significance of the impact.
374	NH8440824526	H	Moderate		Moderate	
376	NH8452124313	H	Moderate		Moderate	This is a very small cutting on a side road. Moderate significance due to the size of the radius of influence and high productivity aquifer underlying site. Due to small size of cutting it is likely that the drawdown has been overestimated. Further groundwater data collection should help to reduce the significance of the impact.
380	NH8381625506	L	Major		Moderate	This is a very large cutting with groundwater data available. Moderate significance due to the size of drawdown and the radius of influence.
383	NH8381625506	L	Major		Moderate	Moderate significance due to the very large drawdown and radius of influence. Radius is smaller than the drawdown due to the very low permeability material at this location. The size of this cutting suggests that there has been a large overestimation of the drawdown at this location, and therefore further groundwater data

Cutting No.	NGR	Sensitivity	Magnitude		Significance	Comments
						is needed at this location. Further data is likely to reduce the significance of the impact at this cutting.
85	NH8837010632	L	Moderate		Slight	Slight significance due to the calculated radius of influence >50m. There is no groundwater data available, therefore groundwater level is assumed to be 0.5m bgl. The conservative assessment suggests that groundwater monitoring data will help to reduce the significance of the impact.
106	NH8915911673	H	Minor		Slight	Slight significance due to the high productivity aquifer and radius of influence >50m. BHDS20212 is less than 50m from these cuttings, this borehole did not encounter groundwater, and has been recorded as dry during all monitoring rounds. The base of this borehole is below the proposed depth of these cuttings suggesting groundwater will not be intercepted at these cuttings. Further groundwater data collection is recommended at this location.
110	NH8915911673	H	Minor		Slight	
111	NH8915911673	H	Minor		Slight	
112	NH8915911673	H	Minor		Slight	
180	NH8934513957	H	Minor		Slight	The cuttings are located near Granish Junction. Slight significance due to the high productivity aquifer underlying the site and the calculated radius of influence >50m. Further groundwater monitoring is recommended at this location.
182	NH8934513957	H	Minor		Slight	
293	NH9105219136	H	Minor		Slight	Slight significance due to the radius of influence >50m and the underlying high productivity aquifer. There is limited groundwater data available for this location, further data collection is recommended
316	NH9075220888	L	Moderate		Slight	Slight significance due to the radius of influence >50m. There is limited groundwater data available in this area, further data collection is recommended.
320	NH9075220888	L	Moderate		Slight	
334	NH8920323124	L	Moderate		Slight	Slight significance due to the calculated radius of influence >50m. further groundwater monitoring is recommended in this area to aid assessment.
335	NH8920323124	L	Moderate		Slight	

Cutting No.	NGR	Sensitivity	Magnitude		Significance	Comments
343	NH8902623200	L	Moderate		Slight	Slight significance due to the size of drawdown. The radius of influence is smaller than the drawdown due to the extremely low permeability recorded at BHDS3032.
349	NH8818124081	L	Moderate		Slight	Slight significance due to the size of drawdown and calculated radius of influence. Borehole BHDS2033 is <30m from cutting and therefore groundwater data is available at this location. Further groundwater data collection is recommended to aid this assessment.
362	NH8534923879	L	Moderate		Slight	Slight significance due to the size of the calculated radius of influence.
375	NH8381625506	L	Moderate		Slight	Slight significance due to the size of the drawdown and the calculated radius of influence. Further groundwater data collection recommended at this location to aid the assessment.
377	NH8381625506	L	Moderate		Slight	
378	NH8381625506	L	Moderate		Slight	
	Low (L), Medium (M), High (H)					

10.4.14. Whilst the assessment identifies cuttings of potentially large significance, this is based on limited site-specific information. Conservative assumptions of hydraulic conductivity values have been made for the majority of the cuttings, based on the available data for the study area. The methodology of the assessment and its limitations are summarised in Section 10.2 and further discussed in Appendix 10.4.

10.4.15. The impact of potential construction pollution on bedrock aquifers is considered to be of Moderate magnitude, with a significance of Moderate.

10.4.16. The potential impact from construction pollution on high and moderate to high productivity superficial aquifers (High sensitivity) is considered to be of Major magnitude, with a significance of Large.

10.4.17. The impact of potential construction pollution on the non-significant superficial aquifers (Devensian Till, Peat) is of Moderate magnitude, with a significance of Slight.

10.4.18. Prior to detailed design further ground investigation, groundwater monitoring and assessment is required to refine the estimation of groundwater drawdown and zone of influence and confirm the significance of the impact. This data will also be required to assess the groundwater volumes seeping into the cuttings, which will inform the cutting drainage design.

10.4.19. If the impacts are confirmed as significant additional mitigation measures may be required. This may be relatively minor measures, such as containing, channelling and directing groundwater to the down gradient side of the cutting, allowing the discharge to infiltrate back to ground. However, if groundwater seepage into the cuttings is substantial then groundwater cut-off walls may be required.

10.4.20. With the above embedded mitigation measures in place it is anticipated that the magnitude of impact on the associated aquifers will be reduced to Minor, resulting in a significance of Slight.

Public Water Supplies

10.4.21. The location of the public water supply boreholes is confidential (detailed in Appendix 10.5). The boreholes are situated approximately 115m to 126m south of the mainline carriageway and approximately 47m to 83m south of the Highland Mainline railway. The depth of the boreholes varies from 35mbgl to 55mbgl. There was no preliminary stage 2 GI in the area. While the direction of the groundwater flow is not confirmed, it is likely that groundwater flow will follow topography flowing southwards to the River Spey. There is no recent groundwater level data from the pumping boreholes, however the rest water level taken from the borehole logs prior to any groundwater abstraction indicated the water level varied from 4.60mbgl to 17.60mbgl.

10.4.22. The groundwater supply for the public supply boreholes is the Upper Spey Valley Sand and Gravel superficial aquifer, an intergranular and fracture flow aquifer of moderate to high productivity. The boreholes are down hydraulic gradient of the carriageway. While the BGS map[lxi] shows the carriageway sits on glaciofluvial deposits, the ground below the carriageway will have been reworked during the original carriageway construction. The Stage 2 GI results from other parts of the scheme have shown the glaciofluvial deposits to be interbedded with silts and occasional clayey sands which may also restrict flow. While the area is not upstream of the A9, the distance of the boreholes from the carriageway is over 100m. The potential for pollutants to be introduced to the aquifer via the creation of a new hydraulic pathway is low.

10.4.23. The groundwater assessment found that the Scottish Water public boreholes do not fall within the radius of influence of any of the cuttings in the Dalraddy to Slochd section.

10.4.24. Mitigation measures will be required in the design to protect the Scottish Water assets. Including the provision that any planned works or activity within 500m of the abstraction borehole assets must be notified to Scottish Water at least 30 days in advance of the works commencing with detailed method statements of any works/activities included. Additional mitigation in the design including lined filter drains in the vicinity of the abstraction boreholes and the catchment area will protect the aquifer from any spillages, the provision of no SuDS infiltration within the borehole catchment area will protect the aquifer from any potential new flow pathways relative to the current baseline situation.

10.4.25. The sensitivity of the public water supply is Very High. Given the mitigation in the design, the impact of construction pollution at the public supply boreholes is anticipated to be Minor with a significance of Moderate/Large**.** As pollution of the borehole assets would result in the temporary disconnection of the supply, tankers would be required temporarily to maintain supply to local communities. While any impact has a Moderate/Large significance, the mitigation measures in place will ensure there is a low likelihood of any impact being realised.

Private Water Supplies

PWS Baddengorm

10.4.26. The borehole supply PWS Baddengorm, supplying the property of Baddengorm, is located 450m north and 10m upslope of the embankments for the Proposed Scheme and 480m from the Proposed Scheme's mainline carriageway.

10.4.27. It is assumed that local groundwater flows generally follow topography, with the Proposed Scheme located downhill and downstream of the borehole, and source zone above the Proposed Scheme. Therefore, the source is considered hydrologically disconnected from the Proposed Scheme by Bogbain Burn and the intervening topography and it is considered that there is a very limited potential for pollutants to be introduced to the aquifer upstream of the supply source. The impact of construction pollution at PWS Baddengorm is considered to be of Negligible magnitude with a significance of Neutral.

PWS Slochd 1

10.4.28. The spring supply of PWS Slochd 1, supplying the property of No. 3 Slochd Railway Cottages is located 130m south and 30m upslope of the Proposed Scheme. It is assumed that the groundwater flows generally follow topography, with the Proposed Scheme located downhill and downstream of the borehole and source zone above. The PWS does not fall within the radius of influence of any cuttings, it is considered that there is very limited potential for pollutants to be introduced to the aquifer upstream of the supply source. It should also be noted that the permeability of the Slochd Psammite is extremely variable depending on the fracturing of the rock and therefore the most conservative permeability values were used to calculate the radius of influence, this has led to a conservative assessment. The impact of construction pollution at PWS Slochd 1 is considered to be of Negligible magnitude with a significance of Neutral.

PWS Slochd 2

10.4.29. The borehole supply of PWS Slochd 2, supplying the properties of Slochd Mhor Lodge and Slochd Railway Cottages 1, 2, 3 and 4, is located 110m south-east and 30m downslope of the Proposed Scheme. The mainline carriageway widening of the

Proposed Scheme is located 20m higher topographically (with the depth of extraction unknown) than the source location and 170m north-east. Construction activities upslope of the supply will include dewatering of cuttings, with blasting required between chainages 21,900 and 22,100. PWS Slochd 2 does not fall within the radius of influence of any cuttings. However, there is still potential for pollutants to be introduced to the aquifer upstream of the supply source. As stated above a very conservative permeability value was used to calculate the radius of influence and therefore a conservative assessment has been carried out. The impact of construction pollution at PWS Slochd 2 is considered to be of Minor magnitude with a significance of Moderate.

PWS Slochd 3

10.4.30. The spring supply of PWS Slochd 3, supplying the properties of Slochd Cottage and Doneen, is located 130m north-east and upslope of cuttings for the Proposed Scheme and 220m from the Proposed Scheme's mainline carriageway.

10.4.31. PWS Slochd 3 is intercepted by the radius of influence from one cutting (365). Given the distance and difference in elevation, it is considered unlikely that any pollutants resulting from cutting activities will impact the quality of supply at PWS Slochd 3, however, infrastructure related to the supply, including the overflow tank, supply pipes stopcock and pipework are located under the land take of the Proposed Scheme, in a planned cutting. The impact of construction pollution at PWS Slochd 3 is considered to be of Major magnitude with a significance of Large.

Mobilisation of Historic Contamination

10.4.32. Potential impacts with regard to historic contamination during construction relate to the disturbance / exposure of sources of potential historical contamination within the proposed scheme footprint. This disturbance could result in an increase in the risk associated with certain pollutant linkages, or could potentially create new pollutant linkages due to new pathways being created.

10.4.33. The potential pollutant linkages identified at baseline have been reassessed for the construction phase, without mitigation, and a comparison of the risk outcomes at each stage has been made to give an indication of the impact significance as shown in Table 10.35 below.

Table 10.35: Risk Evaluation of Plausible Pollutant Linkages – Construction Without Mitigation Measures

Hazard identification	Hazard assessment		Baseline Risk Evaluation	Construction Risk Estimation (without mitigation)		Construction Risk Evaluation (without mitigation)	Impact Significance
Contaminant source	Pathway	Receptor		Consequence of risk being realised	Probability of risk being realised		
S1 Potentially contaminated ground / waters located within Proposed Footprint – Railway, infilled pits / quarries, agricultural use Contamination identified from ground investigation	P1 – Direct Contact with soil / soil derived dust and groundwater	R3 - Drivers & NMUs	Low	Medium	Unlikely	Low	Neutral
		R4 – Local Residents	Low	Medium	Low	Moderate / Low	Minor adverse
		R5 – Ecosystems	Low	Medium	Low	Moderate / Low	Minor adverse
		R6 – Buildings & Crops	Very Low	Mild	Low	Low	Minor adverse
		R7 – Livestock, Pets & Wildlife	Very Low	Mild	Low	Low	Minor adverse
		R8 – Site Infrastructure	Moderate / Low	Mild	Moderate / Low	Moderate / Low	Neutral
	P2 – Ingestion of soil / soil derived dust and groundwater	R3 – Drivers & NMUs	Low	Medium	Unlikely	Low	Neutral
		R4 – Local Residents	Low	Medium	Low	Moderate / Low	Minor adverse
		R5 – Ecosystems	Low	Medium	Low	Moderate / Low	Minor adverse
		R7 – Livestock, Pets & Wildlife	Very Low	Mild	Low	Low	Minor adverse
	P3 – Inhalation of fugitive soil dust and fibres	R3 – Drivers & NMUs	Low	Medium	Low	Moderate / Low	Minor adverse
		R4 – Local Residents	Low	Medium	Low	Moderate / Low	Minor adverse

Hazard identification	Hazard assessment		Baseline Risk Evaluation	Construction Risk Estimation (without mitigation)		Construction Risk Evaluation (without mitigation)	Impact Significance
Contaminant source	Pathway	Receptor		Consequence of risk being realised	Probability of risk being realised		
		R5 – Ecosystems	Low	Medium	Low	Moderate / Low	Minor adverse
		R7 – Livestock, Pets & Wildlife	Very Low	Mild	Low	Low	Minor adverse
	P4 – Inhalation of vapours / soil gas	R3 – Drivers & NMUs	Low	Medium	Unlikely	Low	Neutral
		R4 – Local Residents	Low	Medium	Unlikely	Low	Neutral
		R5 - Ecosystems	Very Low	Mild	Unlikely	Very Low	Neutral
		R7 – Livestock, Pets & Wildlife	Very Low	Mild	Unlikely	Very Low	Neutral
	P5 – Leaching and vertical / lateral migration of contaminants	R1 – Superficial Aquifer	Moderate / Low	Medium	Low	Moderate / Low	Neutral
		R2 – Surface Water	Moderate / Low	Medium	Low	Moderate / Low	Neutral
		R5 - Ecosystems	Low	Mild	Low	Low	Neutral
		R6 – Buildings and Crops	Low	Mild	Low	Low	Neutral
		R8 – Site Infrastructure	Low	Mild	Low	Low	Neutral
	P6 – Vertical and lateral migration of soil gas	R3 – Drivers & NMUs	Moderate / Low	Severe	Unlikely	Moderate / Low	Neutral
		R4 – Local Residents	Moderate / Low	Severe	Unlikely	Moderate / Low	Neutral

Hazard identification	Hazard assessment		Baseline Risk Evaluation	Construction Risk Estimation (without mitigation)		Construction Risk Evaluation (without mitigation)	Impact Significance
Contaminant source	Pathway	Receptor		Consequence of risk being realised	Probability of risk being realised		
		R6 – Buildings (crops unaffected)	Moderate / Low	Severe	Unlikely	Moderate / Low	Neutral
		R8 – Site Infrastructure	Moderate / Low	Severe	Unlikely	Moderate / Low	Neutral
S2 Potentially Contaminated Ground / Waters located outwith proposed footprint but within 250m of Proposed Scheme Footprint.	P1 – Direct Contact with soil / soil derived dust and groundwater	R3 - Drivers & NMUs	Low	Medium	Unlikely	Low	Neutral
	P5 – Leaching and vertical / lateral migration of contaminants	R1 – Superficial Aquifer	Moderate / Low	Medium	Low	Moderate / Low	Neutral
		R2 – Surface Water	Moderate / Low	Medium	Low	Moderate / Low	Neutral
	P6 – Vertical and lateral migration of soil gas	R3 – Drivers & NMUs	Moderate / Low	Severe	Unlikely	Moderate / Low	Neutral
		R8 – Site Infrastructure	Moderate / Low	Severe	Unlikely	Moderate / Low	Neutral

10.4.34. With regard to the significance of the potential impacts during construction, overall this is considered to be Minor Adverse.

Operational Impacts

Loss of Geodiversity

10.4.35. Rock exposures and other geological and geomorphological features can provide an important foundation upon which ecosystems thrive and can provide an important educational and scientific resource. Road construction, in particular excavation of cuttings, can result in the loss of these features both through direct removal and from the obscuring effects of slope stabilisation methods.

10.4.36. The Proposed Scheme involves the widening of the existing carriageway, either to the northbound or the southbound carriageway, which will require modification of existing cuttings. The majority of these are excavated into superficial deposits, however there is one known hard rock cut in the area of the Slochd GCR site (predominantly southbound carriageway). The Slochd GCR is of High sensitivity because of recommendations that it be treated as a "Candidate SSSI". Given that the loss of GCR area is concentrated in an SNH identified critical zone, the magnitude of the impact of the Proposed Scheme Options has been assessed as Moderate. The impact significance is therefore Moderate/Large.

10.4.37. The geodiversity assessment also identifies the other gneissose metamorphic formations at Slochd (Dava Subgroup, Creag Buidhe and Beinn Bhreac) as of great geodiversity value, therefore these formations are also of high sensitivity. The impact significance will be Moderate/Large.

10.4.38. A number of cuttings have been formed in rock to accommodate the existing A9 carriageway between Dalraddy and Slochd. With the exception of the candidate SSSI at Slochd GCR, the majority of these cuttings are considered to have little geodiversity interest. Three features have been highlighted as potential areas of geological/local interest, the Boat of Garten Pluton at Boat of Garten and Tore Hill, the Slochd Mor outcrop and the 'soldier's head' outcrop. The Boat of Garten pluton underlies the scheme however exposures are limited, the magnitude of the impact of the Proposed Scheme has been assessed as Minor, the impact significance is therefore Neutral. The exact location and extent of the meltwater channel landform at Slochd Mor is unknown. The magnitude of the impact of the Proposed Scheme has been assessed as Moderate, the impact significance is therefore Moderate. The 'soldier's head' is a unique feature of notable local interest. There is a geodiversity interest with this feature, however, it has no recognised geological designation. The magnitude of the impact of the Proposed Scheme has been assessed as moderate, the impact significance is therefore Slight.

10.4.39. The potential operational impacts of excavation on previously identified sites of geological diversity is listed in Table 10.36.

Table 10.36: Operational Impacts on Geodiversity Sites

Site of Geodiversity Interest	Sensitivity	Magnitude	Significance
The Slochd	High	Moderate	Moderate/Large
Gneissose Metamorphic Formations Dava Subgroup, Creag Buidhe and Beinn Bhreac	High	Moderate	Moderate/Large
Boat of Garten/Tore Hill Pluton	Low	Minor	Neutral

Site of Geodiversity Interest	Sensitivity	Magnitude	Significance
Slochd Mor	Low	Moderate	Slight
'Soldier's Head'	Low	Moderate	Slight

10.4.40. It should be noted that for exposure sites such as The Slochd and the gneissose metamorphic formations, the excavation of fresh cuttings may significantly enhance the geodiversity interest at the location and provide valuable information to the scientific community. Therefore, while the significance of the impact is moderate to large, there may also be a net major positive effect. Whereas features resulting from the deposit of material such as the deep glacial channel at Slochd Mor are of more limited extent. If this becomes damaged it cannot be so easily recreated and therefore it needs to be protected from erosion/other damage.

Loss of Economic Mineral Deposits

10.4.41. Construction of the Proposed Scheme has the potential to reduce the area available for future quarrying. While the use of quarry material on the scheme could negate any impact, the potential future quarry material may not be suitable for use on the scheme.

10.4.42. A substantial proportion of the Proposed Scheme also crosses unworked glaciofluvial sand and gravel deposits. Although it is possible that these areas have the potential to be worked, these deposits are common in the wider area and the loss of the deposits under the footprint of the Proposed Scheme constitutes a minor loss of resource. Therefore, the impact is considered to be of Minor magnitude resulting in a significance of Neutral.

Loss of Soils

10.4.43. Construction of the Proposed Scheme will result in the disturbance of soils and impact on soil quality. Although it is likely that much of the topsoil will be reused as part of the Proposed Scheme, for landscape mitigation and to dress the earthworks slopes for instance, there is the potential for the quality and value of the soils to be affected if improperly handled.

10.4.44. Based on data provided by the Engineering Road Design team, a topsoil excavation volume of 300,759m^3 will require excavation to a depth of 0.3m for the Proposed Scheme. Based on Engineering Drainage Design team data, a further volume of 47,340m^3 of non-peat material will be excavated during the construction of the ponds. In total, this represents 348,099m^3 of material that will need to be excavated and excludes peat data, which is discussed separately. It is anticipated that there shall be a surplus of topsoil and non-peat excavated material, after on-site re-use, of up to 168,654m^3. The actual surplus volume is subject to landscaping requirements and other feasible on-site applications, with off-site re-use or disposal minimised. Appendix 10.3 provides further information regarding soil and peat management, including excavation calculations, re-use options and material handling good practice.

10.4.45. The area of soils lost or disturbed under the footprint of the Proposed Scheme, subdivided by LCA class is presented in Table 10.37.

Table 10.37: Soil Loss

LCA Class	Sensitivity	Area Loss (ha)	Loss of LCA Class within Study Area (%)	Magnitude	Significance
Class 3 & 4	Medium	155.53	63	Minor	Slight

LCA Class	Sensitivity	Area Loss (ha)	Loss of LCA Class within Study Area (%)	Magnitude	Significance
Class 5 & 6	Low	91.20	36	Minor	Neutral
Class 7	Negligible	0	0	Negligible	Neutral

10.4.46. As shown in Table 10.37, the area of Class 3 soils is less than 15%, and Class 4 is 58% which is considered an impact of Moderate magnitude, as most soil will be reused on site for slope dressing and landscape mitigation where required.

Loss of Peat

Direct Loss

10.4.47. Construction of the Proposed Scheme will result in the disturbance of peat and peaty soils. Although it is likely that much of the peaty soil will be reused as part of the Proposed Scheme, for landscape mitigation and to dress the earthworks slopes for instance, there is the potential for the quality and value of the materials to be affected if improperly handled.

10.4.48. Due to its poor engineering characteristics, any peat present under the footprint of the Proposed Scheme is generally planned to be excavated and replaced with suitable engineering fill. Where excavating peat, it has been assumed that the full depth of peat has to be removed regardless of the type of construction required (cutting, embankment etc) as the engineering design requires competent ground to be reached.

10.4.49. At the Feith Mhor and Black Mount embankment areas, piling is specifically planned to reduce peat excavation. The specific piling methodology applied will be informed by additional ground investigation information at each location that will be available at the detailed design stage and with contractor input. Therefore, following the precautionary principle, a range of surface peat excavation values, from no excavation up to a maximum depth of 1.0m, have been reported for piling locations, to enable pragmatic and comprehensive consideration of the potential range of peat excavation and re-use volumes involved. Low traffic access tracks (Tier 3 access) may also be constructed using floating road techniques to reduce excavation.

10.4.50. Large volumes of excavated peat can present an additional management issue as storage can be difficult and opportunities for successful re-use on site can be limited, due to the lack of suitable sites where the hydrological regime of the peat can be maintained.

10.4.51. The volume of peat under the footprint of the Proposed Scheme that needs to be excavated for the Road Design has been determined as shown in Table 10.38. Two main peat areas were identified, for which piling was evaluated and considered feasible in order to minimise impact upon peatland. Piling at these locations, across Feith Mhor floodplain (CH14500 to 15100) and the Black Mount embankments (CH20100 to 21000), is anticipated to reduce excavated peat volumes by approximately 23,810m^3 to 53,800m^3, dependent upon the surface peat removal requirement. Full results and further information can be found in the Soil and Peat Management Plan (Appendix 10.3).

Table 10.38: Road Design Peat Loss under the Proposed Scheme

Receptor (Area ID)	Volume of Soil and Peat Loss (m^3)				
	Peat (total depth >0.5m)			Geotechnical solution	Total Peat to be excavated (m^3)
	Acrotelm (0-0.3m)	Fibrous Catotelm (0.3-1m)	Amorphous Catotelm (>1m)		
P1 Dalraddy (CH200 – 400)	640	970	90	E&R	1700
P2 Docharn WD (CH13900 – 13930)	1220	2000	1340	E&R	4560
P3 Feith Mhor (01) (CH14500 – 15100)	3110	6330	12180	Piling	0 - 9440**
P4 Feith Mhor (02) (CH14500 – 15100)					
P5 Feith Mhor (CH14950-15000)	800	1540	3400	E&R	5740
P6 Ellan WD (CH15380)	370	380	-	E&R	750
P7 South of Black Mount Junction (CH18410)	50	110	20	E&R	180
P8 Black Mount Junction (East of CH18800)	730	1220	250	E&R	2200
P9 Black Mount - Cuttings (CH19100-20100)	560	370	-	E&R	930
P10 Black Mount – Embankment (01) (CH20100-21000)	8040	12510	11630	Piling	0 - 20550**

Receptor (Area ID)		Volume of Soil and Peat Loss (m^3)			
	Peat (total depth >0.5m)			Geotechnical solution	Total Peat to be excavated (m^3)
	Acrotelm (0-0.3m)	Fibrous Catotelm (0.3-1m)	Amorphous Catotelm (>1m)		
P11 Black Mount – Embankment (02) (CH20100-21000)					
P12 Black Mount – Embankment (03) (CH20100-21000)					
P13 Slochd (CH24200-24300)	310	450	220	E&R	980
P14 Slochd (CH24450-25000)	580	870	530	E&R	1980
Total peat excavated	5260 – 16410**	7910 – 26750**	5850	-	19020 – 49,010**

E&R: Excavation and Replacement
**Precautionary volumes assuming that 1.0m of surface peat in piled areas will require excavation

10.4.52. In addition to the volume of peat excavation, varying between 19,020m^3 and 49,010m^3, for the Road Design identified on Table 10.38, there is a requirement to excavate peat for the installation of ponds and ditches for the Drainage Design. Of the 32 ponds planned, two are located in peatland areas. The Total peat excavation volume for ponds and ditches is estimated as 4,010m^3 (representing 2,202m^3 acrotelmic and 1,808 m^3 fibrous catotelmic peat). The combined volume of peat to be excavated for the Road Design and Drainage Design ranges from 23,030m^3 – 53,020m^3, with all peat planned to be re-used within the Proposed Scheme. Peat re-use will occur in close proximity to excavation locations, where feasible. Appendix 10.3 provides further information regarding soil and peat management, including excavation calculations, re-use options and material handling good practice.

10.4.53. The loss of peat as a proportion of the SNH Priority Peatland Classes within the study area is listed in Table 10.39.

Table 10.39: Peat Loss in Relation to SNH Priority Peatland Class

SNH Peat Class	Sensitivity	Excavated Peat Depth (m)		Area Loss (ha)	Loss of SNH Peat Class within Study Area (%)	Magnitude	Significance
		Ave	Max				
1	High	3.4	3.4	0.04	0.01	Negligible	Slight

SNH Peat Class	Sensitivity	Excavated Peat Depth (m)		Area Loss (ha)	Loss of SNH Peat Class within Study Area (%)	Magnitude	Significance
		Ave	Max				
3	Medium	1.1	2.6	17.42	6.3	Minor	Slight
4	Negligible	0.2	2.7	73.03	26.3	Minor	Neutral
5	Low	0.9	4.6	18.25	6.6	Minor	Neutral
0	Negligible	0.2	2.2	168.85	60.8	Moderate	Neutral

10.4.54. As shown in Figure 10.6 and Tables 10.38 and 10.39 there is a small loss of Class 1 peat under the Proposed Scheme. The avoidance of peat, in particular Class 1 peat, was used as a key constraint in the development of the Proposed Scheme. The magnitude of the impact is considered to be Negligible, with a resulting significance of Slight.

10.4.55. The defined areas of deep peat which will be excavated are generally located as discrete isolated pockets, or as outliers from larger areas of deep peat within the study area. As such they are a small proportion of the peat present within the study area, as shown in Table 10.39. Excavation of these isolated areas of deep peat is unlikely to affect the value or integrity of the peat within the study area. The magnitude of the impact is considered to be Minor, with a resulting significance of Slight for the Class 3 peat, and Neutral for all other peat classes.

Indirect Loss

10.4.56. The construction of cuttings and embankments, the introduction of pre-earthworks cut-off drainage and the direct excavation of peat could alter the groundwater and surface water flow paths through the peat lying adjacent to the Proposed Scheme. This could result in drying out of the peat in some areas and surcharging in others. The effects of this can sometimes be seen extending some distance from the works. This can subsequently cause erosion and/or instability of the peat, resulting in the release of organic carbon to the atmosphere and local watercourses, or potentially catastrophic peat landslides.

10.4.57. Areas of peatland may be impacted by changes to groundwater levels caused by dewatering of cuttings, where the peat is located within the likely groundwater drawdown zone of influence, or where the scheme footprint may act as a barrier to subsurface flow.

10.4.58. Two main peat areas were identified, for which piling was evaluated and considered feasible in order to minimise impact upon peatland. Piling at these locations, across Feith Mhor flood plain (CH14500 to 15100) and the Black Mount embankments (CH20100 to 21000) will reduce deep excavations and/or dewatering and as a consequence will reduce potential for groundwater drawdown influencing these peatland areas adjacent to the Proposed Scheme.

10.4.59. The impact of changes to the hydrological regime resulting in indirect loss of peat is of Minor magnitude, resulting in a significance of Slight.

Pollution from Routine Runoff

Mainline and Junctions

10.4.60. A broad range of potential pollutants, such as hydrocarbons i.e. fuel and lubricants, fuel additives, metal from corrosion of vehicles, de-icer and gritting material, can accumulate on road surfaces. These can subsequently be washed off the road during rainfall events, polluting the receiving water bodies.

10.4.61. Seven networks with groundwater discharges are proposed for the Proposed Scheme, all featuring infiltration basins as shown in Figures 5.2. All networks feature filter drains along the length of the road prior to the second SuDS feature. The indicative groundwater infiltration basins shown in Figures 5.2 includes one location, C9(A) where the local topography dictated that a single infiltration basin could not be accommodated; at this location four closely clustered infiltration basins are proposed, but are essentially a single discharge and have been assessed as such.

10.4.62. All of the mainline road drainage networks have been designed to discharge to a combination of surface waters, via lined SuDS ponds, and groundwaters via infiltration basins. However, each network will include filter drains, which if unlined may allow a proportion of runoff to infiltrate to groundwater. As a result, DMRB Method C calculations have also been carried out for each mainline network to assess the potential impact on groundwater.

10.4.63. On this basis the assessment of routine runoff impacts on groundwater at this location is as shown in Table 10.40.

Table 10.40: Routine Run-off Groundwater Assessment Results for Point Discharges

Outfall ID	Location (NGR)	Location Description	Traffic Density (AADT)	SAAR (mm)	Soakaway Geometry	Depth to Water Table (m)	Flow Type	Geology	Effective Grain Size	Lithology	Overall Risk Score	Risk Category
S6	NH 891 119	South of Loch Puladdern within Craigellachie NNR at the base of a proposed embankment	<50k	740-1060	Single point, deep serving road area >5,000m2	5m - 15m	Dominantly intergranular flow	*Fine to medium sand, and fine to coarse gravel*	Coarse Sand	<1% clay	188	Med
S10	NH 877 100	Southern end of the proposed Aviemore South Junction, where it meets the existing B9152	<50k	740-1060	Single point, deep serving road area >5,000m2	<5m	Dominantly intergranular flow	*Fine to medium sand and fine to coarse gravel*	Coarse Sand	<1% clay	200	Med
C2*	NH 899 153	North of the proposed Granish junction downslope of the existing Allt na Criche watercourse	<50k	740-1060	Single point, deep serving road area >5,000m2	5m - 15m	Dominantly intergranular flow	*Fine to coarse sand and gravels*	Coarse Sand	<1% clay	188	Med
C7	NH 907 171	North of Avielochan between the existing A9 and A95 at the bottom of a proposed embankment	<50k	740-1060	Single point, deep serving road area >5,000m2	<5m	Dominantly intergranular flow	*Sands and gravels to 4m depth and a clayey fine to coarse sand*	Fine sand and below	1-15% clay	200	Med

Outfall ID	Location (NGR)	Location Description	Traffic Density (AADT)	SAAR (mm)	Soakaway Geometry	Depth to Water Table (m)	Flow Type	Geology	Effective Grain Size	Lithology	Overall Risk Score	Risk Category
C8	NH 909 174	Laggantygown west of Loch Vaa between the existing A9 and A95 roads	<50k	740-1060	Single point, deep serving road area >5,000m2	<5m	Dominantly intergranular flow	*Silty fine to coarse gravel and sand with varying degrees of cobble content,*	Coarse Sand	<1% clay	208	Med
C9 (A)	NH 909 177	A cascade pond arrangement featuring four infiltration basins is proposed at C9(A), just north of Laggantygown, west of Loch Vaa between the existing A9 and A95 roads	<50k	740-1060	Single point, deep serving road area >5,000m2	5m - 15m	Dominantly intergranular flow	*Silty fine to coarse gravel with cobbles and boulders*	Coarse Sand	<1% clay	188	Med
C15	NH 901 151	At the existing A95/B9152 junction	<50k	740-1060	Single point, deep serving road area >5,000m2	5-15m	Dominantly intergranular flow	*Silty fine to coarse sand and gravels*	Coarse Sand	<1% clay	188	Med

* A total of three soakaway infiltration test were undertaken in TPDS2068, located 60m north east of Granish junction. The calculated soil infiltration rate ranged from $1.41x10^{-4}$ -$3.56x10^{-4}$ m/s (more information is provided in Appendix 10.4). This implies that the superficial deposits around Granish junction are particularly permeable relative to superficial deposits tested at other locations.

10.4.64. As can be seen in Table 10.40, the overall risk score generated places the groundwater discharge outfalls in the 'Medium Risk of Impact' category. On this basis, the magnitude of the impact on the receiving groundwater (High sensitivity) is considered to be Moderate, with a resulting significance of Moderate.

10.4.65. A summary of the overall risk from routine runoff associated with linear filter drains along each network is presented in Tables 10.41 to 10.43 based on the criteria and weightings detailed in Section 10.2 and Table 10.41.

10.4.66. Note that Tables 10.41 to 10.43 have been completed for all networks, including surface water discharge networks. The options for mitigation only cover those with infiltration discharges. Mitigation for those with surface water discharges could include lining filter drains.

Table 10.41: Routine Run-off Groundwater Assessment Results for Linear Discharges in the Southern Section

Parameter	Weighting	Network Risk Scores											
		S1	S2	S3	S4	S5	S6	S7	S7A	S8	S9	S10	S11
Traffic Density	15	1	1	1	1	1	1	1	1	1	1	1	1
Annual Average Rainfall	15	3	3	3	3	3	3	3	3	3	3	3	3
Soakaway Geometry	15	1	1	1	1	1	1	1	1	1	1	1	1
Depth to water table	20	3	3	3	3	3	3	2	3	2	3	3	3
Flow Type	20	1	1	1	1	1	1	1	1	1	1	1	1
Effective Grain Size	7.5	2	2	1	2	2	2	2	2	2	2	2	1
Lithology	7.5	2	3	3	2	2	2	2	3	3	3	3	3
Overall Risk Score		178	170	163	178	178	178	178	170	157	178	178	178

Table 10.42: Routine Run-off Groundwater Assessment Results for Linear Discharges along the Central Section

Parameter	Weighting	Network Risk Scores											
		C1	C2	C3	C5B	C7	C8	C9(A)	C11	C12	C13	C14	C15
Traffic Density	15	1	1	1	1	1	1	1	1	1	1	1	1

Parameter	Weighting	Network Risk Scores											
		C1	C2	C3	C5B	C7	C8	C9(A)	C11	C12	C13	C14	C15
Annual Average Rainfall	15	3	3	3	3	3	3	3	3	3	3	3	3
Soakaway Geometry	15	1	1	1	1	1	1	1	1	1	1	1	1
Depth to water table	20	2	3	2	2	2	3	2	2	3	2	3	2
Flow Type	20	1	1	1	1	1	1	1	1	1	1	1	1
Effective Grain Size	7.5	2	2	2	2	2	2	2	2	2	2	2	2
Lithology	7.5	3	3	3	3	3	2	3	3	3	3	3	3
Overall Risk Score		158	178	158	158	158	170	158	158	198	158	178	187

Table 10.43: Routine Run-off Groundwater Assessment Results for Linear Discharges along the Northern Section

Parameter	Weighting	Network Risk Scores									
		N1	N2	N4	N5	N7	N8	N9	N10	N11	N12
Traffic Density	15	1	1	1	1	1	1	1	1	1	1
Annual Average Rainfall	15	3	3	3	3	3	3	3	3	3	3
Soakaway Geometry	15	1	1	1	1	1	1	1	1	1	1
Depth to water table	20	2	2	3	3	2	3	2	3	3	3
Flow Type	20	3	3	3	3	2	2	2	3	3	3
Effective Grain Size	7.5	2	2	2	2	2	2	2	1	1	2
Lithology	7.5	3	3	3	3	3	3	3	2	2	3
Overall Risk Score		158	158	178	178	178	198	178	155	155	170

10.4.67. As can be seen in Tables 10.41 to 10.43, the overall risk score generated places the groundwater discharge outfalls via unlined filter drains is primarily in the 'Medium Risk of Impact' category. On this basis, the magnitude of the impact on the receiving groundwater (High sensitivity) is considered to be Moderate, with a resulting significance of Moderate.

10.4.68. Further analysis has been conducted on the efficiency of various drainage treatment levels, taking cognisance of Table 8.1 Indicative Treatment Efficiencies of Drainage

Systems (DMRB Volume 4, Section 2, Part 3 HD33/16 – Geotechnics and Drainage); key details from this table are highlighted in Table 10.44.

Table 10.44: Indicative Treatment Efficiencies of Drainage Systems

Treatment Option	% Reduction Factor		
	SS	Copper	Zinc
Swale / Grass Channel**	80	50	50
Infiltration Basin*	50	0	0
Surface Flow Wetland	60	30	50
Filter Strips	25	15	15
Filter Drains	60	0	45
*Infiltration Basins use detention pond percentages; due to similar vegetative semi wet nature ** Bespoke grass channel/filter drain (as used on N11) but only consider swale for treatment			

Source of table: DMRB Volume 4, Section 2, Part 3 HD33/16.

10.4.69. A summary network report was previously produced in discussion with SEPA[lxii]. The pollution impact analysis within this report deemed two levels of treatment to be sufficient. Chapter 5: The Proposed Scheme, states that the drainage networks will be subject to at least two levels of mitigation, typically comprising filter drains and retention ponds, detention basins or swales prior to discharge.

10.4.70. There are four potential different design options for treatment that could be employed within the current proposed drainage arrangement and footprint without incurring a major impact to the design. There is flexibility in the mitigation options proposed to increase treatment (if necessary), within the bounds of the proposed land available.

10.4.71. With regard to Network S5, the sensitivity of this network is considered as Very High due to the presence of the South Aviemore Groundwater Public Water Supply downgradient of the Proposed Scheme. Whilst the traffic volumes associated with the networks (both the linear and point discharges) are at the lower end of the parameter class, and only a small proportion of run-off will infiltrate to the ground, there is potential for routine runoff to accumulate in the source zone of the aquifer from which the boreholes abstract water. On this basis, the magnitude of the impact on this receiving groundwater (Very High sensitivity) is considered to be Moderate, with a resulting significance of Moderate**.**

10.4.72. All of the remaining network assessments, for both the filter drains and infiltration ponds, have been identified as a Medium Risk, primarily due to the shallow groundwater levels and lithology. However, it is considered that the assessment is likely to be over estimating the risk to groundwaters, due to a number of reasons. The traffic volumes associated with the networks (both the linear and point discharges) are at the lower end of the parameter class. For networks that discharge to surface water, only a small proportion of the runoff will discharge to groundwater, meaning that the pollutant load being discharged to groundwater is likely to be overestimated. For networks discharging entirely to groundwater, the network is assessed twice as the drains are unlined. With this in mind the overall risk is considered to be Low.

10.4.73. The impact of routine run-off on all bedrock and superficial aquifers (High sensitivity) is of Minor magnitude, with a significance of Slight.

Side Roads and Access Tracks

10.4.74. The simple index approach (CIRIA, 2015) has been used as the criteria to assess side roads and access tracks. All side roads and access tracks are designed to drain primarily to surface waters, with the exception of network S11 for the B9152 road, which will drain to an infiltration basin. However, as with the mainline each network will include features such as filter drains or vegetated ditches which are likely to be unlined and may allow a small proportion of runoff to infiltrate to groundwater.

10.4.75. Traffic volumes on these roads are expected to be very low and therefore pollutant loads will be very low. Additionally, the runoff will have been subject to some treatment from the filter drains and vegetated ditches prior to infiltration.

10.4.76. The magnitude of impact of routine runoff from side roads into medium and high productivity superficial aquifers is Negligible, with a significance of Neutral.

10.4.77. The magnitude of impact of routine runoff from side roads into low productivity superficial aquifers is Negligible, with a significance of Neutral.

Pollution from Accidental Spillage

10.4.78. On all roads there is a risk that road traffic accidents or vehicle fires may result in accidental spillage of potential pollutants on the road surface. These may then enter the road drainage network and subsequently be discharged to the water environment, causing an acute pollution event. The proposed mainline groundwater outfalls have been assessed for accidental spillage, and are summarised in Table 10.45 below.

Table 10.45: Summary of Accidental Spillage Assessment Results

Receptor	Attribute	Sensitivity	Drainage Network ID	Return Period Probability (1 in years)	Pass / Fail	Magnitude	Significance
Glaciofluvial Sheet Deposits	Water quality	High	S6	9806	Pass	Negligible	Neutral
River Terrace Deposits			S10	92268	Pass	Negligible	Neutral
Hummocky (Moundy) Deposits		Low	C2	20784	Pass	Negligible	Neutral
Glaciofluvial Sheet Deposits		High	C7	12080	Pass	Negligible	Neutral
			C8	13503	Pass	Negligible	Neutral
			C9(A)	9045	Pass	Negligible	Neutral
Hummocky (Moundy) Deposits		Low	C15	6580	Pass	Negligible	Neutral

10.4.79. The result of the calculations relating to operational accidental spillage demonstrate that, whilst applying conservatively high traffic data for the Proposed Scheme, the 8 network discharges to groundwater via infiltration basins will meet the minimum DMRB standard of a 1 in 200 year return period, with the worst calculated annual probability being 1 in 6,596 years. This outcome indicates that no further mitigation would be required.

10.4.80. It has accordingly been concluded that the magnitude of impact of the Proposed Scheme on the receiving groundwaters (High sensitivity) would be of Negligible magnitude, with the associated significance being Neutral.

Loss or Change to Groundwater Aquifers

10.4.81. Under the Controlled Activities Regulations 2011[lxiii] the abstraction of water from the dewatering of road cuttings is regulated during the construction phase. Once an operational final passive drainage system is in place the activity no longer requires authorisation. However, road cuttings excavated to below the groundwater table, and associated drainage, have the potential to permanently lower groundwater levels in the aquifer adjacent to the cutting and alter groundwater flowpaths. This could also potentially affect nearby groundwater dependent receptors, such as wetlands, surface water bodies or groundwater abstractions.

10.4.82. A groundwater assessment was carried out to assess the potential impact of each cutting on groundwater aquifers. This has been provided in full in Appendix 10.4. Locations of cuttings can be seen on figure 10.4.1. More details on the conclusions of this assessment are included under construction phase impacts, with key findings summarised below.

10.4.83. 27 cuttings have been identified as having an impact of Large significance, 32 cuttings have been identified as having an impact of Moderate significance and 18 cuttings have been identified as having an impact of Slight significance. This assessment is discussed in more detail in Appendix 10.4.

10.4.84. Tables to determine sensitivity and magnitude of a groundwater receptor are provided within Technical Appendix 10.4 tables 2.1. and 2.2.

10.4.85. The assessment identified that further ground water monitoring is required across the scheme to produce a more comprehensive assessment on the loss or change to groundwater aquifers. It is anticipated that this information will be provided with the completion of the Stage 3 Dalraddy to Slochd ground investigation in 2018.

Loss or Change to Public Water Supplies

10.4.86. As discussed above, impacts on the groundwater aquifers within the study area could also impact on groundwater abstractions, resulting in a loss of yield and failure of public water supplies.

10.4.87. The Aviemore public water supply is a groundwater source located in the vicinity of the Proposed Scheme. The main carriageway of the proposed scheme lies approximately 115m uphill of the source, at the nearest point. The carriageway construction requires cutting into the uphill hillside, with the nearest point of cutting lying 130m uphill of the source. The maximum cutting height/depth in this area is approximately 9m. Initial dip information for the public supply boreholes shows a range in groundwater depth from 4.6mbgl to 17.60mbgl. However, the current pumping level of the groundwater is understood to be >20mbgl.

10.4.88. The groundwater assessment found that the public water supply boreholes do not fall within the radius of influence of any of the cuttings in the Dalraddy to Slochd section. Therefore, it is unlikely the cuttings will cause any negative impact.

10.4.89. The existing drainage situation involves unlined drains flowing to surface water courses that may contribute to the aquifer via infiltration. Mitigation measures in the design will protect the Scottish Water assets. Lined filter drains in the vicinity of the abstraction

boreholes and the catchment area will protect the aquifer from any spillages, the provision of no SuDS infiltration within the borehole catchment area will protect the aquifer from any potential new flow pathways relative to the current baseline situation. In terms of pollution risk, lined drains will effectively break the potential pathway to groundwater.

10.4.90. On the basis of the distance of the supply, the results of the aquifer assessment and the proposed mitigation measures in the design, the impact magnitude is anticipated to be Negligible. Given the Very High sensitivity of the public supply the corresponding impact significance will be Slight.

Loss or Change to Private Water Supplies

10.4.91. As discussed above, impacts on the groundwater aquifers of the study area could also impact on groundwater abstractions, resulting in a loss of yield and failure of private water supplies.

10.4.92. Four private water supplies have been identified within the study area (850m buffer of the Proposed Scheme). The impact on these supplies has been determined based on their proximity to the Proposed Scheme. The sensitivity of the private water supply sources has been based on the number of properties served and assigned as follows.

10.4.93. The borehole supply of PWS Baddengorm, supplying the property of Baddengorm, is located 450m north and 10m upslope of the embankments for the Proposed Scheme and 480m from the Proposed Scheme carriageway. As the source is hydrologically disconnected from the Proposed Scheme by Bogbain Burn and the intervening topography, and the upstream aquifer does not contain any parts of the Proposed Scheme, no groundwater changes are predicted. It is anticipated that the impact on this supply will be of Negligible magnitude, resulting in a significance of Neutral.

10.4.94. The spring supply of PWS Slochd 1, supplying the property of No. 3 Slochd Railway Cottages is located 130m south and 30m upslope of the Proposed Scheme. This source is not currently in use by the property, with the resident stating that the source is in poor condition and as a result is not considered as fit for use. As the upstream aquifer does not contain any parts of the Proposed Scheme, no groundwater changes are predicted. It is anticipated that the impact on this supply will be of Negligible magnitude, resulting in a significance of Neutral.

10.4.95. The borehole supply of PWS Slochd 2, supplying the properties of Slochd Mhor Lodge and Slochd Railway Cottages 1, 2, 3 and 4, is located 145m south-east and downslope of the Proposed Scheme. In this area, the Proposed Scheme features southbound widening with a corresponding large cutting on the southbound side of the carriageway. This cutting is located upslope and north of the existing A9 within the Slochd psammite formation, which intercepts groundwater 10 m bgl. The bedrock aquifer productivity is fracture flow - very low productivity. Any groundwater flow within the psammite is likely to be confined to near surface fractures and faults. The borehole supply of PWS Slochd 2 does not lie within the radius of influence of any cutting. With the distance between the rock cutting and groundwater supply, the notable difference between the permeability of geological units and also the dependence on fractures for flow, hydraulic connectivity between geological units will be minor and related to planes of weakness such as fractures/faults. There are unlikely to be significant changes to groundwater flow as a result of cuttings within the psammite bedrock. It is anticipated that the impact on this supply will be of Negligible magnitude, resulting in a significance of Neutral.

10.4.96. The spring supply of PWS Slochd 3, supplying the properties of Slochd Cottage and Doneen, is located 130m north-east and upslope of cuttings for the Proposed Scheme

and 220m from the Proposed Scheme's mainline carriageway. As the Proposed Scheme is located downslope of the source, no groundwater changes are predicted. However, PWS Slochd 3 lies just within the boundary of the radius of influence for cutting 365, therefore a potential impact on groundwater level cannot be ruled out at this source. It is anticipated that the impact on this supply will be of Moderate magnitude, resulting in a significance of Moderate.

10.4.97. With regard to the impact of routine runoff on the water quality of the private water supplies, the assessment in the 'Pollution from Routine Runoff' section described a Minor magnitude impact on the aquifers due to the nature of the proposed drainage systems. The only private water supply located downslope of the Proposed Scheme is the borehole at PWS Slochd 2, located 140m south-east. This supply is unlikely to be impacted due to the intervening distance, and anticipated very low pollutant load within the runoff as the only a small proportion of the runoff will infiltrate to groundwater. Therefore, the magnitude of impact on all groundwater private water supply sources is considered to be Negligible, with a significance of Neutral.

Indirect Loss or Change to Surface Water Receptors

10.4.98. There are a large number of surface water features within the study area which may rely to a greater or lesser degree on groundwater, i.e. base flow in the rivers and groundwater inflows to standing waters. Groundwater drawdown in cuttings located close to these surface water features may result in a loss of groundwater inputs to these surface waters, causing indirect loss or change to the surface waters.

10.4.99. Details of the surface waters within the study area are provided in Chapter 11: Road Drainage and the Water Environment. The sensitivity of the surface waters ranges from very high for the River Spey and the Allt na Criche (Lynwilg), due to their SAC designation, to low sensitivity for numerous small drains and ponds.

10.4.100. Of the 184 cuttings which are currently proposed to intersect groundwater, 69 cuttings have surface water features within their calculated radii of influence. The affected watercourses which may register an impact by reduced base flows are summarised below, more detail is provided in Appendix 10.4.

10.4.101. Based on information from the Dalraddy to Slochd Stage 2 Ground Investigation, generally groundwater has been identified at depth and not within the superficial materials. Glaciofluvial sands and gravels identified along the majority of the route appear to be very dense, dry and of low permeability. This would suggest that in general there is limited hydraulic conductivity between the groundwater and the surface water bodies. However, further GI data is needed to better understand the groundwater regime and to what extent groundwater baseflow contributes to the flow of the watercourses. Where data was absent the groundwater assessment assumed a water level of 0.5 m bgl (to represent a worst case scenario in the absence of more accurate groundwater levels). However, this assumption will currently overestimate the radii of influence for some cuttings. These cuttings have been identified in Appendix 10.4.

10.4.102. The hydrological sensitivity of the watercourses ranges from high - Allt an Fhearna, Allt Chriochaidh, Caochan Ruadh and Feith Mhor to medium including Aviemore Burn, AnCG bifurcation south, Allt Cnapach, Bogbain Burn and Slochd Mhuic to low sensitivity watercourses such as Ballinluig Burn, AnCG bifurcation north, Allt na Criche (Granish), Feith Mhor Trib 1 and 2 and Slochd Mhuic Trib.

10.4.103. Other surface water features range from the high sensitivity Loch Alvie, Loch Puladdern, MacDonald Pond and Granish Pond to low sensitivity features including Craigellachie Pond, Loch Vaa Pond 2 and the following drains: Ballinluig Drain, Kinakyle Drain,

Aviemore Drains 1,2 and 3, Milton Drain 1, Granish Drain 3, Kinveachy Drain 2, Carrbridge Drain 1, Feith Mhor Drains 1, 2, 3, 4, 5 and 6, Ceatharnach Drain, Slochd Drains 1, 2, 3, 4, 5 and 6.

10.4.104. A summary of the significance outcomes based on sensitivity of the receptor and the magnitude of impact are outlined below, further details are provided in Appendix 10.4

10.4.105. The magnitude of impact at Slochd Mhuic is anticipated to be Major with an associated significance of Large. Feith Mhor has a magnitude of Moderate with a significance of Large. For the Allt an Fhearna, Allt Chriochaidh and Caochan Ruadh the magnitude of impact is anticipated to be Moderate due to the small proportion of the watercourse affected; a small amount of baseflow may be lost. The impact significance is Moderate.

10.4.106. The Ballinluig Burn and Feith Mhor Trib 1 and 2 have a magnitude of impact of Moderate with a significance of Slight.

10.4.107. Aviemore Burn, AnCG bifurcation south, Allt Cnapach, Bogbain Burn and Slochd Mhuic Trib have a magnitude of impact of Minor with a corresponding significance of Slight. While the AnCG bifurcation north and Allt na Criche (Granish) have a magnitude of impact of Minor with a significance of Neutral.

10.4.108. Slochd Drains 3, 4 and 5 have a magnitude of impact of Major and a significance of Slight. Craigellachie Pond and the following drains: Ballinluig, Kinakyle, Feith Mhor 1, 2, 3, 4 and 5, Ceatharnach, Slochd 1, 2 and 6 all have a magnitude of impact of moderate and a significance of slight. While Loch Alvie and MacDonald Pond have a magnitude of impact of Minor with a significance of Slight.

Loss or Change to GWDTEs

10.4.109. GWDTEs within the study area may be impacted through direct loss of habitat under the footprint of the Proposed Scheme, through severance of habitat and through changes to the groundwater regime supporting the habitat. This could result in altered vegetation in corridors close to infrastructure.

10.4.110. The direct and indirect loss of GWDTEs falls under SEPA LUPS-GU 31 guidance Option 4, which features “infrastructure involving development on a sensitive receptor and/or excavations deeper than 1m within 250m of sensitive receptors” which requires a bespoke risk assessment. Each GWDTE area (polygon) identified within the study area has undergone assessment as detailed in Appendix 10.4.

10.4.111. Following this assessment, a total of 286 habitats (216.63 Ha) will not be impacted. These habitats are located outside of the Proposed Scheme footprint, either upslope of the scheme, where there is no hydrological or topographical connection between the habitat and the Proposed Scheme, or where the distance between the two is such that there is no impact anticipated.

10.4.112. A total of 111 habitats (15.42 Ha) will be partially or completely lost under the footprint of the Proposed Scheme (Land Made Available (LMA) boundary). This includes 31 habitats (5.07 Ha) where there is a loss of over 95% of the habitat, 22 habitats (6.44 Ha) where 50%-95% of the habitat is lost, 29 habitats (2.94 Ha) where there is a loss of 15%-50% and 29 habitats (0.96 Ha) which feature less than 15% loss of habitat.

10.4.113. The GWDTEs located within temporary works areas will be cleared for construction works, but the majority of these areas will not be impacted by long term changes to groundwater flows (with the exception of those which also lie within the drawdown zones of the permanent cuttings, as discussed below). The groundwater table is likely to remain unchanged over the long term, therefore although the GWDTE habitat will be lost

in the short term, the ground conditions conducive to GWDTE formation will remain, with the possibility of some form of GWDTE habitat re-establishing in the long term. Therefore, the total area of GWDTEs lost under the footprint is a conservative estimate, given some of these areas could return in the long term.

10.4.114. Also, the area of GWDTE loss includes both dominant and sub-dominant habitats. A number of these mosaics will feature non-groundwater dependent habitats, which may result in an over-estimate of true GWDTE loss.

10.4.115. A number of cuttings are required as part of the Proposed Scheme design, some of which intercept groundwater. Dewatering within cuttings can alter the groundwater flow in the surrounding area (zone of influence) with long term changes to groundwater levels.

10.4.116. Of the 396 cuttings associated with the Proposed Scheme, 184 have been identified as intercepting the groundwater table, primarily at the deeper cutting locations. These include new cuttings required at Aviemore South Junction, Ballinluig Underpass and a new ditch connected to S2 SuDS pond. Further details on the cuttings are provided within Technical Appendix 10.4.

10.4.117. A total of 109 habitats (59.82 Ha) are located within the zone of influence of cuttings, all of which intercept groundwater. However, the majority of these GWDTEs will be lost directly within the LMA boundary. As the changes to groundwater levels in these areas are likely to be permanent, any habitats that are located within these areas which may be used for temporary works are not likely to be re-established as they could not be supported by groundwater in the long term.

10.4.118. Of the 109 habitats, 87 habitats are located within groundwater drawdown zones of influence which extend outside of the LMA, resulting in an additional permanent loss of 41.05 Ha. The zones of influence relate to cuttings 1, 2, 3, 6, 9, 10, 11, 12, 15, 18, 19, 82, 100, 101, 102, 104, 105, 113, 114, 115, 136, 140, 167, 183, 184, 185, 186, 269, 321, 322, 323, 332, 334, 335, 337, 349, 363, 364, 365, 369, 374, 375, 376, 377, 378, 380, 383 and 384. This results in a percentage of GWDTEs (17.15%) impacted solely by groundwater changes.

10.4.119. A total of 229 habitats are located downslope of the Proposed Scheme and may be impacted indirectly by changes to subsurface flows. Many of these habitats also lie within the LMA and partially under the permanent earthworks footprint, and so will suffer from direct loss in the both the short and long term. Given the combined effects of these impacts it is not possible to quantify the areas associated solely with indirect loss. However, the impacts have been assessed qualitatively, and the potential area impacted can conservatively be assumed to be the GWDTE area downslope of the permanent earthworks.

10.4.120. An overall impact magnitude and significance has been determined for each GWDTE habitat assessed, taking into consideration each of the impact types discussed above.

10.4.121. A summary of the potential GWDTE impacts before any mitigation is provided in Table 10.46 below. The final row of Table 10.46 summarises all significance outcomes of moderate or greater, with these outcomes derived from various combinations of dependency, sensitivity and magnitude.

Table 10.46: Impacts on GWDTEs

Groundwater Dependency	Sensitivity	Number of Polygons	Area Loss (ha)	% of Total Area of Baseline GWDTE	% of Overall Study Area, 250m Buffer	Potential Impact Magnitude	Potential Significance on Individual GWDTE
High	Very High	2	0.312	0.191	0.018	Major	Very Large
		3	0.012	0.007	0.001	Major	Large
		11	0.175	0.107	0.010	Moderate	Moderate
		5	0.0016	0.001	0.000	Minor	Slight
		19	0.101	0.062	0.006	Negligible	Neutral
	Subtotal	40	0.6016	0.368	0.034	-	-
Moderate	High	16	2.404	1.472	0.137	Major	Very Large
		13	4.361	2.670	0.249	Major	Large
		32	2.91	1.782	0.166	Moderate	Moderate
		28	0.661	0.405	0.038	Minor	Slight
		208	0.077	0.047	0.004	Negligible	Neutral
	Subtotal	297	10.413	6.375	0.595	-	-
Low	Medium	13	2.361	1.445	0.135	Major	Very Large
		7	1.743	1.067	0.100	Major	Large
		14	0.282	0.173	0.016	Moderate	Moderate
		6	0.022	0.013	0.001	Minor	Slight
		59	0	0.000	0.000	Negligible	Neutral
	Subtotal	99	4.408	2.699	0.252	-	-
Various	Various	111	14.56	8.914	0.833	Various	Individual GWDTE Areas with Very Large / Large / Moderate Significance Values

Table Source: NVC July 2017 data.

10.4.122. The baseline conditions and potential impacts of the Proposed Scheme on individual GWDTE polygons are provided in Appendix 10.4, with significance values for individual polygons, following review, summarised in Table 10.46. This table identifies that there are 111 GWDTE polygons, with an aggregated area of 14.56 hectares, with direct and indirect losses that each have a potentially significant impact (i.e. Very Large, Large or Moderate significance values). This equates to 8.9% of the total area of baseline GWDTE identified and 0.83% of the overall study area.

10.4.123. Individual GWDTE locations have been assessed and, due to local characteristics, wide-ranging outcomes have been collated, with sensitivity values ranging from Medium to Very High, magnitude values ranging from Negligible to Major and significance outcomes ranging from Neutral to Very Large.

10.4.124. The allocation of sensitivity and importance of GWDTEs has been a key consideration, with individual polygons evaluated on the basis of potential groundwater dependency, enabling design input and monitoring and mitigation to target appropriate locations. When considering the overall GWDTE effect in an EIA context, it would not be appropriate to consider a GWDTE area not located within a designated area, which may represent a widespread vegetation community in Scotland, to hold equivalent importance to a receptor within an international designation, such as a SAC, as there is a clear differential in status, leading to design influence and degree of protection that should be applied. Medium and high sensitivity locations represent all 16.86 hectares identified as potentially significant, overall GWDTEs within designated sites at the Proposed Scheme are therefore considered of High sensitivity.

10.4.125. During the revision of the groundwater dependency, a confidence value was added to each polygon based on the available information to undertake the assessment. Confidence ranks High, Medium or Low depending on the groundwater levels, geology, hydrogeology, site information available as well as the certainty/uncertainty concerning, where relevant, the predicted drawdown at the GWDTE.

10.4.126. The outcomes for individual GWDTE polygons were evaluated using a purposefully precautionary approach, in order to establish constraints during the design process, specific mitigation measures are proposed to limit adverse impact on groundwater conditions and identify groundwater monitoring locations. This approach is likely to have led to an overestimate in the total number of habitats that are truly groundwater dependent, which further monitoring during detailed design will help to refine, it is also reasonable to anticipate that a substantial proportion of the identified habitats could re-establish within temporary construction areas in the longer term.

10.4.127. Notwithstanding the individual GWDTE area outcomes recorded in Table 10.46 (i.e. ranging from Medium to Very High sensitivity, Negligible to Major magnitude and Neutral to Very Large significance) in order to determine a proportionate assessment outcome an overall High sensitivity has been applied to GWDTE receptors and with a Moderate magnitude, this results in a Moderate significance outcome. This approach takes into account the relatively small areas of GWDTE where significant impacts are anticipated, with further rationale for the overall evaluation provided in Appendix 10.4.

Mobilisation of Historic Contamination

10.4.128. The impacts related to the mobilisation of historic contamination are mainly considered to be construction phase impacts. Construction activities have a potential to mobilise contamination, e.g. through soil management and exposure of the underlying deposits. As these activities are not anticipated during the operational phase of the road it is considered that the level of risk will not be elevated during operation compared to the construction phase.

10.4.129. Site conditions and activities during the operational phase will be similar to those present for the baseline and therefore it is considered that a Neutral impact significance will be present during operation based on the available GI information. Further GI is proposed for the study area and this will allow the CSM to be developed further and the impact significance to be confirmed. This does not take account of mitigation measures that may be implemented during the design and construction of the Proposed Scheme and these are identified in Section 10.5.

10.4.130. The potential environmental liabilities relating to the possible presence of contamination and its likely impact on the environment are considered to be of Moderate / Low significance in accordance with CIRIA C750.

10.5. Mitigation

10.5.1. Embedded mitigation has been included within the Proposed Scheme design as described in Section 10.4. In addition to this there is a need for further environmental mitigation, both standard and project specific.

10.5.2. A list of standard mitigation measures has been developed for all projects within the A9 Dualling Programme; those related to geology, soil, contaminated land and groundwater impacts are detailed below in Table 10.47. In addition to these, scheme specific mitigation measures have also been developed. These mitigation measures are also set out in Chapter 21 Schedule of Environmental Commitments, with further details on location, timing and responsibilities detailed there.

Table 10.47: Geology, Soils, Contaminated Land and Groundwater Standard A9 Mitigation

Mitigation Item	Description
SMC-G1	To reduce impacts from contaminated land sources: 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.
SMC-G2	To determine the extent and type of contaminants present and to inform identification of appropriate construction methods and any additional mitigation: 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.
SMC-G3	To ensure appropriate health and safety and waste management procedures for working with potentially contaminated soils are followed: Prior to construction, appropriate health and safety and waste management procedures for working with potentially contaminated soils will be established. Waste management procedures will include, but are not limited to: Waste Management Licence Regulations 1994 (as amended by Waste management licensing Amendment (Scotland) Regulations 2003), HSE Guideline Note MS13 Asbestos 1988 and the Health and Safety Commission Approved Code of Practice and Guidance Note. These procedures will be implemented as appropriate during construction.
SMC-G4	To reduce impacts from contaminated land sources and confirm the safety of construction and maintenance staff:

Mitigation Item	Description
	Risks to construction and maintenance staff working with/near contaminated land will be mitigated by the implementation of Mitigation Item 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.
SMC-G5	To identify potential presence of previously unidentified contamination: Appropriate training of personnel involved in earthworks activities to implement a watching brief to identify potential presence of previously unidentified contamination.
SMC-G6	To mitigate the loss/disturbance of any septic tanks: Where required, landowner consultation and site visits will be undertaken to confirm the location and network of septic tanks. Where septic tanks are located within the LMA they will be relocated and/or rebuilt subject to discussion and agreement with the affected landowner(s).
SMC-G7	To prevent cross contamination and pollution from piling works undertaken in areas of land affected by contamination, the Contractor will 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'.
SMC-G8	To determine whether disposed soils are hazardous or non-hazardous: Prior to disposal, soils 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.
SMC-G9	To identify any potential risks posed to human health and the water environment: 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.
SMC-G10	To comply with relevant waste management practices under The Waste Management Licensing (Scotland) Regulations 2011 and reduce impacts on peatlands: If peat is encountered during construction, it will be extracted, excavated, stored, with any off-site removal undertaken with 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 will comply with relevant waste management practices under The Waste Management Licensing (Scotland) Regulations 2011.
Note	Further to the above, the intention is that excavation of soils and peat shall be the standard technique, however, the use of non-excavation techniques (e.g. piling) shall be employed to avoid excavating large volumes of peat material at specific locations on the Proposed Scheme (Feith Mhor and Black Mount). Further details are provided in Appendix 10.3.
SMC-G11	To ensure that ground conditions are appropriate for the use of concrete at each given location: Where concrete materials are proposed to be used, appropriate guidance such as 'Building Research Establishment (BRE) SD1:2005' and 'British Standard

Mitigation Item	Description
	(BS) BS8500' should be followed to ensure that ground conditions are appropriate for the use of concrete at each given location.
SMC-G12	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: Where potential pollutant pathways for ground gas have been identified, a ground gas monitoring program will be developed prior to construction in adherence to 'CIRIA 665 Assessing Risks Posed by Hazardous Ground Gases to 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 significant 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.
SMC-G13	To mitigate against potential impacts on water quality due to leaching from SuDS features: 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 features, operational SuDS features should be lined. Any potential water quality impacts due to leaching from SuDS features will be addressed through the CAR process.
Note	For drainage network S5, to reduce the impact on water quality for the aquifer supplying the South Aviemore Public Water Supply, all filter drains will be lined.
SMC-G14	To ensure that no polluted water percolates into the ground or contaminated run-off is generated: Where required, storage of excavated soils and made ground will be minimised on site (spatially and in duration) and all storage areas will be appropriately lined, with adequate drainage management in place.
SMC-G15	To minimise or control the impact of blasting on bedrock geology and to limit the risk to identified geodiversity sites - risk assessments will be required before explosives can be used on site.
SMC-G16	To minimise or control the impact of blasting on the bedrock aquifer. Blasting physically disturbs a rock face. It can cause geological instabilities which may affect the aquifer by altering groundwater flow paths/flow direction. Risk assessments will be required before explosives can be used on site. The blast design will seek to minimise any potential disturbance.
Note	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. 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).
P11-G17	To monitor potential construction pollution at the South Aviemore groundwater and PWS Slochd 2 and 3 abstractions: A programme of monitoring (water quality sampling) will be undertaken. The frequency and duration of sampling and the water quality parameters to be tested will be agreed with the landowners/users, SEPA and The Highland Council. Contingency plans will be drawn up to provide an alternative water supply in the unlikely event of a pollution incident.

Mitigation Item	Description
Note	To minimise the impact of potential construction pollution at the south Aviemore Public Supply boreholes any planned works or activity within 500m of the abstraction borehole assets must be notified to Scottish Water at least 30 days in advance of the works commencing with detailed method statements of any works/activities included. Extra treatment equipment to be on standby at any works - such as portable sediment removal kits. Filter drains will be lined in the vicinity of the abstraction boreholes and their catchment area, SuDS features will also be lined to prevent infiltration.
P11-G18	To minimise disruption to the private water supplies at PWS Slochd 2 and PWS Slochd 3 the Contractor will: - accurately locate and map supply lines prior to construction; - take measures to prevent damage to supply lines and to avoid pollution during supply line diversions, excavations and groundworks; - provide an alternative water supply if supply lines are to be temporarily disrupted by the works; and - consult with the owners/users of the affected private water supplies to ensure the effects of any disruption are minimised.
P11-G19	To avoid impacts on groundwater quality from operational routine runoff the contractor will: - revisit the Method C assessment for the proposed filter drains as more detailed GI and groundwater level data becomes available at detailed design; - should the Method C assessment indicate there is a Medium to High Risk to groundwater, further site specific assessment will be carried out; and - if it is concluded that groundwater quality impacts are likely, the proposed filter drains will be lined or alternative appropriate mitigations implemented. Any potential water quality impacts due to leaching from SuDS features will be addressed through the CAR process.
P11-G20	To avoid impacts to groundwater flows and levels: Further ground investigations, groundwater monitoring and assessment will be carried out pre-construction and during construction across the scheme to enable the refinement of the groundwater assessment, additional focus will be on the cuttings assessed as having a potentially significant impact on groundwater levels and flows, namely Cuttings 1, 2, 3, 5, 6, 10, 11, 12, 15, 18, 19, 27, 83, 93, 95, 100, 101, 102, 104, 105, 154, 167, 183, 184, 186, 332 and 373. If the impacts are confirmed as significant, additional mitigation measures may be required, such as containing, channelling and directing groundwater to the down gradient side of the cutting, allowing the discharge to infiltrate back to ground. The potential volume of groundwater seeping into the above cuttings will also be considered in relation to the design of the cutting drainage and potential groundwater abstraction CAR licensing. Ground and surface water monitoring will be required to monitor any changes adjacent to and at Pond 4 during construction due to its close proximity to the scheme.
P11-G21	To mitigate any impacts on GWDTEs: Pre-construction groundwater monitoring will be carried out at a representative sample of high and moderate groundwater dependency GWDTEs to determine whether they are true GWDTEs. This will comprise a minimum of ten samples over a six month period, with at least five taken during the summer period. Where GWDTEs will be affected by groundwater drawdown in the vicinity of cuttings, any groundwater entering cuttings will be directed to the down gradient side and allowed to infiltrate. Where possible the location and frequency of

Mitigation Item	Description
	these discharges will be designed to replicate the natural groundwater flow as closely as possible. Where GWDTES are located downslope of proposed road embankments, permeable fill material will be used in the embankment construction wherever possible, to maintain groundwater flows. Cross formation drains will be used where practicable to facilitate groundwater through flow. Should a spring issue within the footprint of the scheme this will be dealt with using standard construction practice, however the outflow will be located where it is able to feed the same downslope GWDTE habitat wherever possible. The precise design mitigation for each GWDTE will be devised during the detailed design stage. Monitoring during construction to be determined in consultation with SEPA. Post-construction monitoring will be carried out (a minimum of ten measurements over a twelve month period, for a minimum of three years) until it is demonstrated that receptors are not impacted. Should post-construction monitoring reveal residual impacts, consultation with SEPA will be carried out to determine feasible mitigation measures.
P11-G22	To reduce impacts on soil and peat loss through peat re-use: The Peat Management Plan will be revised and refined during detailed design. At present it is proposed that all soil and peat excavated as part of the Proposed Scheme will be re-used for on-site landscaping purposes, with no excess peat identified. This should continue to be the preferred reuse option. Should the refined design identify an excess of peat, consideration should be given to additional reuse options, both onsite and offsite in preference to disposal. Consultation with landowners and statutory stakeholders will continue to confirm where peat will be stored and re-used as part of the pre-construction phase. Information on WML requirements should be provided by the contractor at detailed design stage as part of the detailed Soil and Peat Management Plan to ensure compliance for any temporary storage, transportation and re-use of soil and peat on-site.
P11-G23	To prevent pollution impacts on the water environment from the temporary storage and handling of soil and peat: Where soil and peat needs to be temporarily stored and/or naturally dried within the scheme area, pollution prevention requirements will be considered to avoid impacts to surface and groundwater bodies and to comply with '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 relevant waste management practices under The Waste Management Licensing (Scotland) Regulations 2011. This includes the standard and specific mitigation items included within this chapter and Chapter 11, including: - SMC-G10 - To comply with relevant waste management practices under The Waste Management Licensing (Scotland) Regulations 2011 and reduce impacts on peatlands; - SMC-G14 **-** To ensure that no polluted water percolates into the ground or contaminated run-off is generated; - SMC-W4 **-** In relation to construction site runoff and sedimentation, the Contractor will adhere to GPPs/PGGs (SEPA, 2006-2017) and other good practice guidance (Table 11.1); and - P11-W18 Prior to construction the Contractor shall produce a Surface Water Management Plan (SWMP) (or similar such document) that will be submitted to SEPA for approval as part of the CAR authorisation process for site discharges.
P11-G24	To maximise areas of accessible rock exposure for identified geodiversity sites, thereby ensuring maintenance of their national importance as key scientific resources.

Mitigation Item	Description
	In relation to earthworks proposals that concern the excavation, trimming and stabilisation of rock faces of national importance (SSSI/GCR), the Contractor will adhere to best practice guidance in the conservation of the rock faces, minimizing areas of rock exposure lost beneath concrete, netting/mesh and walling, providing rock faces that can be accessible for research, subject to health and safety risk assessment and due consideration of trunk road operations.

10.6. Residual Impacts

10.6.1. A summary of the impact assessment for the Proposed Scheme is provided in Table 10.48 below. It should be noted that the impact significance stated in the table represents the residual impact, taking into account the mitigation discussed above. As such there may be differences in the significance ratings listed compared with those discussed in the Section 10.4 Potential Impacts.

Table 10.48: Summary of Residual Impacts

Sub-topic	Receptor	Potential Impact	Impact Significance (Residual Impacts)
Construction Impacts			
Construction Pollution	Dava Bedrock – Psammite, Gneissose	Reduction in water quality	Slight
	Findhorn Pluton Bedrock – Granodiorite, biotite		
	Devensian Till Peat		Neutral
	Glaciofluvial Sheet deposits Glaciofluvial Ice Contact Deposits		Neutral
	Alluvial Fan Deposits Alluvium Undifferentiated River Terrace Deposits		
	South Aviemore Public Water Supply		Neutral
	PWS Baddengorm		
	PWS Slochd 1		
	PWS Slochd 2		Slight
	PWS Slochd 3		Neutral
Mobilisation of historic contamination	Groundwater, surface water, ecosystems, buildings and crops, ecosystems	Mobilisation of pollutants into groundwater / surface water	Minor beneficial

Sub-topic	Receptor	Potential Impact	Impact Significance (Residual Impacts)
	Drivers & NMUs, local residents, livestock, pets & wildlife within ecosystems	Direct contact with / ingestion of / inhalation of soil, soil dust, vapours, ground gas	Neutral
	Buildings & crops, site infrastructure	Direct contact with contaminants	Neutral
	Local Residents, buildings & crops, site infrastructure	Migration of soil gas	Neutral
Groundwater*	South Aviemore Public Water Supply	Loss or change to supply	Slight
	PWS Baddengorm		Neutral
	PWS Slochd 1		
	PWS Slochd 2		
	PWS Slochd 3		Slight
Operational Impacts			
Geodiversity	Geological deposits (general)	Loss of geodiversity sites	Neutral
Economic minerals	Superficial deposits	Loss of economic minerals	Neutral
	Granish Quarry		Neutral
Soils & Peat	LCA Class 3 & 4	Loss of soils	Slight
	LCA Class 5, 6 & 7		Neutral
	SNH Peat Class 1	Loss of peat	Slight
	SNH Peat Class 3		
	SNH Peat Class 5		Neutral
	SNH Peat Class 0 and 4		
Groundwater*	Slochd Psammite	Changes to water quality from routine runoff	Neutral
	Devensian Till Hummocky (Moundy) Glacial Deposits Peat		
	Glaciofluvial Sheet deposits Glaciofluvial Ice Contact Deposits		
	Alluvial Fan Deposits Alluvium		
	PWS Baddengorm		
	PWS Slochd 1		
	PWS Slochd 2		
	PWS Slochd 3		

Sub-topic	Receptor	Potential Impact	Impact Significance (Residual Impacts)
	Slochd Psammite	Loss or change to groundwater flow	Minor
	Devensian Till Hummocky (Moundy) Glacial Deposits Peat		Neutral
	Glaciofluvial Sheet deposits Glaciofluvial Ice Contact Deposits		Minor
	Alluvial Fan Deposits Alluvium		Minor
	South Aviemore Public Water Supply	Changes to water quality from routine runoff	Neutral
	GWDTEs (overall)	Loss of GWDTEs / Loss of Biodiversity	Slight
Allt Chriochaidh Caochan Ruadh Loch Puladdern Feith Mhor Slochd Mhuic	(overall)	Loss or change to baseflow	Slight
Mobilisation of historic contamination	Groundwater, surface water, ecosystems, buildings and crops, ecosystems	Mobilisation of pollutants into groundwater / surface water	Minor beneficial
	Drivers & NMUs, local residents, livestock, pets & wildlife within ecosystems	Direct contact with / ingestion of / inhalation of soil, soil dust, vapours, ground gas	Neutral
	Buildings & crops, site infrastructure	Direct contact with contaminants	Neutral
	Local Residents, buildings & crops, site infrastructure	Migration of soil gas	Neutral

*The groundwater assessment is based on limited groundwater monitoring data collected as part of the Dalraddy to Slochd Stage 2 ground investigation.

10.6.2. There is recognition that a number of individual GWDTE locations may have a localised significant impact (approximating 0.75% of the overall study area), ranging up to Very Large significance, however, taking into context DMRB guidance, the scale of the Proposed Scheme and mitigation/monitoring commitments, the overall impact on GWDTE receptors across the Proposed Scheme has been evaluated as Slight adverse. Further GWDTE information is provided in Appendix 10.4.

10.6.3. It is recognised that the potential operational impact on the previously identified sites of geodiversity interest is moderate/large for The Slochd and the gneissose metamorphic formations. However, it is also acknowledged that there may be a net major beneficial impact as the excavation of fresh cuttings may enhance the geodiversity interest through the provision of fresh exposures. This gives an overall residual impact of neutral.

10.6.4. The assessment concludes that there are no residual significant impacts predicted, with the largest impact of Slight Adverse predicted.

10.6.5. With regards to the mobilisation of historical contamination, the above Table 10.48 provides an overview of the likely residual effects. The potential pollutant linkages identified at baseline have been reassessed for the construction phase incorporating the recommended mitigation measures and a comparison of the risk outcomes at each stage has been made to give an indication of the significance. The updated CSM showing the outcome of this process is shown in Table 10.49 below and is summarised in Table 10.48 above.

10.6.6. As stated earlier, operational phase effects are considered to be similar to those identified for the baseline and Table 10.49 reflects this.

Table 10.49: Risk Evaluation of Plausible Pollutant Linkages – Construction with Mitigation Measures

Hazard Identification	Hazard Assessment		Risk Estimation – Construction with Mitigation		Risk evaluation – Construction with Mitigation	Baseline Risk evaluation	Impact Significance
Contaminant Source	Pathway	Receptor	Consequence of Risk being realised	Probability of Risk being realised	Classification		
S1 Potentially contaminated ground / waters located within Proposed Footprint – Railway, infilled pits / quarries, agricultural use	P1 – Direct Contact with soil / soil derived dust and groundwater	R3 - Drivers & NMUs	Medium	Unlikely	Low	Low	Neutral
		R4 – Local Residents	Medium	Unlikely	Low	Low	Neutral
		R5 – Ecosystems	Medium	Unlikely	Low	Low	Neutral
		R6 – Buildings & Crops	Mild	Unlikely	Very Low	Very Low	Neutral
		R7 – Livestock, Pets & Wildlife	Mild	Unlikely	Very Low	Very Low	Neutral
		R8 – Site Infrastructure	Mild	Likely	Moderate / Low	Moderate / Low	Neutral
Contamination identified from ground investigation	P2 – Ingestion of soil / derived soil dust and groundwater	R3 – Drivers & NMUs	Medium	Unlikely	Low	Low	Neutral
		R4 – Local Residents	Medium	Unlikely	Low	Low	Neutral
		R5 – Ecosystems	Medium	Unlikely	Low	Low	Neutral
		R7 – Livestock, Pets & Wildlife	Mild	Unlikely	Very Low	Very Low	Neutral
	P3 – Inhalation of fugitive soil dust and fibres	R3 – Drivers & NMUs	Medium	Unlikely	Low	Low	Neutral
		R4 – Local Residents	Medium	Unlikely	Low	Low	Neutral
		R5 – Ecosystems	Medium	Unlikely	Low	Low	Neutral
		R7 – Livestock, Pets & Wildlife	Mild	Unlikely	Very Low	Very Low	Neutral
		R3 – Drivers & NMUs	Medium	Unlikely	Low	Low	Neutral
		R4 – Local Residents	Medium	Unlikely	Low	Low	Neutral

Hazard Identification	Hazard Assessment		Risk Estimation – Construction with Mitigation		Risk evaluation – Construction with Mitigation	Baseline Risk evaluation	Impact Significance
Contaminant Source	Pathway	Receptor	Consequence of Risk being realised	Probability of Risk being realised	Classification		
	P4 – Inhalation of vapours / soil gas	R5 - Ecosystems	Mild	Unlikely	Very Low	Very Low	Neutral
		R7 – Livestock, Pets & Wildlife	Mild	Unlikely	Very Low	Very Low	Neutral
	P5 – Leaching and vertical / lateral migration of contaminants	R1 – Superficial Aquifer	Medium	Unlikely	Low	Moderate / Low	Minor beneficial
		R2 – Surface Water	Medium	Unlikely	Low	Moderate / Low	Minor beneficial
		R5 - Ecosystems	Mild	Unlikely	Very Low	Low	Minor beneficial
		R6 – Buildings and Crops	Mild	Unlikely	Very Low	Low	Minor beneficial
		R8 – Site Infrastructure	Mild	Unlikely	Very Low	Low	Minor beneficial
	P6 – Vertical and lateral migration of soil gas	R3 – Drivers & NMUs	Severe	Unlikely	Moderate / Low	Moderate / Low	Neutral
		R4 – Local Residents	Severe	Unlikely	Moderate / Low	Moderate / Low	Neutral
		R6 – Buildings (crops unaffected)	Severe	Unlikely	Moderate / Low	Moderate / Low	Neutral
		R8 – Site Infrastructure	Severe	Unlikely	Moderate / Low	Moderate / Low	Neutral

Hazard Identification	Hazard Assessment		Risk Estimation – Construction with Mitigation		Risk evaluation – Construction with Mitigation	Baseline Risk evaluation	Impact Significance
Contaminant Source	Pathway	Receptor	Consequence of Risk being realised	Probability of Risk being realised	Classification		
S2 Potentially Contaminated Ground / Waters located outwith proposed footprint but within 250m of Proposed Footprint	P1 – Direct Contact with soil / soil derived dust	R3 - Drivers & NMUs	Medium	Unlikely	Low	Low	Neutral
	P5 – Leaching and vertical / lateral migration of contaminants	R1 – Superficial Aquifer	Medium	Low	Moderate / Low	Moderate / Low	Neutral
		R2 – Surface Water	Medium	Low	Moderate / Low	Moderate / Low	Neutral
	P6 – Vertical and lateral migration of soil gas	R3 – Drivers & NMUs	Severe	Unlikely	Moderate / Low	Moderate / Low	Neutral
		R8 – Site Infrastructure	Severe	Unlikely	Moderate / Low	Moderate / Low	Neutral

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