13. Geology, Soils, Groundwater and Land Contamination

Summary

This chapter considers the potential impacts and effects of the A9 Dualling: Pass of Birnam to Tay Crossing scheme (hereafter referred to as the proposed scheme) on geology, soils, groundwater and land contamination.

The assessment has been informed by consultation and desk-based assessments, including the review of ground investigation data. This process established that no designated Geological Receptors, Sites of Special Scientific Interest (SSSI) and Geological Conservation Review sites fall within the study area. One Special Area of Conservation (SAC) was noted within the study area associated with the River Tay, although not designated for its geological features. Superficial deposits were primarily alluvium, alluvial fan deposits, river terrace deposits, glaciofluvial deposits and Devensian – Diamicton glacial till. The underlying bedrock geology was primarily composed of low grade metamorphic rock of Dalradian age (Southern Highland Group) with sedimentary bedrock of Devonian age (Arbuthnott-Garvock Group) recorded to the southern section of the study area.

The study area is underlain by the Isla and Lower Tay Sand and Gravel Aquifer (superficial deposits), the Tummel and Tay Sand and Gravel Aquifer (superficial deposits), the Bankfoot aquifer (bedrock) and the Killin, Aberfeldy, and Angus Glens aquifer (bedrock). Of the four aquifers, the Killin, Aberfeldy and Angus Glens Aquifer, and the Tummel and Tay Sands aquifers are classified as of a Good status by SEPA, while the Bankfoot aquifer and the Isla and Lower Tay Sand and Gravel aquifer are classified as of a Poor status. The Bankfoot aquifer and the Isla and Lower Tay Sand and Gravel aquifers are both locally important while the Tummel and Tay Sand and Gravel aquifer has local potential, and the Killin, Aberfeldy and Angus Glens aquifer has low productivity. Potential groundwater associated receptors are also identified within the study area, including the River Tay, the Inchewan Burn and numerous small unnamed streams. No groundwater dependant terrestrial ecosystems (GWDTE) nor Groundwater Abstractions were identified in proximity to the proposed scheme. However, an area of bog and bog woodland was recorded at the Muir of Thorn to the south of the scheme. These habitats have the potential to constitute GWDTE, however no further surveys have been undertaken as these areas will not be impacted by construction activities.

Seven potential sources of land contamination were identified within the boundaries of the site (on-site) including the existing A9, and potentially infilled ground (curling pond and gravel pit). A further ten potential sources of land contamination have been identified within 250m of the boundaries of the site (off-site) including industry (e.g. factories or garages), utilities such as sewage works, gas works and Ladywell Landfill. Four receptor types were identified for human health, three receptor types were identified for the Water Environment and one receptor type were identified each for property and ecology.

The impact assessment was designed to assess the significance of both direct and indirect (groundwater dewatering) effects from the proposed scheme. Minor groundwater dewatering impacts are predicted, and as such the effect on groundwater flow is expected to be of Slight significance. The construction of new structures and associated sheet pile walls and other piles could potentially create new vertical or horizontal flow paths for pollutant migration, as such the effect on groundwater quality is expected to be of Slight significance. Both the superficial aquifers and bedrock aquifers may be at risk of water quality impairment due to accidental spillage during both construction and operation phases, the impact is expected to be of Slight to Large significance. As part of the construction of the proposed scheme, removal of peaty soils are expected to be limited resulting in a potential impact of Slight significance. There will be direct and indirect disturbance of potential sources of Land Contamination with potential impacts ranging between of Moderate to Neutral significance.

Following the implementation of proposed mitigation measures, residual effects remain. In relation to land contamination issues mitigation is expected to reduce potential residual effects to Slight significance during construction and Neutral significance during operation. Localised residual effects of Slight significance are expected on groundwater flow within superficial and bedrock deposits. Implementation of mitigation in relation to the protection of the groundwater environment against pollution incidents is expected to reduce the potential impacts on groundwater quality and associated receptors to a residual effect of Slight and Neutral significance (respectively). Residual effects on surface water receptors from indirect dewatering are expected to be Neutral to Slight significance.

13.1 Introduction

13.1.1 This chapter presents the assessment of potential significant effects on Geology, Soil, Groundwater and Land Contamination as a result of the A9 Dualling: Pass of Birnam to Tay Crossing scheme, Hereafter referred to as the 'proposed scheme'. A detailed description of the proposed scheme is presented in Chapter 6 (The Proposed Scheme).

13.1.2 The DMRB Stage 3 assessment focuses on potential impacts to bedrock and superficial geology, mineral extraction, soils, groundwater, associated groundwater receptors including Groundwater Dependent Terrestrial Ecosystems (GWDTE) and private water supplies (PWS); and land contamination. The assessment has been undertaken with reference to the Design Manual for Roads and Bridges (DMRB) LA 104, DMRB LA 109 and DMRB LA 113 guidance from Highways England et. al (2020a, 2019 and 2020b). Additionally, the assessment takes cognisance of the Water Framework Directive and aligns with the UKTAG guidance (UKTAG, 2005). The UKTAG guidance brings together the degree of groundwater dependency (low, moderate, high), and the level of ecological designation / protection of a site to determine the overall importance of potential GWDTE.

13.1.3 Geological impacts can occur due to excavating or masking exposures of rocks or superficial geological deposits of particular scientific interest, particularly if the features of interest are not reproduced elsewhere, nationally or regionally. Impacts can also include restrictions on existing or potential commercial exploitation of resources, and conversely previous exploitation of resources can impose constraints on the proposed scheme; for example, where land has become unstable due to mining or has been contaminated by previous land uses. It

is also recognised that rock exposures can deliver some environmental benefit, such as improved access to, and exposure of, new areas of geological interest.

13.1.4 During construction, there is an inherent risk of spillage or leakage of fuel or oil from storage tanks or construction plant. Without suitable mitigation measures, these pollutants could enter superficial and bedrock aquifers and cause degradation of water quality. Construction work can also lead to the dewatering of these aquifers which may cause differential settlement effects and impact sensitive receptors such as water supplies or wetlands.

13.1.5 Similarly, during operation of the proposed scheme, runoff from the road surface may contain elevated concentrations of pollutants, such as oils, suspended solids, metals, engine coolants (e.g. ethylene glycol) and, in winter, salt which may find their way into the groundwater system. Groundwater flows can also be intercepted or altered by new cuttings and other significant changes to landform.

13.1.6 The assessment is supported by the following appendices:

- Appendix A13.1: Land Contamination Supporting Information;
- Appendix A13.2: Potential Impacts on Infrastructure, Properties and Cultural Heritage from Groundwater Dewatering; and
- Appendix A13.3: Surface Water Indirect Dewatering Assessment.

13.1.7 The assessment is further supported by the following figures, which are cross-referenced where relevant:

- Figure 13.1(a-e): Land Capability for Agriculture Classifications;
- Figure 13.2(a-d): Private Water Supplies and Geological Constraints; and
- Figure 13.3(a-d): Potential Land Contamination Sources.

13.1.8 This chapter makes reference to Chapter 12 (Biodiversity), Chapter 14 (Material Assets and Waste), Chapter 16 (Population - Land Use) and Chapter 19 (Road Drainage and the Water Environment. The potential impacts on the economic value of agricultural soils are assessed within Chapter 16 (Population – Land Use). The potential impacts on geological resources with respect to their value as a raw material are assessed within Chapter 14 (Material Assets and Waste).

Legislative and Policy Context

13.1.9 The assessment of geology, soils, groundwater and land contamination reported in this EIAR has been undertaken to satisfy the Roads (Scotland) Act 1984 (Environmental Impact Assessment) Regulations 2017, which require that an EIA identifies, describes and assesses the direct and indirect significant effects of the project on environmental factors including 'land, soil and water' (Regulation 5, Section 20B (3) and Schedule 1A).

13.1.10 The assessment takes cognisance of relevant legislation, policy, guidance and regulations, including those listed in Table 13.1. Relevant documents will be referred to throughout this chapter and all will be noted in the references (Section 13.9).

Table 13.1: Key Legislation, Policy, Guidance and Regulations

Topic	Name of Relevant Legislation, policy, Guidance and Regulations
Legislation	▪ The Roads (Scotland) Act 1984 (Environmental Impact Assessment) Regulations 2017 (Scottish Government, 2017a); ▪ EU Water Framework Directive (2000/60/EC) (European Commission, 2000); ▪ Groundwater Daughter Directive (2006/118/EC) (European Commission, 2006); ▪ Water Environment Water Services (WEWS Act) (Scotland) Act 2003 (Scottish Government, 2003); ▪ The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended) (CAR) (Scottish Government, 2011a); ▪ The Water Environment (Miscellaneous) (Scotland) Regulations 2017 (Scottish Government, 2017b); ▪ Environment Act 1995 (UK Government, 1995); ▪ Part IIA of the Environmental Protection Act 1990 (Scottish Executive, 2006); and ▪ The Contaminated Land (Scotland) Regulations 2005 (Scottish Government, 2005).
Policy	▪ The Water Environment (Controlled Activities) (Scotland) Regulations. A Practical Guide v9.4 (SEPA, 2024); and ▪ National Planning Framework 4 (Scottish Government, 2023).
Key Guidance and Standards	▪ DMRB LA 104: Environment assessment and monitoring (formerly HA 205/08, HD 48/08, IAN 125/15, and IAN 133/10), Revision 1 (Highways England, Transport Scotland, Welsh Government and The Department for Infrastructure Northern Ireland, 2020a), hereby referred to as DMRB LA 104; ▪ DMRB LA 109: Geology and Soils (formerly DMRB Volume 11, Sections 3, Parts 6 (Land Use) and 11 (Geology and Soils), Revision 0 (Highways England, Transport Scotland, Welsh Government and The Department for Infrastructure Northern Ireland, 2019), hereby referred to as DMRB LA 109; ▪ DMRB LA 113: Road Drainage and the Water Environment (formerly HD 45/09), Revision 0 (Highways England, Transport Scotland, Welsh Government and The Department for Infrastructure Northern Ireland, 2020b), hereby referred to as DMRB LA 113; ▪ UK Technical Advisory Group on the Water Framework Directive - Draft Protocol for Determining 'Significant Damage' to a Groundwater Dependent Terrestrial Ecosystem (UKTAG, 2005) ▪ SEPA The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended) A Practical Guide (SEPA, 2024); ▪ SEPA Position Statement (WAT-PS-10-01) (SEPA, 2014); ▪ SEPA Supporting Guidance (WAT-SG-53) (SEPA, 2020);

Topic	Name of Relevant Legislation, policy, Guidance and Regulations
	▪ SEPA Regulatory Method (WAT-RM-11) (SEPA, 2017a); ▪ SEPA Land Use Planning System (LUPS) Guidance Note 31: Guidance on assessing the impacts of development proposals on groundwater abstractions and groundwater dependant terrestrial ecosystems (SEPA, 2017b); ▪ CIRIA C532: Control of water pollution from construction sites (CIRIA, 2001a); ▪ C552: Contaminated Land Risk Assessment: A guide to good practice (CIRIA, 2001b); ▪ Land contamination: risk management (LCRM) (EA, 2023); ▪ BS 10175:2011 + A2:2017 (BSI, 2017); ▪ Planning Advice Note (PAN) 33: Development of Contaminated Land (Scottish Government, 2017); and ▪ Contaminated Land Statutory Guidance (DEFRA, 2012).

13.1.11 Areas of key legislation and policies of relevance to the overall proposed scheme are further described in the Appendix A3.1 (Assessment of Policy Compliance).

13.2 Approach and Methods

Study Area

13.2.1 As shown in Figures 13.1, 13.2 and 13.3, the assessment study area extends 250 m from the boundaries of the site (BotS) of the proposed scheme. The BotS includes all design aspects of the proposed scheme and any areas that are likely/expected to be required for construction. DMRB LA 109 does not specify a study area, stating that it should be based on project specific considerations. The addition of the 250 m buffer to the BotS of the proposed scheme is based on the Guidance for the Safe Development of Housing on Land Affected by Contamination (NHBC, EA and CIEH, 2008). As such, the assessment study area is a conservative, but sensible approach in the context of the proposed scheme, taking into account the distance over which contamination can migrate.

13.2.2 In line with DMRB LA 113 and as agreed with SEPA, the study area for the consideration of Groundwater Dependant Terrestrial Ecosystems (GWDTE) extended 100 m from the existing A9 carriageway with the option to extend this boundary should the dewatering impact assessment require so.

13.2.3 Impacts and effects on groundwater abstractions within 1.2 km of the BotS have been assessed. Typically, the minimum study area to be applied for groundwater abstraction licensing is 850 m under The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended) (Scottish Government, 2011a) and based on "Regulatory Method (WAT-RM-11) Abstraction from Groundwater V6" (SEPA, 2017a). However, following consultation with SEPA regarding the A9 Dualling: Pass of Birnam to Tay Crossing Scoping Report for DMRB Stage 3 EIA (Transport Scotland, 2024), it was agreed, given the high productivity of the superficial aquifer in the construction areas along the River Tay and the possibility of a large

volume of dewatering being required (possibly in excess of 500m^3/d), the study area would be expanded to 1.2 km for abstractions.

Baseline Conditions

13.2.4 Baseline conditions cover the following aspects of ground conditions:

- soil resources;
- bedrock and superficial geology;
- features of geological importance;
- mineral extraction;
- groundwater environment including PWS, GWDTE and baseflow to surface water features; and
- land contamination.

13.2.5 Baseline conditions were determined through desk-based assessment, consultation with landowners and statutory and non-statutory bodies, targeted site surveys and ground investigations.

Desk-based Assessment

13.2.6 The desk-based assessment included a review of the following information:

- British Geological Survey (BGS) data including BGS Superficial and Bedrock Geological Maps, BGS Hydrogeological and Groundwater Vulnerability Maps, BGS Geoindex (BGS, 2025) (http://mapapps2.bgs.ac.uk/geoindex/home.html) and other relevant BGS publications (BGS, 1988; 1995)).
- Macaulay Institute for Soil Research (The James Hutton Institute), Aberdeen 1981, Soil Survey of Scotland Map, Sheet 5, Eastern Scotland, 1981 viewed on the Scotland's soils website (Scotland's soils, 2018) (The James Hutton Institute, 1982).
- Ordnance Survey (OS) historic maps dating back to 1866 for information on former land use, any potential contamination and physical hazards and information on PWS (Landmark Information Group, 2015).
- Landmark Envirocheck Report (Landmark Information Group, 2015).
- Scottish Environment Protection Agency's (SEPA) Groundwater Vulnerability Maps, the interactive Water Environment Hub (SEPA, 2024) and the interactive Water Classification Hub (SEPA, 2025).
- NatureScot SNHi data services (SiteLink - Map Search) (NatureScot, 2025).
- Scottish Natural Heritage (SNH) (now named NatureScot) (2016) Carbon-rich soils, deep peat and priority peatland habitat mapping, Consultation analysis report (NatureScot, 2016) as viewed on Scotland's Soil Interactive Map Viewer (Scotland's Soils, 2023).
- Scotland's Environment Web (Scottish Government, 2025) (https://www.environment.gov.scot/).

- James Hutton Land Capability for Agriculture (LCA) (The James Hutton Institute, 2025) (Land Capability for Agriculture (LCA) - James Hutton Institute).
- UK Soil Observatory Map Data (UK Soil Observatory, 2025) (UK Soil Observatory).
- Mining Remediation Authority, Interactive Map Viewer (Mining Remediation Authority, 2025) (Mining Remediation Authority Map Viewer).
- Previous assessments:
  - AECOM, A9 Dualling: Pass of Birnam to Tay Crossing Ground Investigation Report Final Revision 03 (AECOM, 2016).
  - Scott Wilson, A9 Pass of Birnam to Tay Crossing Preliminary Sources Study Report (Scott Wilson, 2011).
  - Jacobs, A9 Dualling Perth to Inverness, Geotechnical Preliminary Sources Study Report, Tay Crossing to Pitlochry, Chainage 22800 to 36300m (Jacobs, 2013a).
  - Jacobs, A9 Dualling Perth to Inverness, Geotechnical Preliminary Sources Study Report, Birnam, Chainage 13000 to 14700m (Jacobs, 2013b).
  - Transport Scotland, A9 Route Improvement Strategy – Dualling of Birnam to Tay Crossing, Stage 2 Options Assessment Report, Part 2 Environmental Assessment, Volume 1 Environmental Report, Volume 2 Figures, Volume 3 Appendix, June 2011 (Transport Scotland, 2011).
  - Transport Scotland A9 Dualling Programme: Strategic Environmental Assessment (SEA) (Transport Scotland, 2013a, 2014a and 2014b).
  - Transport Scotland A9 Dualling Programme: Strategic Environmental Assessment – Environmental Report (June 2013). Non-technical Summary (a9 - sea -er - non-tech summary for publication.pdf) (Transport Scotland, 2013b)

Consultation

13.2.7 Consultations have been undertaken with a number of statutory and non-statutory bodies. These include the following:

- Consultation with SEPA was undertaken in March 2015 and May 2024, for information on licenced groundwater abstractions (via The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended)) and on former and current contaminated land use.
- Consultation with Perth & Kinross Council (PKC) was undertaken in March 2015, and May 2024 for information on former contaminated land use, Part IIA legislative led determinations, PWS, licensed fuel storage and any additional relevant information. No further relevant data was received from PKC following the May 2024 consultation.
- NatureScot was consulted in June 2024 for information on the location and extent of environmental sensitivities in the vicinity of the proposed scheme and to establish any future development constraints.
- Consultation with Private property/landowners was undertaken in August 2015 and June 2024, to identify presence of PWS, septic tanks and soakaways and obtain information on water source location and type, water storage, treatment and intended use.

13.2.8 The responses received from the consultations have been included is the assessments as appropriate. Further information on the consultation process is provided in Chapter 7 (Consultation and Scoping).

Site Walkover and Surveys

13.2.9 A site walkover was undertaken on 13 September 2018 to obtain further information on Ladywell Landfill. Various site visits also took place between May 2024 and October 2024 to obtain further information on targeted PWS and septic tanks.

Ground Investigation

13.2.10 Eight phases of Ground Investigation (GI) associated with the A9 Dualling project have been undertaken within the study area as detailed in Table 13.2. The first was designed by AECOM and undertaken in 2014/2015 by Soil Engineering. The seven subsequent GIs were designed by Jacobs and undertaken by Fugro Geoservices Limited and Soil Engineering.

Table 13.2: Ground Investigation Timeline and Summary

Report Reference	Soil Engineering (2015)	Fugro (2016a)	Fugro (2016b)	Fugro (2018)	Fugro (2019)	Soil Engineering (2019)	Soil Engineering (2021)	Soil Engineering (2023)
Designer	AECOM	Jacobs						
Drilling Contractor	Soil Engineering	Fugro Geoservices Limited				Soil Engineering		
Date Undertaken	June 2014 - February 2015	August – December 2015		October – December 2016	February – April 2018	January 2019	February 2019	February – March 2020
Total No. of Boreholes	310	6	6 within P02 study area	6 within P02 study area	16 within P02 study area	44	0 within P02 study area	74
Cable Percussion (CP)	275	0	3 within P02 study area	2 within P02 study area	5 within P02 study area	0	0 within P02 study area	22
Rotary Coring (RC)	146 (111 follow on from CP)	1 (follow on from SD)	3 within P02 study area (follow on from SD)	28 within P02 study area	6 within P02 study area	4	0 within P02 study area	14
Sonic Drilled (SD)	0	6	3 within P02 study area	2 within P02 study area	5 within P02 study area	0	0 within P02 study area	38
Groundwater and/or Gas Monitoring Locations	64	6	4 within P02 study area	0 within P02 study area	11 within P02 study area	4	0 within P02 study area	55
Data Logger Information	0	0	0	0	0	0	0	9

Report Reference	Soil Engineering (2015)	Fugro (2016a)	Fugro (2016b)	Fugro (2018)	Fugro (2019)	Soil Engineering (2019)	Soil Engineering (2021)	Soil Engineering (2023)
Trial Pits	192	0	0	4 within P02 study area	12 within P02 study area	0	5 within P02 study area	48
Windowless Samples	0	0	0	0	0	0	0	6
Hand Pits	0	0	0	0	0	1	6 within P02 study area	16
Laboratory Testing	Alcontrol Laboratories	Derwentside Environmental Testing Services				Concept Life Sciences (CLS)		Chemtest
Geo-environmental Soil and Groundwater Testing	November 2015	April 2017	May 2017	July 2018	April 2019	October 2020	N/A: No Gas or Groundwater Monitoring locations within P02 study area	April 2022

13.2.11 In addition, historic GI data obtained from BGS exploratory hole records from the 1970s (prior to the construction of the existing A9) and GI data and subsequent monitoring data associated with Ladywell Landfill (provided by PKC) has been reviewed.

13.2.12 Relevant data gathered from all GI have informed this assessment.

Impact Assessment

13.2.13 The assessment of impacts and effects reported in this chapter has been undertaken in accordance with the guidance provided in DMRB LA 104, LA 109 and LA 113 (Highways England et al., 2020a, 2019, 2020b) whereby the level of significance of a potential effect on the existing baseline condition is determined by the value/importance of the receptor/attribute, combined with the magnitude of impact. The criteria outlined in Table 13.3 and Table 13.4 are based on those that have been applied to similar schemes in Scotland and are designed to comply with relevant DMRB and UKTAG guidance.

13.2.14 In relation to soils, appreciation has been given to potential soil conservation value and rarity based on professional judgement, as well as the SNH Carbon and Peatland Map (Scotland's Soils, 2023) and the Macaulay Land Capability for Agriculture (LCA) classification scheme (The James Hutton Institute, 2025).

13.2.15 Impacts on groundwater quality and/or flow may also have direct or indirect effects on groundwater abstractions, ecological receptors with potential groundwater dependency and surface water features. The assessment is undertaken within the context of the Water Framework Directive (WFD) (2000/60/EC) and the Groundwater Daughter Directive (2006/118/EC) (European Commission, 2000 and 2006).

13.2.16 In compliance with DMRB LA 109, a desk study has been undertaken to identify potential sources of contamination associated with current and historic land uses, and pathways to receptors in accordance with Land contamination: risk management (LCRM) (EA, 2023) and BS 10175:2011 + A2:2017 (BSI, 2017). This desk study and land contamination risk assessment is presented in the Preliminary Sources Study Report (PSSR)s (Scott Wilson, 2011; Jacobs, 2013a and 2013b) and subsequently updated in the draft GeAR (Jacobs, 2024a) with the relevant findings summarised in Appendix A13.1 (Land Contamination Supporting Information). The findings from the desk study and land contamination risk assessment presented within Appendix A13.1 have informed the land contamination impact assessment.

Value/Importance

13.2.17 The value/importance of receptors/attributes is assigned in Section 13.3 (Baseline Conditions) and was categorised on a scale of negligible to very high based on professional judgement in accordance with the criteria and examples outlined in Table 13.3.

Magnitude

13.2.18 The magnitude of potential impacts was assessed on a scale of major to negligible/no change for both adverse and beneficial impacts based on the likely effect of the proposed activities, based on professional judgement in accordance with the criteria and examples provided in

Table 13.4. The assessment of magnitude was influenced by the timing, scale, size and duration of changes to the baseline conditions, as well as the likelihood or probability of occurrence.

Table 13.3: Value/Importance criteria

Value/ Importance	Criteria	Examples
Very High	Attribute has a very high importance/ quality and/or rarity on a national and/or international scale.	Geology
		Areas containing very rare geological features considered to be of international importance such as UNESCO World Heritage Sites, UNESCO Global Geoparks, Sites of Special Scientific Interest (SSSI) or Geological Conservation Review (GCR) sites where citations indicate features of international importance.
		Soils
		Soils directly supporting an EU designated site. Land classified as Land Capability for Agricultural (LCA) classes 1 and 2.
		Groundwater
		Groundwater aquifer(s) with very high productivity. Exploitation of groundwater resource is extensive for public, private domestic and/or agricultural use (i.e. feeding ten or more properties) and/or industrial supply. Groundwater feeding GWDTE with a high or moderate groundwater dependence within areas of international or national environmental importance such as Ramsar, SACs, SPAs and Sites of Special Scientific Interest (SSSIs). Urban Community. Buildings of national importance, such as scheduled monuments, critical infrastructure and industrial buildings
		Land Contamination
		Very high sensitivity land use such as residential or allotments. Very high value groundwater body as defined above. Very high value surface water feature as defined in Table 19.5 in Chapter 19 (Road Drainage and the Water Environment). Internationally designated ecological sites. Scheduled Monument/Listed Building.
High		Geology

Value/ Importance	Criteria	Examples
	Attribute has a high importance/ quality and/or rarity on a national scale.	Areas containing geological features considered to be rare and of national importance with little potential for replacement such as SSSI, candidate SSSI, GCR sites or geological sites which meet national designation criterion yet are not designated as such.
		Soils
		Soils directly supporting a UK designated site such as SSSI. Land classified as LCA class 3.1. NatureScot priority peatland Class 1 (nationally important carbon-rich and peaty soils, deep peat and priority peatland habitat likely to be of high conservation value) and Class 2 (nationally important carbon-rich and peaty soils, deep peat and priority peatland habitat likely to be of potentially high conservation value and restoration potential).
		Groundwater
		Groundwater aquifer with moderate/ high productivity. Exploitation of groundwater resource is not extensive (i.e., private domestic and/ or agricultural supply feeding less than ten properties). Localised community. Groundwater feeding GWDTEs with a low groundwater dependence within areas of international or national environmental importance such as Ramsar, SACs, SPAs and SSSIs or groundwater feeding GWDTEs with a high or moderate groundwater dependence within a regional or local environmental importance such as Wildlife Sites and Sites of Interest for Nature Conservation. Buildings of regional importance, such as retail/commercial buildings, community facilities.
		Land Contamination
		High sensitivity land use such as public open space. Proposed scheme construction/maintenance areas. High value groundwater body as defined above.

Value/ Importance	Criteria	Examples
		High value surface water feature as defined in Table 19.5 in Chapter 19 (Road Drainage and the Water Environment).
Medium	Attribute has a medium quality and/or rarity on a regional/local scale	Geology
		Areas containing geological features of regional importance with limited potential for replacement and considered worthy of protection for their educational, research, historic or aesthetic importance, such as Local Geodiversity Sites (LGS)/ Regionally Important Geological Sites (RIGS) or geological sites which meet regional designation criterion yet are not designated as such.
		Soils
		Soils directly supporting a non-statutory designated site such as Local Nature Reserves or Sites of Nature Conservation Importance. Land classified as LCA class 3.2. NatureScot 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).
		Groundwater
		Groundwater aquifer with low productivity. No current known exploitation of groundwater as a resource and aquifer(s) properties make potential exploitation appear unlikely. Individual dwelling. Groundwater feeding GWDTEs with a low groundwater dependence within a regional or local designation such as a Wildlife Sites or Sites of Interest for Nature Conservation or groundwater feeding GWDTEs with a high or moderate groundwater dependence within areas of no environmental designation. Buildings of local importance, such as residential properties.
		Land Contamination
		Medium sensitivity land use such as commercial or industrial.

Value/ Importance	Criteria	Examples
		Medium value groundwater body as defined above. Medium value surface water feature as defined in Table 19.5 in Chapter 19 (Road Drainage and the Water Environment). Structural elements of built environment associated with A9 and adjacent land uses – buried concrete, utility services etc.
Low	Attribute has a low quality and/or rarity on a local scale	Geology
		Sites and geological features of local importance not currently identified as SSSI, GCR or LGS/ RIGS but that may require protection in the future.
		Soils
		Land classified as LCA classes 4.1 to 7. NatureScot 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).
		Groundwater
		Groundwater aquifer with no significant productivity. No known past or present exploitation of groundwater aquifer(s) as a resource. Infrequently used area. Groundwater feeding GWDTEs with a low groundwater dependence within areas of local environmental importance.
		Land Contamination
		Low sensitivity land use such as highways and rail. Low value groundwater body as defined above. Low value surface water feature as defined in Table 19.5 in Chapter 19 (Road Drainage and the Water Environment).
Negligible		Geology

Value/ Importance	Criteria	Examples
		Geological features not currently protected and unlikely to require protection in the future (no geological exposures or little/no local interest).
		Soils
		Previously developed land with little potential to return to agriculture. NatureScot 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)).
		Land Contamination
		Undeveloped surplus land/no sensitive land use proposed.

Table 13.4: Magnitude criteria

Magnitude	Criteria	Examples
Major Adverse	Results in a reduction in the quality and integrity and/or loss of the attribute	Geology
		Partial (greater than 50%) or total loss of a geological feature/designation; detrimental change to quality or integrity or severe damage to key characteristics, features or elements; or where there would be complete severance of a site such as to affect the value of the site/resource.
		Soils
		Physical removal or permanent sealing of soil resource, peatland or agricultural land or where the value of the area would be severely affected. Over 2ha loss/sealing of very high/high value/importance soils or over 10ha loss/sealing of medium to low value/importance soils.
		Groundwater
		Major or irreversible change to groundwater aquifer(s) flow, water level, quality or available yield which endangers the resources currently available. Groundwater resource use / abstraction is irreparably impacted upon, with a major or total loss of an existing supply or supplies. Changes to water table level or quality would result in a major or total change in, or loss of, a groundwater dependent area, where the value of a site would be severely affected. Changes to groundwater aquifer(s) flow, water level and quality would result in major changes to groundwater baseflow 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 effects create significant differential settlement effects on existing infrastructure and buildings leading to extensive repairs required. Short-term (acute) damage to human health (significant harm).
		Land Contamination
		Contamination levels encountered in excess of assessment criteria (for human health, environment and/or property) requiring substantial remediation works or treatment, or qualitative risk assessment identifies one or more high-risk relevant pollutant linkage (as defined in Appendix 13.1 Land Contamination Supporting Information).
Moderate Adverse		Geology

Magnitude	Criteria	Examples
	Results in a measurable change in the quality and integrity and/or the loss of attribute	Partial loss of geological feature/designation, potentially adversely affecting the integrity of the feature/designation; partial loss of and/or damage to key characteristics, features or elements such that the value of the site would be affected, but not to a major degree.
		Soils
		Permanent loss/reduction of one or more soil function(s) and restriction to current or approved future use (e.g. through degradation, compaction, erosion of soil resource). Between 1 and 2ha loss/reduction of very high to high value/importance soils or between 1 and 10ha loss/reduction of medium to low value/importance soils.
		Groundwater
		Moderate long-term or temporary significant changes to groundwater aquifer(s) flow, water level, quality or available yield which results in moderate long term or temporarily significant decrease in resource availability. Groundwater resource use/abstraction is impacted slightly, but existing supplies remain sustainable. Changes to water table level or groundwater 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 baseflow contributions to surface water and/ or alterations in surface water quality, resulting in a moderate shift from baseline conditions upon which the WFD status rests. Dewatering effects create moderate differential settlement effects on existing infrastructure and buildings leading to consideration of undertaking minor repairs. Long-term (chronic) damage to human health (significant harm).
		Land Contamination
		Contamination levels marginally above assessment criteria (for human health environment and/or property) requiring some treatment; or qualitative risk assessment identifies one or more moderate risk relevant pollutant linkage (as defined in Appendix 13.1 Land Contamination Supporting Information).
Minor Adverse	Results in a minor measurable change in the	Geology
		Geology: minor measurable change (up to 15%) in geological feature/designation attributes, quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements.

Magnitude	Criteria	Examples
	quality or vulnerability of attribute	Soils
		Temporary loss/reduction of one or more soil function(s) and restriction to current or approved future use (for example through degradation, compaction, erosion of soil resource).
		Groundwater
		Minor changes to groundwater aquifer(s) flow, water level, quality or available yield leading to a noticeable change, confined largely to the scheme area. Changes to water table level, groundwater quality and yield result in little discernible change to existing resource use. Changes to water table level or groundwater 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 baseflow 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 effects create minor differential settlement effects on existing infrastructure and buildings which may need to be monitored but where repairs may be avoidable. No significant impact or harm to human health based on the potential effects on the critical human health receptor.
		Land Contamination
		Contamination levels marginally above assessment criteria (for human health environment and/or property) and minor remediation/mitigation works required; or qualitative risk assessment identifies one or more low-risk relevant pollutant linkage (as defined in Appendix 13.1 Land Contamination Supporting Information).
Negligible	Results in effect on attribute but of insufficient magnitude to affect the use or condition	Geology
		Very slight change from geological feature/designation baseline conditions where overall integrity of resource is not affected.
		Soils
		No discernible loss/reduction of soil function(s) that restrict current or approved future use. Under 1ha loss/sealing for all grades of soil value/importance.

Magnitude	Criteria	Examples
		Groundwater
		Very slight change from groundwater baseline conditions, approximating to a 'no change' situation. Dewatering effects create no or no noticeable differential settlement effects on existing infrastructure and buildings. Non-permanent health effects to human health.
		Land Contamination
		Contamination levels below human health, environment and property assessment criteria and no remediation required; or qualitative risk assessment identifies no risk (as defined in Appendix 13.1 Land Contamination Supporting Information).
Minor beneficial	Results in some beneficial effect on attribute or a reduced risk of negative effect occurring	Geology
		Improvement of existing geological features/designations such as cleaning existing rock exposures.
		Soils
		Return of a minor area of land (i.e. removal of hardstanding) increasing soil function(s) and increased opportunity for future beneficial use.
		Groundwater
		Reduction of groundwater hazards to existing structures
		Land Contamination
		Change in land use so that existing risk levels are reduced.
Moderate beneficial	Results in moderate improvement of the quality of the attribute	Geology
		Improved access to existing geological features/designations.
		Soils
		Return of a moderate area of land (i.e. removal of hardstanding) increasing soil function(s) and increased opportunity for future beneficial use.
		Groundwater

Magnitude	Criteria	Examples
		Contribution to improvement in waterbody WFD classification. Support to significant improvements in damaged GWDTE.
		Land Contamination
		Removal of existing pollutant linkages.
Major beneficial	Results in major improvement of attribute quality	Geology
		Creation of new geological features/designations.
		Soils
		Return of a major area of land (i.e. removal of hardstanding) increasing soil function(s) and increased opportunity for future beneficial use.
		Groundwater
		Recharge of an aquifer. Improvement in WFD classification.
		Land Contamination
		Removal of contamination source.
No Change		No temporary or permanent loss or alteration of characteristics, features or elements; no observable impact in either direction.

Significance

13.2.19 The significance of effects was determined as a function of the value/importance of the receptor/attribute and the magnitude of the predicted impact. According to the environmental assessment methodology within DMRB LA 104, specifically for projects in Scotland, the significance of potential effects shall be reported including embedded mitigation measures. Any residual effects shall be reported after assessment of the effectiveness of essential mitigation measures required to reduce and, if possible, offset likely significant adverse environmental effects. The matrix for the determination of significance, provided in the DMRB LA 104 guidance, is shown in Table 13.5.

Table 13.5: Matrix for determination of impact significance

Magnitude / **Importance**	**No change**	**Negligible**	**Minor**	**Moderate**	**Major**
Very High	Neutral	Slight	**Moderate or Large**	**Large or Very Large**	**Very Large**
High	Neutral	Slight	Slight or **Moderate**	**Moderate or Large**	**Large or Very Large**
Medium	Neutral	Neutral or Slight	Slight	**Moderate**	**Moderate or Large**
Low	Neutral	Neutral or Slight	Neutral or Slight	Slight	Slight or **Moderate**
Negligible	Neutral	Neutral	Neutral or Slight	Neutral or Slight	Slight

Note: Where significance is between two levels, professional judgement has been used to assign the most appropriate significance and a justification provided.

13.2.20 Effects of Moderate significance and above are considered significant in the context of The Roads (Scotland) Act 1984 (Environmental Impact Assessment) (Scotland) Regulations 2017, hereafter referred to as the EIA Regulations, and the level at which mitigation would be proposed.

Cumulative Effects

13.2.21 Potentially significant cumulative effects of the proposed scheme, and those of the proposed scheme in combination with other reasonably foreseeable developments, are assessed in Chapter 21 (Assessment of Cumulative Effects).

Limitations to Assessment

13.2.22 The identification of potential contamination sources relies on the accuracy of historic mapping. For example, assessment of historic quarrying activity is based on a desk-based review of OS maps. It is possible that quarrying works could have been undertaken and the void backfilled between the recorded years of mapping, such that no map evidence exists. This assessment is based on available data.

13.2.23 Information on PWS depends on the accuracy provided through consultations with landowners and the local authority. No information has been obtained for private water supplies and potential land contamination sources within the Muir of Thorn and Gelly Woods area.

13.2.24 Geological and hydrogeological information obtained from the GI phases provided in Table 13.2 have been used for this assessment. In areas where no data were available, the nearest geological and hydrogeological information was extrapolated from the wider available dataset.

13.2.25 A number of soil and groundwater geo-environmental analytical results from the GI were noted as deviating due to sample hold times being exceeded. The deviating results were noted to have failed the laboratory's quality standards due to determinand specific sample hold times being exceeded, hence the sample age exceeds the determinand's stability time. Affected results, particularly for organic determinands which are more likely to degrade over time, may be underestimates of the true concentration. Full details of deviating samples are noted within the Contractor's Factual Reports and further discussed within the draft GeAR (Jacobs, 2024a).

13.2.26 The GI and assessments undertaken to date are considered appropriate to the project stage and sufficient to identify potential constraints associated with ground conditions. However, potential remains for previously unidentified contamination to be present which may impact the scheme.

13.2.27 The assessment is reliant on the accuracy of the information provided during consultation.

13.3 Baseline Conditions

Geology

Designated Geological Receptors

13.3.1 There are no designated Geological Receptors, including Sites of Special Scientific Interest (SSSI) and Geological Conservation Review (GCR) sites within the 250m study area. There is one Special Area of Conservation (SAC) within the study area, the River Tay SAC. The River Tay is designated as a Special Area of Conservation (SAC) throughout the study area, however, it is designated for its clear-water lakes, Atlantic salmon, lamprey (river, brook and sea) and otter and not for its geological features. Further details are described in Chapter 12: Biodiversity.

Soils

13.3.2 From a review of the available online map data (UK Soil Observatory, 2025), the majority of the study area is underlain by humus-iron podzols which may also contain some alluvial soils associated with the valley floors, terraces and mounds. In the east of the study area, near the Pass of Birnam, parts of the existing A9 and the proposed scheme are underlain by alluvial soils of the River Tay floodplain. There are also brown forest soils within the study area which are present on the hills and valley sides along with some humus-iron podzols and humic gleys.

Agricultural Soils

13.3.3 The Land Capability for Agriculture (LCA) classification system was devised to rank land on the basis of the land's potential productivity and cropping flexibility (The James Hutton Institute, 2025). The determination of the land's potential productivity and cropping flexibility is based on the extent to which the physical characteristics of the land (soil, climate and relief) impose long term restrictions on its use and capability to grow certain types of crops and grass. Land is classified into seven main classes, some of which have subdivisions, with Class 1 being the best quality agricultural land and Class 7 the poorest with limited agricultural potential. These can be simplified into four land use categories which are broadly indicative of the land's agricultural capability:

- arable agriculture (LCA classes 1 to 3.1);
- mixed agriculture (LCA classes 3.2 to 4.2);
- improved grassland (LCA classes 5.1 to 5.3); and
- rough grazing (LCA classes 6.1 to 7).

13.3.4 Classes 1, 2 and 3.1 are known as prime agricultural land and Classes 3.2 to 7 are known as non-prime land.

13.3.5 There is no LCA Class 1 or 2 agricultural land within the study area. There are four areas of prime agricultural land within the study area, all of which are classified as LCA Class 3.1 as shown on Figures 13.1a to 13.1e. One area to the south of Birnam (north of Dalpowie Plantation) on both banks of the River Tay, a second area to the northeast of Dunkeld, a third area in proximity to the River Tay Crossing on the western bank of the River Tay and a fourth area at the northernmost extent of the study area on the eastern bank of the River Tay. Based on the criteria within Table 13.3, agricultural soils of LCA Class 3.1 are recognised as being of high value/importance.

13.3.6 LCA Class 3.2 (land capable of average production although high yields of barley, oats and grass are possible) is present from the southernmost extent of the study area to the junction between the A9 and B867, to the west of Dunkeld at Bishop's Hill, to the northwest of Inver at the Hermitage and south of the existing Dalguise Junction at the foot of Inver Wood. Based on the criteria within Table 13.3, agricultural soils within this classification are considered to be of medium value/importance.

13.3.7 LCA Class 4.2 (land capable of producing a narrow range of crops, primarily grassland with short arable breaks of forage crops and cereal) is shown to underlie the proposed scheme infrastructure between the Hermitage Junction and The River Tay Crossing (approximately ch7450); LCA Class 5.2 (land capable of use as improved grassland but pasture may be difficult to maintain) underlies the proposed scheme between The River Tay Crossing to the end of the proposed scheme (ch8437); and LCA Class 6.2 (land capable of use as rough grazing with moderate quality plants) is shown to underlie the outer edges of the proposed scheme infrastructure situated in proximity to the slopes of Newtyle Hill (approximate ch2600) and Craig a Barns (approximate ch8300). LCA Classes 4.1 and 6.3 are also shown within the study area but do not underlie the proposed scheme or footprint. Based on the criteria within Table

13.3, agricultural land within LCA Classes 4.1 and 7 is considered to be of low value/importance.

13.3.8 Further information on the economic/operational value of agricultural land is provided in Chapter 16 (Population – Land Use).

Peat Soils

13.3.9 No peat deposits are recorded on BGS Onshore Geoindex (BGS, 2025) within 250 m of the proposed scheme and the existing A9. In addition, the entire study area is classified as Class 0 (mineral soils where peatland habitats are not typically found) by the SNH Carbon and Peatland Map (NatureScot, 2016) with a small area at Birnam, Little Dunkeld and Dunkeld classified as Class -2 (non-soil, i.e. loch, built up area, rock and scree). The alluvial soils associated with the valley floors, terraces and mounds in the southern extent of the study area may contain component peaty alluvial soils (UK Soils Observatory, 2025).

13.3.10 References to "peat" were noted during a review of the soil descriptions in the GI data at a relatively small and localised number of exploratory hole locations across the site, indicating that peat/peaty soils may be present. These locations included those beneath the existing A9 embankment, within the BotS and within the wider study area. As part of this assessment, we have adopted the following definition of peat, published by NatureScot *"Peat soils in Scotland are defined as soil with a surface peat layer with more than 60% organic matter and of at least 50cm thickness. Peaty soils have a shallower peat layer (<50cm) at the surface."* (NatureScot, 2023). Note that any materials where peat was referenced as a minor constituent e.g., "slightly (<5 %) peaty gravel" have been discounted. The localised presence of pockets of peat within made ground have also been discounted.

13.3.11 Following the review of the logs, peat/peaty soils/peaty topsoils were recorded in 23 locations, however in 11 locations the peat was recorded by historic borehole records excavated during the construction of the existing A9 and are therefore unlikely to represent present day ground conditions. A review of exploratory locations recording peat/peaty soils and their potential to be impacted by the proposed scheme and relative significance is presented in Table 13.6.

Table 13.6: Review of Peat/Peaty Soils Locations Identified within Exploratory Logs

Area (Approximate Chainage	Description	Identified Area	Comment
Byres Wood (ch510 - ch140)	Four historical exploratory locations that are located adjacent to or beneath the existing A9 footprint. • Three locations recorded peat as topsoil from ground level to a maximum depth of 0.8 m bgl. • One location recorded dark brown fibrous peat between 0.5 – 2.0 mbgl at a thickness of 1.5m.	All locations fall within the BotS.	Historical locations either fall beneath the current A9 or are located adjacent to the A9 and it is likely that any peat has excavated during the construction of the existing A9 and no longer present. **Therefore these locations are not considered further in the following assessments.**
Dalpowie Plantation (ch640 – ch1200)	Three exploratory locations recorded peat/peaty topsoil between ground level and 0.1 mbgl with a maximum thickness of 0.1m.	All locations fall within the BotS.	The exploratory hole logs note driller's description against the peaty topsoil horizons. **Noting the minimal thickness these locations are not considered further in the following assessments.**
Ring Wood (ch1380 – ch2000)	Seven exploratory locations within this area recorded peat/peaty topsoils. • Five locations recorded peaty topsoils at a thickness of between 0.1 m and 0.2m. • One location encountered a buried peat horizon at 3.4 mbgl with a thicknesses of 0.2m.	All locations fall within the BotS.	The exploratory hole logs note driller's description against the peaty topsoil horizons. **Noting the minimal thickness these locations are not considered further in the following assessments.**
	One location encountered a buried peat horizons at 1.9 mbgl with a thicknesses of 0.9m.		The 0.9m thick peat horizon at 1.9 mbgl may be encountered during constructions works. **This location may therefore represent a potential peat deposit (albeit not notably continuous).**

Area (Approximate Chainage	Description	Identified Area	Comment
Present day A9 Embankment between A9 and Perth Road (ch2360 – ch2510)	Seven historical locations located within the footprint of the present day A9 embankment. • One location recorded a peaty topsoil at ground level with a thickness of 0.1m • Five locations recorded buried peat horizons between 1.4 mbgl and 7.6 mbgl. • One location recorded silt with peat bands between ground level and 1.4mbgl.	All locations fall within the BotS.	Historical locations either fall beneath the current A9 or are located adjacent to the A9 and it is likely that any peat has excavated during the construction of the existing A9 and no longer present. **Therefore these locations are not considered further in the following assessments.**
North of the A9 (ch2950)	One exploratory hole location north of the A9 encountered buried spongy dark brown and grey silty pseudo fibrous peat horizon at 6.0 mbgl to 6.5 mbgl with a thickness of 0.5m.	Within BotS	Whilst this location falls within the BotS no earthworks are proposed in this area hence due to the depth of the horizon it is unlikely to be directly affected by the proposed construction. **Therefore this location is not considered further in the following assessments.**
West of the A9 (ch7250)	One exploratory hole encountered a gravelly sand horizon from ground level to 0.1 mbgl with a remark “driller notes peat”.	Within BotS	**This location falls within the BotS but noting the minimal thickness this location is not considered further in the following assessments.**

13.3.12 As noted in Table13.6, only one location has identified a peat horizon that could be impacted by the proposed works.

13.3.13 Noting the presence of ad-hoc localized peaty soils and peat, recorded as shallow / limited depth deposits and limited/discontinued geographical distribution and the absence of peatland habitats, these soils present in the study area are considered to be of negligible value/importance based on the criteria presented in Table 13.3.

Made Ground

13.3.14 No made ground is recorded on the BGS Onshore Geoindex (BGS, 2025) within 250 m of the proposed scheme. However, it is likely that made ground is present in the vicinity of the existing A9 and the Highland Main Line railway as both were constructed upon embankment in several sections which are likely to comprise significant deposits of made ground.

13.3.15 The GI encountered made ground within localised areas throughout the site. Following the approach in the GIR (Jacobs, 2024b), made ground has been split into three main types – general made ground with anthropogenic material, made ground comprising embankment fill and made ground comprising reworked natural deposits.

13.3.16 Made ground with anthropogenic material was encountered locally across the site, notably where exploratory holes were undertaken in the areas adjacent to the existing A9 carriageway, other roads or areas of development (e.g. near the railway line, residential property, farms etc.). Typical anthropogenic material recorded includes brick, ash, glass, timber, wood, metal, concrete and tarmac. These materials were recorded from ground level to a maximum thickness of 4.90 mbgl. Evidence of any visual and/or contamination along with a summary of anthropogenic material recorded in exploratory location descriptions is detailed in Appendix 13.1.

13.3.17 Embankment fill was encountered at various locations throughout the site associated with existing A9 embankments. These deposits were encountered from ground level to a maximum depth of 12.80 mbgl. Embankment fill was typically described as orangish/greyish brown, slightly silty or clayey sand and subangular to sub rounded fine to course gravel with low cobble content.

13.3.18 Reworked natural deposits were encountered locally across the site. These are likely to have been excess or unsuitable material sourced from excavations to form cuttings during construction of the existing A9. These deposits were typically described as dark/light/ greyish or orangish brown, silty gravelly fine to coarse sand or very sandy silty fine to coarse subangular to subrounded gravel with low to medium cobble content. The deposits were encountered from ground level to a maximum thickness of 5.4 mbgl.

13.3.19 Based on the criteria presented in Table 13.3, made ground present in the study area is considered to be of negligible value/importance.

Superficial Geology

13.3.20 Superficial deposits are recorded as alluvium, alluvial fan deposits, river terrace deposits, glaciofluvial deposits and Devensian – Diamicton glacial till (BGS, 2025).

13.3.21 The majority of the existing A9 is underlain by glaciofluvial deposits comprising sand and gravel with local lenses of silt, clay and organic matter. Where the existing A9 is located close to the River Tay, for example at Inver, the River Tay Crossing and west of Little Dunkeld, the underlying superficial material comprises river alluvium, a silty clay which can contain layers of silt, sand, gravel and peat.

13.3.22 River terrace deposits are recorded in the west of the study area, further up slope on the edge of the floodplain, and are generally described as being comprised of sand and gravel with local lenses of silt, clay or peat.

13.3.23 Alluvial fan deposits are present at the base of Birnam Hill and are defined as low, outspread, relatively flat to gently sloping masses of loose rock material, shaped like a fan or segment of a cone from a localised source.

13.3.24 Glacial till is generally recorded on the higher ground of the valley sides and is typically composed of a wide range of poorly sorted clays, sands and gravels.

13.3.25 GI encountered a highly variable sequence of superficial deposits, predominantly comprising medium dense to very dense, locally silty or clayey sands and gravels with variable cobble and boulder content. The total thickness of superficial materials ranged from locally absent in an area west of Inver (around ch5580) to 79.5 mbgl to the north of the River Tay Crossing (ch7690). From the boreholes reviewed within the proposed cutting areas, the proven total thickness of superficial deposits was generally greater than 15 m thick, with the exception of the areas described in further detail in Section 13.3.30.

13.3.26 Based on the criteria presented in Table 13.3, superficial deposits present in the study area are considered to be of negligible value/importance.

Bedrock Geology

13.3.27 The bedrock geology underlying the majority of the study area is low grade metamorphic bedrock of Dalradian age, belonging to the Southern Highland Group (SHG). Generally, the SHG is comprised of interbedded pelites, semipelites, psammities and metasandstones. The BGS Onshore Geoindex (BGS, 2025) indicates a dyke of the Central Scotland Late Carboniferous Tholeiitic Dyke Swarm (of quartz-microgabbro) within the SHG at approximately ch3700 of the proposed scheme, in the vicinity of Ladywell landfill.

13.3.28 Sedimentary bedrock of Devonian age belonging to the Craighall Conglomerate Formation of the Arbuthnott-Garvock Group underlies the southern section of the project at the Pass of Birnam (ch-576 to ch800). The Craighall Conglomerate Formation is generally a massive, well rounded, pebble and boulder conglomerate of andesitic lava interbedded with basaltic lava members and minor sandstone, siltstone and mudstone beds.

13.3.29 The Highland Boundary Fault Zone forms the boundary between the Dalradian metamorphic bedrock and the Devonian sedimentary bedrock. The zone comprises a series of faults which cross the proposed scheme in the vicinity of the Pass of Birnam trending south-west to north-east.

13.3.30 Historic BGS borehole data confirmed the BGS published data with igneous and conglomerate bedrock encountered at the Pass of Birnam and Birnam Wood, and metamorphic and meta-sedimentary bedrock encountered across the remainder of the proposed scheme.

13.3.31 Historic boreholes encountered the Craighall Conglomerate Formation in Byres Wood between ch-300 to ch0 as sandstone, siltstone and conglomerate at surface to 7.7 mbgl.

13.3.32 The depth to the SHG bedrock varied along the project between surface outcrop to the west of Inver to over 55 mbgl in depth at the River Tay Crossing. The maximum depth of bedrock encountered was 79.5 mbgl (north of the River Tay Crossing at ch7690). The majority of borehole locations did not encounter bedrock and overall rockhead is generally greater than 15 mbgl across much of the study area with the exception of the following areas:

- north of existing A9 at approximately ch100 to ch350, rockhead was recorded between 7 mbgl and 10 mbgl;
- east of the existing A9 at approximately ch2250 to ch2300, rockhead was recorded between 0.1 mbgl and 10 mbgl;
- west of the existing A9 at ch2700 to ch2900, rockhead was recorded between 1.3 mbgl and 11.3 mbgl;
- in the vicinity of Inchewan Burn to the south of existing A9 at approximately ch3450, rockhead was recorded between 2.35 mbgl and 10 mbgl;
- south-west of the Highland Main Line railway at approximately ch3500 to ch3900 (vicinity of Ladywell Landfill) rockhead was recorded between 3 mbgl and 10 mbgl;
- west of Inver in the vicinity of the existing A9 (approximately ch5600) rockhead was recorded between surface outcrop and 7.5 mbgl;
- to the west and immediately below the existing A9 (approximately ch6250 to ch6330) rockhead was recorded between 0.3 mbgl and 4.1 mbgl; and
- to the east of the existing A9 from approximately ch7900 to the end of the project, rockhead was recorded between 4 mbgl and 10.2 mbgl.

13.3.33 Based on the criteria presented in Table 13.3, bedrock in the study area is considered to be of negligible value/importance.

Mineral Extraction

13.3.34 There are no records of historic or current coal mining activity within the study area. A Mineral Valuer's Report included within a preliminary sources study report (PSSR) undertaken by Scott Wilson in 2011 (Scott Wilson, 2011) states that historic mining for lead, copper and zinc (potential mineral veins within the Dalradian bedrock) may have taken place within a 1 km (approximate) section of the then proposed scheme (approximately equivalent to ch5100 to ch6100 of the currently proposed scheme). The mineral valuer's report also provided co-ordinates for two known mine entries (301200,724600 and 301300,742600), located in the study area on the opposite bank of the River Tay. Although no historic or current workings are recorded in the vicinity of the proposed scheme, it is possible that unrecorded workings exist at shallow depth (less than 30 m depth). The mineral valuer's report stated that, on the basis

of available information, future underground mining workings were considered unlikely to occur.

13.3.35 Review of the Mining Remediation Authority Interactive Map Viewer (Mining Remediation Authority, 2025) confirms no records of historic or current coal mining activity in the study area.

13.3.36 Review of historic OS maps supplied within the Envirocheck report (Landmark Information Group, 2015) recorded four old or disused quarries (PBTC-C7, PBTC-C9, PBTC-C10 and PBTC-C22) and two gravel pits (PBTC-C4 and PBTC-C15) in the study area. Additional information from the Envirocheck report (2015) states that PBTC-C7 (Birnam Lower Level) and PBTC-C9 (Birnam) were opencast slate mines which have now ceased to operate. The Envirocheck report (2015) also states that PBTC-C22 (Ladywell Landfill) was an opencast igneous and metamorphic (bedrock) mine which has now also ceased to operate. Further details are provided in Appendix A13.1: Land Contamination Supporting Information with locations shown on Figure 13.3.

Geotechnical Hazards

13.3.37 The geotechnical PSSR undertaken in 2011 by Scott Wilson provided details on a historic landslide event to the north of the River Tay Crossing (Scott Wilson, 2011). The PSSR reported that after a period of prolonged rainfall, a historic landslide (later classified as a debris flow) occurred in August 2004 between approximately Ch7900 and Ch8200.

13.3.38 The landslide was formally investigated at the time by Jacobs Babtie on behalf of BEAR Scotland. It was concluded that extensive rainfall in August 2004 had overwhelmed the drainage system of the Dunkeld – Rotmell Road (C502) and water began to flow over the slope as surface water runoff causing instability of the slope. This caused debris to reach the A9 Trunk Road, subsequently closing the road. Remedial measures included improvements to the drainage system, repairs to the Dunkeld – Rotmell Road (C502), and placement of rock fill and a geotextile separator to backfill and stabilise the failed slope section.

13.3.39 From a review of the Scottish Road Network Landslides Study (Winter et al., 2008) two areas of elevated landslide hazards have been identified in the vicinity of the proposed scheme, as detailed in Table 13.7.

Table 13.7: Landslide Hazards from Scottish Road Network Landslides Study (Winter et al., 2008)

Approximate Chainage (m) along the route of the proposed scheme	Hazard Ranking / Comments on Hazard
ch2100 to ch2900	Potential hazards to west of road; hazards on hill, probably on open ground in forestry. This route code for this section is A9-45 within the landslide study.
ch7600 to ch8400	Potential hazards to east of road, as is the Dunkeld – Rotmell Road (C502); limited hazard potential highlighted, but the history of movement in the area north of the River

Approximate Chainage (m) along the route of the proposed scheme	Hazard Ranking / Comments on Hazard
	Tay crossing, such as the August 2004 landslide caused by inadequate drainage, indicate that further assessment would be prudent. Hazards are more closely associated with localised geotechnical issues (cut slope stability management) than longer distance debris flow events. This section has a route code of A9-44 within the landslide study.

13.3.40 The landslide hazard identified between ch2100 and ch2900 is to the west of the A9 and Highland Main Line railway. As a result, construction of the proposed scheme is not envisaged to impact on the existing landslide hazard at this location.

13.3.41 However, the landslide hazard identified between ch7600 and ch8400, which encompasses the historic landslide event detailed in the PSSR and summarised above, could be affected by the proposed scheme. Detailed assessment of slope stability will be required during specimen design to determine the appropriate slope angle for cutting and strengthening design taking cognisance of the geotechnical hazard.

13.3.42 The AECOM GIR (AECOM, 2016) investigated a 150m section of natural slope in the vicinity of ch1600 and ch1750 which shows evidence of several historical slope failures. The failures are located between the existing A9 embankment and the River Tay on a natural river terrace slope. The slope dips at approximately 45° to 60°. The largest noted failure was approximately 23m across and 20 m from the crown to toe, with a 3m deep back scar. It was noted that a significant volume of debris and displaced material was gathered at the bottom 10m of the escarpment. It was surmised in the GIR that the failures have occurred due to a combination of erosion of riverbank which has resulted in steepened slopes as well as surface water and flow from the culvert passing below the A9.

13.3.43 The affected slope is located to the east of the existing A9. As the new A9 Trunk Road is proposed to the west of the existing A9 at this location, construction of the proposed scheme is not envisaged to impact the existing landslide hazard at this location; however, the outfall from Pond A which is to be culverted beneath the A9 at this location, should include erosion protection measures to prevent erosion of the riverbank.

13.3.44 Evidence of historical failure southwest of the Birnam Glen Underbridge was also noted within the AECOM GIR (AECOM, 2016). The section of the slope was approximately 120 m in length and ranged between 45° and 80°, varying in height from around 3 m to 10 m. The slope is situated where Birnam Glen Road forks. Construction of the proposed scheme is not envisaged to impact on the area of historic failure.

13.3.45 Three locations were highlighted within the PSSR (Scott Wilson, 2011) as showing some sign of distress. Convex tree trunks were noted between ch5200 to ch5650 (cut slope adjacent to A9) and adversely oriented discontinuities and instability on the northbound side at ch5500 to ch5650 and ch6170 to ch6320.

13.3.46 The DMRB Stage 2 Engineering Assessment (Jacobs, 2019) outlines several hazards that have been identified on the rock slopes, as listed in Table 13.8. One location is classed as Category 2 (where slopes are to be reviewed in five years' time), whereas the other two locations are classed as Category 3 (where a detailed inspection on a priority basis is recommended). Only one location is classed as Category 1 where no further action is recommended.

Table 13.8: Rock Slope Hazards (Jacobs, 2019)

Approximate Chainage (m)	Anticipated Earthwork Maximum Height (m)		Hazard Index / Action Category
	Embankment	Cutting	
5,600	1.1	-	8.28 / Action Category 2
5,900	13.2	-	17.35 / Action Category 3
6,100	6.1	-	0.38 / Action Category 1
6,300	5.9	23.0	41.97 / Action Category 3
Action Category 1 - No further action recommended. Action Category 2 - Slopes to be reviewed in 5 years. Actions Category 3 - Detailed inspection recommended as a priority			

Groundwater

13.3.47 The superficial deposits within the study area have been identified and discussed within the Superficial Geology section. Table 13.9 provides the hydrogeological characteristics of the geological units identified within the study area, discusses the potential for groundwater connectivity between these units using information adapted from the BGS Hydrogeological Map of Scotland (1988). and assigns a value/importance based on the criteria presented in Table 13.3.

Table 13.9: Hydrogeological Characteristics of Superficial and Bedrock Geological Units

Geological Unit	Geological Characteristic	Hydrogeological Characteristic	Value / Importance
Superficial			
Peat/peaty soils	Partially decomposed organic matter	Very poor groundwater potential and limited spatial extent. No, or very little, connectivity with higher permeability deposits.	Low
Made Ground	Variable composition	Highly variable groundwater potential due to surface/close	Low

Geological Unit	Geological Characteristic	Hydrogeological Characteristic	Value / Importance
Superficial			
		surface location and variable permeability.	
Glaciofluvial Deposits	Sand and gravel, locally with lenses of silt, clay and organic material.	Locally important aquifer with groundwater potential, the groundwater system is expected to be hydraulically connected to surface water and other high permeability superficial deposits.	High
River Terrace Deposits	Sand and gravel, locally with lenses of silt, clay or peat.	Local groundwater potential, the groundwater system is expected to be hydraulically connected to surface water and other high permeability superficial deposits.	Medium
Alluvial Fan Deposits	Comprised of variable sediments including clay, silt, sand, gravel and peat	Local groundwater potential, the groundwater system is expected to be hydraulically connected to surface water and other high permeability superficial deposits.	Medium
Glacial Till	Comprised of boulders, sands and gravels in a clay matrix	Poor groundwater potential due to generally low and variable permeability. No, or very little, connectivity with higher permeability deposits.	Low
Bedrock			
Southern Highland Group	Interbedded pelites, semipelites, psammities and metasandstones.	This unit has typically poor groundwater potential except through fracture networks. Some connectivity with high/moderate permeable deposits/strata where direct contact with fractures and weathered surfaces exists.	Low
Arbuthnott-Garvock Group	Massive well rounded, pebble and boulder conglomerate strata of andesitic lava interbedded	Locally yields moderate amounts of groundwater. Likely connected with high/moderate permeable deposits/strata where direct contact exists.	Medium

Geological Unit	Geological Characteristic	Hydrogeological Characteristic	Value / Importance
Superficial			
	with basaltic lava members and minor sandstone, siltstone and mudstone beds.		
Tholeiitic Lava Dyke	Intrusive igneous rocks.	Very poor groundwater potential. No, or very little, connectivity with higher permeability deposits and limit.	Low

13.3.48 Groundwater within superficial deposits underlying the site is predominantly present within glaciofluvial deposits, river terrace deposits and alluvial fan deposits and there is likely a high degree of connectivity between these deposits where contact exists. SEPA has identified these superficial deposits into two separate water bodies; the Isla and Lower Tay Sand and Gravel aquifer, located east of Little Dunkeld and the Tummel and Tay Sand and Gravel aquifer, located to the west.

13.3.49 SEPA has identified two bedrock aquifers in the study area; the Bankfoot aquifer and the Killin, Aberfeldy and Angus Glens aquifer, both correlating to the underlying published geological units; the Arbuthnott-Garvock Group and the Southern Highland Group respectively. There is potential for connectivity between the superficial and bedrock aquifers, however, the presence of glacial till deposits and other cohesive layers, such as silt and clay, within the superficial deposits may act as a barrier or aquitard between the bedrock and superficial aquifers where they are present.

13.3.50 Table 13.10 provides further detail on the characteristics of each identified water body summarising information from the SEPA Water Environment Hub (SEPA, 2024), interactive SEPA Water Classification Hub (SEPA, 2025) and the BGS Hydrogeological Map of Scotland (BGS, 1988).

Table 13.10: Groundwater Water Body Characteristics

Groundwater Aquifer (SEPA identification)	Characteristics	Corresponding Geological Unit(s)
Isla and Lower Tay Sand and Gravel aquifer (150740)	A locally important aquifer, groundwater potential varies depending upon the thickness of the saturated material giving borehole yields up to 10-15 l/s. The overall status of the aquifer was classified as good in 2022. The overall status was previously classified as poor from 2019 to 2020 after a good overall classification in 2018. This	Glaciofluvial Deposits, Alluvium, Alluvial Fan Deposits, Glacial Till and localised presence of Peat/peaty soils, Made Ground

Groundwater Aquifer (SEPA identification)	Characteristics	Corresponding Geological Unit(s)
	was due to an upward trend in pollutants attributed to arable farming abstractions and diffuse pollution.	
Tummel and Tay Sand and Gravel aquifer (150735)	A concealed aquifer which has limited or local potential, borehole yields are typically small (between 1-2l/s). Classified as good overall between 2012 and 2022. The Tummel and Tay Sand and Gravel aquifer is associated with the wider River Tay Catchment.	Alluvium, River Terrace Deposits, Glaciofluvial Deposits and localised presence of Made Ground
Bankfoot aquifer (150657)	A locally important aquifer with reported yields varying between 1l/s and 10-12l/s. Classified as good overall from 2018 to 2022. Previously, arable farming abstractions were recognised as a pressure on the aquifer, resulting in a poor overall classification between 2012 and 2017.	Craighall Conglomerate Formation (Arbuthnott-Garvock Group)
Killin, Aberfeldy and Angus Glens aquifer (150699)	Low productivity aquifer with typically poor groundwater potential except through fracture networks associated with tectonism or near surface weathering. Classified as good overall between 2012 and 2022.	Southern Highland Group, Tholeiitic Lava Swarm

Groundwater Flow

13.3.51 Groundwater level data was available for 150 boreholes installed along the length of the existing A9 within the study area. The number of monitored locations and duration of monitoring varied by phase of GI as detailed in Table 13.11.

Table 13.11: Groundwater Monitoring locations

GI Phase	Range of Groundwater Level/Heights Recorded (mAOD)	Number of Monitoring Events	Number of Boreholes with Data Loggers	Monitoring Period	Total number and Location IDs of Monitoring Wells included in Groundwater Monitoring Program
SEGL 2015	20.56 – 78.88	14	0	June 2014 – February 2016	**65**: BHBT001, BHBT010, BHBT017, BHBT020B, BHBT021A, BHBT022, BHBT023, BHBT025, BHBT026, BHBT034, BHBT038, BHBT041, BHBT043A, BHBT045, BHBT049, BHBT050, BHBT052, BHBT059A, BHBT061, BHBT067, BHBT074, BHBT083, BHBT087, BHBT090, BHBT091B, BHBT094, BHBT098A, BHBT100, BHBT103, BHBT105, BHBT106, BHBT109A, BHBT110, BHBT114, BHBT115, BHBT116, BHBT120, BHBT122, BHBT124, BHBT129, BHBT135, BHBT138, BHBT139A, BHBT141, BHBT144, BHBT153, BHBT155A, BHBT157A, BHBT158, BHBT169, BHBT177, BHBT179, BHBT182, BHBT185, BHBT189-1, BHBT190, BHBT196, BHBT202-1, BHBT204, BHBT207, BHBT209A, BHBT216, BHBT217, BHBT219 and BHBT223A
Fugro 2016a	40.80 – 53.65	12	0	January 2016 – April 2017	**6**: BH16650, BH17440, BH17600, BH18100, BH18500 and BH18720
Fugro 2016b	46.94 – 98.50	14	0	January 2016 – April 2017	**5**: BH21550, BH21900B, BH22260, BH22900 and BH23200D
Fugro 2017	86.90 – 92.48	7	0	November 2016 – May 2017	**3**: BTB1002, BTB1003 and TBB1001
Fugro 2019	47.96 – 67.35	12	0	March 2018 – February 2019	**12**: BTB2001, BTB2002, BTB2003, BTB2004, BTB2006, TBB2001, TBB2003A, TBB2004, TBB2006, TBB2008, TBB2009, TBB3004

GI Phase	Range of Groundwater Level/Heights Recorded (mAOD)	Number of Monitoring Events	Number of Boreholes with Data Loggers	Monitoring Period	Total number and Location IDs of Monitoring Wells included in Groundwater Monitoring Program
SEGL 2019a	44.23 – 55.09	2	0	April 2019 – May 2019	**4**: BTB1004, BTB1005A, BTB1006, BTB1007
SEGL 2023	37.14 – 94.22	4	9	May 2021 – April 2022	**55**: BTB4000, BTB4001, BTB4002, BTB4003, BTB4004, BTB4005, BTB4006A, BTB4007A, BTB4008, BTB4009, BTB4010, BTB4012, BTB4013, BTB4014, BTB4016, BTB4017, BTB4018, BTB4020, BTB4022, BTB4023, BTB4024, BTB4025, BTB4026A, BTB4027, BTB4028, BTB4029, BTB4031, BTB4032, BTB4035, BTB4036A, BTB4037, BTB4038, BTB4039, BTB4042, BTB4043, BTB4044, BTB4045, BTB4046, BTB4047, BTB4048, BTB4049, BTB4050, BTB4052, BTB4053, BTB4054, BTB4055, BTB4057, BTB4061B, BTB4062, BTB4063, BTB4065, BTB4066, BTB4067, BTB4068, BTB4069

13.3.52 Thirteen of the installed boreholes were screened across both superficial and bedrock units generally located where the superficial material was under 15 mbgl. At four locations, the boreholes were installed exclusively in shallow bedrock (between 0.5 and 4.1 mbgl) and three boreholes had dual installations, one in superficial material and one bedrock. The limited data available from the dual installations indicates that water levels in the bedrock are generally slightly higher than in the superficial deposits (between 0.1 m higher and 0.5 m higher). The remaining 128 borehole installations were screened entirely within superficial deposits reaching depths between 0.5 mbgl and 50 mbgl.

13.3.53 Thirty-one locations were noted to be dry during their respective monitoring periods with a further eight locations recording groundwater levels close to the installation depth limit, making them a potentially unreliable indicator. The remaining 113 locations recorded maximum groundwater levels generally at depths in excess of 5 mbgl. However, there was a large variation seen throughout the study area with maximum recorded groundwater levels ranging from surface level to over 30 mbgl. Three locations recorded maximum groundwater levels in excess of 30 mbgl, the deepest at 38 mbgl in proximity to the existing A9 at Dunkeld & Birnam Railway Station (ch3200).

13.3.54 Shallow groundwater levels were typically encountered close to surface water features (the River Tay and River Braan) and in areas where especially thin superficial deposits lie upon the low permeability metamorphic bedrock. Four locations recorded maximum groundwater levels within the top 1 m, three of which were in proximity to surface water features or shallow superficial deposits. Groundwater flow direction within the superficial deposits is likely to be controlled by local topography and directed towards the surface watercourses. The direction of bedrock groundwater flow is unknown.

13.3.55 Based on these groundwater monitoring results and the local geology (highly permeable sands and gravels overlying low permeability bedrock), groundwater flow is expected to be predominantly within the immediate overlying superficial deposits (typically sands and gravels) and the uppermost weathered section of bedrock (if present). The consequence of this is that the depth to groundwater and groundwater flow is highly variable across the project area and can be dependent upon the depth to bedrock.

Groundwater Quality

13.3.56 The Envirocheck report (Landmark Information Group 2015) indicates that there are six discharge consents within the study area. One is associated with Dunkeld Waste Water Treatment Works (PBTC-C12). The remaining five are all linked to discharge of treated water from private septic tanks, primarily clustered around Inver (PBTC-C42 to PBTC-C46). Fifteen septic tanks have been recorded as part of the landowner consultation responses (PBTC-C32 to PBTC-C41, PBTC-C48 and PBTC-C54 to PBTC-C57). Additionally, following landowner consultation nine points of interest were raised from consultation with SEPA which includes three likely discharge points (PBTC-C60 to PBTC-C62) and six additional septic tanks (PBTC-C63 to PBTC-C68). The locations of the waste water treatment works and the private septic tanks are shown in Figure 13.3.

13.3.57 The Baseline Scotland: The Lower Devonian aquifer of Strathmore (BGS, 2006) report, which encapsulates the Bankfoot aquifer, describes the groundwater in the aquifer as generally weakly mineralised, with near neutral to alkaline pH values; and high nitrate and elevated phosphate concentrations were recorded across aquifer units. The study area lies within a groundwater Drinking Water Protected Area as all groundwater bodies in Scotland have a protected designation. The southern extent of the study area, where the Isla and Lower Tay Sand and Gravel aquifer and Bankfoot aquifer are present, is classed a Nitrate Vulnerable Zone (NVZ) by the Scottish Government under the European Commission's Nitrates Directive 91/676/EEC (European Commission, 1991).

13.3.58 The BGS Groundwater Vulnerability Map (BGS, 1988) indicates that the superficial deposits within the study area are moderately permeable, with intermediate leaching potential (i.e. moderate ability to attenuate diffuse pollution). In addition, the Baseline Scotland: the Lower Devonian aquifer of Strathmore (BGS, 2006) confirms that groundwater in the Bankfoot aquifer is highly vulnerable to contamination from surface activities. Low permeability ground cover such as hardstanding (existing road infrastructure and Highland Main Line Railway embankments) over the areas of made ground will prevent or reduce the amount of surface water (and potential diffuse pollution) infiltration.

13.3.59 As part of the GI, groundwater samples were obtained from boreholes across the scheme and were sent for laboratory analysis for a range of geo-environmental testing suites including metals, organics, inorganics, hydrocarbons, semi-volatile organic compounds and volatile organic compounds; a full summary of the testing is included in the draft GeAR (Jacobs, 2024a). The groundwater sample chemical analysis results from GI data have been compared against Resource Protection Values (RPV) as defined within SEPA Position Statement WAT-PS-10-01 (SEPA, 2014). SEPA have not assigned an RPV for petroleum hydrocarbons, therefore, the laboratory limit of detection (LOD) has been adopted as a conservative GAC. This screening exercise identified predominantly marginal and isolated exceedances for chloride, arsenic, chromium, iron, manganese, nickel, benzo(a)pyrene, total of 4 PAHs and bis(2-ethylhexyl)phthalate in no more that 5-10% of samples analysed across the study area. The exception to this were infrequent exceedances (circa one order of magnitude above the GAC) throughout the site for manganese, benzo(a)pyrene and bis(2-ethylhexyl)phthalate, without any notable pattern that would suggest an association to a particular source. Furthermore, corresponding leachate analysis did not suggest a directly comparable source within associated soils.

13.3.60 It is notable that exceedances of nickel were recorded consistently over multiple monitoring rounds at BTB4029, located within the off-site Ladywell landfill site (PBTC-C22) source. Exceedances of RPV for manganese and Bis(2-ethylhexyl)Phthalate were also recorded at other locations within the waste management licenced area of the landfill site, including the spray irrigation zones . BTB4029 is located close to the northern edge of the area where waste is contained within a historic quarry and there is a possible pathway though groundwater migration north towards the scheme. Further details regarding the Ladywell landfill site history and associated historic groundwater monitoring are provided in Appendix A9.2 (Ladywell Landfill) of the DMRB Stage 2 Chapter 9 Geology, Soils and Groundwater (Jacobs, 2019).

13.3.61 Appendix A13.1 (Land Contamination Supporting Information) considers the chemical analysis of groundwater samples in greater detail including additional groundwater quality data information from PKC.

Groundwater Abstractions

13.3.62 There are no groundwater licenced abstractions within the study area.

13.3.63 Details of the PWS identified within the study area are presented in Table 13.12 and the active PWS are shown on Figure 13.2. It should be noted that some of the PWS identified at the DMRB Stage 2 using OS map information have now been found to be abandoned/inactive following landowner consultation; these are included in Table 13.12 with an update on their status. Abandoned/inactive PWS have not been assessed. All active PWS networks identified are of high value/importance.

Table 13.12: Summary of identified abstractions, springs and private water supplies

PWS Reference	Source of Information	Nature of PWS	Property	Status	Comments
PBTC-S1	Spring noted on OS map and landowner consultation.	Spring	Unknown?	Abandoned/not active	
PBTC-S2	Spring noted on OS map and landowner consultation.	Spring	Unknown?	Abandoned/not active	
PBTC-S3	Spring noted on OS map and landowner consultation.	Mains Supplied	Unknown?	Abandoned/not active	Review of information obtained from land owner consultation shows this is mains supplied to feed the pond within Beatrix Potter community garden and is therefore excluded.
PBTC-W1	Well noted on OS map and landowner consultation.	Well	Unknown?	Abandoned/not active	
PBTC-PWS1	Identified during landowner consultation.	Spring	Murthly Castle and associated rental properties.	Active	Spring feeds domestic/ commercial water supply for Murthly Castle and associated rental properties. Also used to supply drinking water for cattle. 150 years old.
PBTC-PWS2	Identified during landowner consultation.	Borehole	Boat of Murthly	Active	Borehole supply for one residential property, Boat of Murthly (60ft deep). Eight-year-old domestic/drinking water supply. No water mains supply to property.
TB-PWS1	Identified during landowner consultation.	Borehole	Woodlands Cottage	Active	Borehole supply for one residential property: Woodlands Cottage. Fourteen-year-old domestic/drinking water supply. No water mains supply to property.

PWS Reference	Source of Information	Nature of PWS	Property	Status	Comments
TB-PWS4	Identified during landowner consultation.	Surface water	Various	Unknown	Consultation indicated a PWS was in place to feed houses at location but other details absent from consultation. In order to conduct a conservative assessment this receptor was considered in the below assessment section

Ecological receptors with potential groundwater component

13.3.64 Preliminary assessment of ecological receptors based upon the Phase 1 habitat survey provided by AECOM (Transport Scotland, 2011) identified eight habitats which had the potential to be, at least partially, supported by groundwater inflows. However, following further surveys undertaken by Jacobs in October 2015, it was considered that the assemblages of species and habitats observed did not constitute GWDTEs as defined in Land Use Planning System Guidance Note 31 (SEPA, 2017b) and no further surveys and/or analysis is required.

13.3.65 Further habitat surveys (and subsequent desk-based assessment and reviews) were undertaken in 2021, 2022, 2024 and 2025 to update Phase 1 habitat survey data and to collect baseline data for two areas to the south of the scheme identified for ecological mitigation, specifically woodland planting and management. It was confirmed that no GWDTE are present within the proposed works study area.

13.3.66 As part of the identified area for ecological mitigation, an area of blanket bog and wet woodland was recorded at the Muir of Thorn, approximately 2km to the south of the scheme, (see Chapter 12, Figure 12.3) in 2025. These habitats have the potential to constitute GWDTE, however no further surveys have been undertaken as these areas will not be impacted by construction activities due to their distance from the scheme. Further details on these habitats are provided in Chapter 12 (Biodiversity Appendix).

13.3.67 Other ecological receptors are identified and described further in Chapter 12 (Biodiversity).

Surface Water Features

13.3.68 Surface water features are expected to have a groundwater baseflow component, and groundwater may be a contributor to river flooding mechanisms.

13.3.69 The main watercourse within the study area is the River Tay, which is predominantly situated to the north and east of the existing A9 as far as the crossing of the River Tay at the northern end of the proposed scheme, where it is then located to the west (ch7500). Throughout the study area, the River Tay is designated as a Special Area of Conservation (SAC) and is designated for its clear-water lakes, Atlantic salmon, lamprey (river, brook and sea) and otter. Further information on protected species and habitats is provided in Chapter 12 (Biodiversity).

13.3.70 The stretch of the River Braan, a tributary of the River Tay, within the study area also forms part of the River Tay SAC designation. The River Braan flows in close proximity to the existing A9 near Inver, subsequently crossing beneath the existing A9 between Inver and Little Dunkeld (ch3400).

13.3.71 Watercourses within the study area are identified and described further in Chapter 19 (Road Drainage and the Water Environment).

13.3.72 The value/importance of each surface water feature for the purposes of assessing potential impacts relating to groundwater dewatering effects follows the groundwater criteria in Table 13.3 and reflects the hydrological importance of that surface water feature in supporting sensitive ecosystems. As such, the River Tay is considered to be of very high value/importance.

The value/importance of surface water features with respect to potential dewatering effects are provided within Appendix A13.3 (Surface Water Indirect Dewatering Assessment).

Land Contamination

13.3.73 The assessment of potential land contamination has focused on the potential for impacts on receptors as a direct consequence of the proposed scheme encountering contamination. To support the EIAR a separate land contamination risk assessment has been undertaken in the PSSRs (Scott Wilson, 2011) (Jacobs, 2013a) (Jacobs, 2013b) and subsequently updated in the draft GeAR (Jacobs, 2024a) with the relevant findings summarised in Appendix A13.1 (Land Contamination Supporting Information). The updated land contamination risk assessment within the draft GeAR utilised the information gathered during the scheme-specific GIs and supporting GIs. A summary of the potential sources of contamination and potential receptors within the study area is provided in this section.

Potential Sources of Contamination

13.3.74 Seven potential sources of land contamination have been identified on-site (within the BotS) and a further ten potential sources of land contamination have been identified off-site.

13.3.75 The on-site potential sources of contamination include the existing A9, potentially infilled ground (a curling pond and a gravel pit) and historic tanks which have the potential for localised leaks and spills to have occurred throughout their lifetime.

13.3.76 The off-site potential sources of contamination comprise industry (e.g. factories or garages), potentially infilled ground (quarries and pits), utilities such as sewage works, gas works, and Ladywell Landfill. The ten off-site potential sources have been included due to potential of either historic contributary impact to on-site conditions from the migration of groundwater contamination or ground gas; or there is potential for the construction works to alter the existing groundwater/ground gas flow regimes.

13.3.77 Further information on each potential source of land contamination is provided in Appendix A13.1 (Land Contamination Supporting Information) and locations are provided in Figure 13.3.

Potential Receptors

13.3.78 The risk of land contamination has been assessed as the impact on certain receptors. These receptors have been chosen to represent those most at risk from contamination which are present within the study area and can be grouped into human health, surface water and groundwater receptor groups. Table 13.13 assigns a value based on the definitions within the methodology (Table 13.3). Professional judgement has been adopted to assign a value where the receptor value is not assigned by DMRB LA 109. Note that the Livestock Receptor (R8) that was previously identified in the PSSR has been discounted on account of there being no livestock within the study area.

Table 13.13 Assigned Value for Potential Receptors within Study Area

Receptor Name	Receptor Reference[1]	Value	Description
Human Health			
Construction Workers	R1	High	Associated with the proposed scheme during construction
Adjacent Residents/Workforce	R2	Very High	Residential areas throughout the proposed scheme
		High	Public Open Space throughout the proposed scheme
		Medium	Commercial/Industrial areas throughout the proposed scheme
Maintenance and Landscape Workers	R3	High	Associated with the proposed scheme during operation
Future Site Users (Road Users)	R4	Low	Existing road throughout the proposed scheme
Water Environment			
Surface Water	R5	Very High* Medium to Low #	River Tay and River Braan* (Major Watercourses) and all other Surface Water Features within study area #
Groundwater within Superficial Deposits	R6	High	Isla and Lower Tay Sand and Gravel aquifer
		High	Tummel and Tay Sand and Gravel aquifer
Bedrock groundwater	R7	Medium	Bankfoot aquifer (AGG)
		Low	Killin, Aberfeldy and Angus Glens aquifer (SHG)
Property			
Buildings and Services	R9	Medium	Associated with buried concrete and pipes

Receptor Name	Receptor Reference[1]	Value	Description
Ecological			
Environmentally Sensitive Areas	R10	Very High	River Tay SAC is adjacent to the route

1 -The Receptor reference is associated with the conceptual site model (CSM) developed for the land contamination risk assessment presented within Appendix A13.1 (Land Contamination Supporting Information).
* Very High Value relates to River Tay and River Braan only
# Medium to Low Value relates to all other watercourses

Future Baseline

13.3.79 It is unlikely that baseline conditions will change prior to the construction of the Scheme across the majority of the study area. It is possible that there may be further development works (for example, at Dunkeld & Birnam Railway Station), however any such works are unlikely to significantly change the baseline with respect to geology, soils, groundwater and land contamination.

13.4 Potential Impacts and effects

Introduction

13.4.1 This section describes the assessment of potential impacts and effects of the proposed scheme that could arise in the absence of mitigation measures beyond those embedded in the design. Mitigation measures are then identified and described in Section 13.5 (Mitigation).

13.4.2 When assessing potential impacts and effects from the proposed scheme, construction and operational phases have been considered together, as the majority of construction impacts (such as removal of excavated material or dewatering due to proposed cuttings) would extend throughout the operational phase. Where differences in impacts are predicted between the construction and operational phases, these impacts have been assessed for each phase in turn.

13.4.3 There are a variety of ways in which road development schemes can impact on geology, soils, land quality and hydrogeology. Most common impacts are as follows:

- excavating or masking exposures of bedrock or superficial geological deposits of specific scientific interest if the features of interest are not reproduced elsewhere in the area;
- constraint/limitation to existing or potential commercial exploitation of resources;
- effects on underlying groundwater aquifers, for example, through the dewatering of aquifers as a result of construction works involving excavation;
- risk of spillage or leakage of fuel or oil from storage tanks or construction plant, which without suitable mitigation measures, can enter aquifers;
- effects of changes to groundwater flow or quality on secondary receptors such as groundwater abstractions, surface water or GWDTE; and

- surface runoff from the operational dual carriageway alignment may contain elevated concentrations of pollutants such as oils, suspended solids, metals (e.g. copper and zinc) and, in winter, salt and antifreeze agents (e.g. ethylene glycol), leading to pollution of the aquifers.
- disturbance of any contamination within existing soils and human exposure or releases to the environment.

Proposed Areas of Excavation

13.4.4 A key aspect of the impact assessment is to identify areas of excavations. Information on proposed excavated areas is provided in Table 13.14 and shown on Figures 13.1, 13.2 and 13.3. It should be noted that only proposed cuttings deeper than 1m are included. Groundwater level and depth to bedrock data from GI and monitoring work has been assessed and interpolated to produce indicative bedrock and groundwater levels as far as possible across the footprint of the proposed scheme. GI data indicate that the depth of bedrock is variable across the study area.

13.4.5 In Table 13.14 the Cutting ID prefix identifies the purpose of the proposed cutting as follows:

- C – Mainline road cutting
- CS – Side road cutting
- W – Widening of existing road cutting
- Pond – Drainage attenuation pond
- Swale – Drainage swale
- FPL – Flood plain development
- TCC – Temporary construction cutting
- CWF - Culvert
- CSTR – Structures (e.g. bridge, retaining wall)
- CPED – Pre-earthworks drainage

Table 13.14: Cutting Depths

Name	Approximate Chainage	Approximate maximum Excavation Depth (mbgl)	Depth to bedrock (drift thickness) (m)	Depth to Groundwater (mbgl)	Likelihood of Intercepting Bedrock	Likelihood of Intercepting Groundwater
W2A	-340	4.00	15	4	Unlikely	**Likely**
CPED1	-255	1.54	15	4	Unlikely	Unlikely
W2B	-140	4.09	15	4	Unlikely	**Likely**
CWF01	-125	1.61	15	4	Unlikely	Unlikely
CPED2	133	1.13	8.55	3.95	Unlikely	Unlikely
CS1	380	1.57	8	5	Unlikely	Unlikely
CPED3	420	1.25	9.9	3.95	Unlikely	Unlikely
W3	450	1.85	8	4	Unlikely	Unlikely
W4	550	1.79	23	18	Unlikely	Unlikely
CPED4	635	1.47	>30	19	Unlikely	Unlikely
Pond A	775	7.26	27	19	Unlikely	Unlikely
CS2	880	8.80	27	12.9	Unlikely	Unlikely
CSTR1	885	10.70	27	13	Unlikely	Unlikely
W5	950	4.56	>20	10.55	Unlikely	Unlikely
CPED5	1050	1.20	>12	1	Unlikely	**Likely**
W6	1300	7.02	>27	27	Unlikely	Unlikely
CPED6	1315	1.05	>19	11	Unlikely	Unlikely
CPED7	1518	1.08	>27	11	Unlikely	Unlikely
CPED8	1690	1.03	>15	27	Unlikely	Unlikely
CS7A	1700	2.05	12	13	Unlikely	Unlikely
CWF05	1735	2.55	>27	13	Unlikely	Unlikely
CS4B	1760	6.38	>22	1	Unlikely	**Likely**
Pond B1	1800	3.65	12	11	Unlikely	Unlikely

Name	Approximate Chainage	Approximate maximum Excavation Depth (mbgl)	Depth to bedrock (drift thickness) (m)	Depth to Groundwater (mbgl)	Likelihood of Intercepting Bedrock	Likelihood of Intercepting Groundwater
CS7B	1860	13.30	12	7.67	**Likely**	**Likely**
CS6	1900	5.75	12	11	Unlikely	Unlikely
CPED11	1960	1.50	>25	1	Unlikely	**Likely**
CWF05A	1970	3.42	>22	0.73	Unlikely	**Likely**
CPED9	2025	1.69	>18	26.98	Unlikely	Unlikely
CPED10	2035	1.12	>25	1	Unlikely	**Likely**
CS8	2200	21.74	10	26	Likely	Unlikely
CSTR2	2205	5.30	2	3	**Likely**	**Likely**
CS9A	2230	3.93	10	3	Unlikely	**Likely**
W7	2230	2.27	6	3	Unlikely	Unlikely
CPED12	2385	1.25	13.4	2.7	Unlikely	Unlikely
CWF07	2430	11.63	7	9	**Likely**	**Likely**
Pond B2	2800	4.20	10	12	Unlikely	Unlikely
Pond C (C5)	3230	5.67	>30	17	Unlikely	Unlikely
C6	3290	4.40	>32	14	Unlikely	Unlikely
C4	3340	6.16	>32	14	Unlikely	Unlikely
CSTR4	3345	4.80	>30	9.01	Unlikely	Unlikely
C7	3380	3.45	25	11	Unlikely	Unlikely
Swale C	3380	3.45	25.3	17.32	Unlikely	Unlikely
C8	3450	1.80	>30	11	Unlikely	Unlikely
CSTR6	3460	4.20	31	7	Unlikely	Unlikely
W8	3490	6.75	20	17	Unlikely	Unlikely
CPED13	3970	1.50	28	1	Unlikely	**Likely**
CS24	4000	4.03	28	6	Unlikely	Unlikely

Name	Approximate Chainage	Approximate maximum Excavation Depth (mbgl)	Depth to bedrock (drift thickness) (m)	Depth to Groundwater (mbgl)	Likelihood of Intercepting Bedrock	Likelihood of Intercepting Groundwater
Pond E (C9)	4000	1.02	>25	6	Unlikely	Unlikely
CS10	4037	3.22	>40.5	20	Unlikely	Unlikely
CSTR9	4040	1.30	>39	0	Unlikely	**Likely**
CWF09B	4090	4.08	6	0	Unlikely	**Likely**
CPED14	4096	1.50	28	0	Unlikely	**Likely**
Pond D	4150	1.60	>40	7	Unlikely	Unlikely
CWF09 - FRC	4200	3.35	6	0	Unlikely	**Likely**
CS10A	4300	1.41	>40.5	11	Unlikely	Unlikely
CSTR10	4325	3.40	>40.5	1.05	Unlikely	**Likely**
CS25	4400	4.04	>25	2.37	Unlikely	**Likely**
CSTR11	4440	3.1	>25	1.05	Unlikely	**Likely**
FPL1	4555	3.69	>25	2	Unlikely	**Likely**
CSTR12	4575	0.6	>25	1.05	Unlikely	Unlikely
Pond F	4750	1.60	>12	3	Unlikely	Unlikely
CSTR13	4940	1.6	>12	7.6	Unlikely	Unlikely
CSTR15	4940	4	>12	7.6	Unlikely	Unlikely
W9	4980	7.45	>22	7.63	Unlikely	Unlikely
W10	5400	6.82	14	21	Unlikely	Unlikely
CS21	5510	5.78	13.5	6.91	Unlikely	Unlikely
Pond G	5560	7.70	13.5	6.1	Unlikely	**Likely**
Swale G	5560	7.43	14	6	Unlikely	**Likely**
CSTR16	5755	7	26	7.58	Unlikely	Unlikely
C13	6130	17.63	0	2	**Likely**	**Likely**
C14	6495	3.43	28	16	Unlikely	Unlikely

Name	Approximate Chainage	Approximate maximum Excavation Depth (mbgl)	Depth to bedrock (drift thickness) (m)	Depth to Groundwater (mbgl)	Likelihood of Intercepting Bedrock	Likelihood of Intercepting Groundwater
CWF12B	6615	10.59	>15	22	Unlikely	Unlikely
W11	6630	28.50	28	26	**Likely**	**Likely**
CS16	6800	2.70	28	26	Unlikely	Unlikely
CWF13	6870	11.43	29.7	0.76	Unlikely	**Likely**
CS17	6900	4.73	30	4	Unlikely	**Likely**
CS19A	6900	5.59	>25	5.5	Unlikely	**Likely**
CSTR17	6915	6.5	>25	6.35	Unlikely	**Likely**
CS18	6920	6.25	>25.45	5.8	Unlikely	**Likely**
CS22	6950	5.06	>26	8	Unlikely	Unlikely
CSTR18	6975	6.7	>30	5.8	Unlikely	**Likely**
CPED15	7045	1.15	>45	4.2	Unlikely	Unlikely
Pond H	7050	2.91	>25	6	Unlikely	Unlikely
CS23	7090	2.78	>25	6	Unlikely	Unlikely
CS20	7250	13.92	>25	16	Unlikely	Unlikely
CSTR19	7355	7.2	42.5	9.2	Unlikely	Unlikely
CWF14	7460	1.64	42.5	7.4	Unlikely	Unlikely
CSTR20	7575	7.5	42.5	2.3	Unlikely	**Likely**
W12	7690	4.83	7	5	Unlikely	Unlikely
TCC1	7700	2.83	>22.70	2	Unlikely	**Likely**
Pond I	7790	12.30	7	9	**Likely**	**Likely**
W13	8000	6.34	5.4	8.43	**Likely**	Unlikely
CWF16	8005	5.16	7.4	0.55	Unlikely	**Likely**
CPED17	8090	1.22	>12	1	Unlikely	**Likely**
CPED16	8225	1.01	>8.5	4	Unlikely	Unlikely

Name	Approximate Chainage	Approximate maximum Excavation Depth (mbgl)	Depth to bedrock (drift thickness) (m)	Depth to Groundwater (mbgl)	Likelihood of Intercepting Bedrock	Likelihood of Intercepting Groundwater
CWF18	8350	8.88	5	3	**Likely**	**Likely**

Geology

Designated Geological Receptors

13.4.6 Geological receptors can be vulnerable to development by the removal or burial of an outcrop or exposure of value. However, where a new exposure is created permanently (e.g. by the creation of a cutting), and not subsequently re-buried (e.g. with spray concrete), then this can create a positive impact.

13.4.7 The proposed scheme is likely to intercept bedrock within nine cuttings: CS7B, CS8, CSTR2, CWF07, W11, C13, Pond I, W13 and CWF18. Cutting C13 is located on the projected hinge of the Highland Border Downbend and may expose deformation structures associated with the Tay Nappe. Therefore, the proposed scheme offers an opportunity for enhancement of local geodiversity knowledge/sites. This will lead to a moderate beneficial impact.

Soils

13.4.8 Soils within the study area may be impacted by permanent land take (i.e. under the footprint of the proposed scheme), temporary land take (i.e. under temporary site compounds and access routes) and by soil degradation through compaction.

Agricultural Soils

13.4.9 The calculated areas of agricultural soils land take, classified by LCA Class, for the Permanent Land take areas (land beneath the footprint of the proposed scheme) and Temporary land take areas are presented in Table 13.15. Any land within the BotS which is currently classed as Scottish Ministers Land and land classed as Woodland (under Native Woodland Survey of Scotland and Ancient Woodland Inventory) is assumed unlikely to contain agricultural land and these areas have therefore been excluded from the calculations. The potential affects and impacts on agricultural soils has been assessed based on LCA class and land take calculations is presented in Table 13.15 below.

Table 13.15: Potential Impacts and Effects on Agricultural Soils for Proposed Scheme

Land Capability for Agriculture	LCA Class	Value/ Importance	Approximate Land-take (ha)	Magnitude	Significance
Permanent Land Take					
Prime agricultural land	3.1	High	2.00	Major	**Large** or very Large
Non-prime agricultural land	3.2	Medium	3.89	Moderate	Moderate
	4.1 to 7	Low	0.94		Slight
Temporary Land Take					
Prime agricultural land	3.1	High	1.72	Minor	**Slight** or Moderate
Non-prime agricultural land	3.2	Medium	6.59		Slight
	4.1 to 7	Low	24.4		**Neutral** or Slight
Note: Calculations exclude land currently classed as Scottish Ministers Land and Land classed as Woodland (under Native Woodland Survey of Scotland and Ancient Woodland Inventory) as these areas are unlikely to contain agricultural land.					

13.4.10 Alternative areas of land take for the proposed scheme were considered at the design stage, and areas of high value prime agricultural land were avoided as far practicable based on the constrained lateral area available along the route.

13.4.11 To assess land take, non-prime agricultural land, classed as in DMRB as 'other agricultural land', has been combined to create an overall non-prime agricultural land take value.

13.4.12 Some permanent sealing of agricultural land and/or loss of land to agricultural production would be unavoidable, therefore a moderate magnitude of impact would arise affecting high, medium and low value soil receptors. Given medium value soils make up the majority of non-prime agricultural land, the overall impact of significance is assessed as **Large** for prime agricultural soils and **Moderate** for non-prime agricultural soils.

13.4.13 The permanent sealing or wastage of topsoil would be avoided as far as practicable via stripping and sustainable reuse elsewhere, in addition to following good practice soil management measures to ensure handling and storage of soils is unlikely to restrict future use.

13.4.14 Temporary land takes are unlikely to result in permanent sealing or removal of soil, and the impacts are likely to be of minor magnitude. Overall, impact significance on prime agricultural land is assessed as slight. Given low value LCA class soils make up the majority of non-prime agricultural land, the overall impact of significance on non-prime agricultural land is assessed as Neutral.

Peat Soils

13.4.15 A buried peat horizon (negligible value/importance) identified within Ring Wood may be indicative of localised peat deposits within this area which could be potentially impacted by the construction of the proposed scheme options. Removal of peat from this isolated area is expected to be limited and would represent a minor magnitude of impact, resulting in a potential impact of Slight significance.

Superficial Geology

13.4.16 Superficial geology (negligible value/importance) within the study area is likely to be impacted by the construction of all cuttings and other earthworks as part of the proposed scheme. The reduction in extent of superficial deposits, including made ground, as a result of the construction activities is considered to be of minor magnitude because of the widespread presence of these deposits elsewhere in the region. This results in an overall impact significance of Neutral during both the construction and operation phases.

Bedrock Geology

13.4.17 The screening assessment presented in Table 13.14 and in Appendix A13.3 (Surface Water Indirect Dewatering Assessment) indicate that bedrock (negligible value/importance) is likely to be intercepted by nine proposed cuttings. This is expected to represent a negligible magnitude of impact because of the widespread presence of these deposits, resulting in an overall potential impact of Neutral significance.

13.4.18 The use of blasting to excavate bedrock in places cannot be ruled out at this stage. There are three major mechanisms where rock blasting can impact on rock structure:

- generation of new fractures in previously intact rock;
- dilation of existing joints and discontinuities by the action of high pressure explosive gases; and
- promotion of slip planes along favourably oriented joints and fracture surfaces.

13.4.19 All three mechanisms are vibration controlled. The generation of new fractures in previously intact rock and the dilation of existing joints and discontinuities occur close to the blast zone (termed ‘near-field’ effects), and the promotion of slippage along favourably oriented joints can occur several hundreds of metres from the blast (termed ‘far-field’ effects).

13.4.20 Blasting effects on rock mass, as described above, may result in consequential impacts on hydrogeology by creating or changing groundwater pathways. Potential impacts could therefore occur if the Contractor opts to use explosives in the excavation of the cuttings where there are sensitive hydrogeological receptors and significantly contaminated sites in relatively close proximity. The potential impact of blasting on groundwater is assessed in the groundwater section. Blasting on solid geology is considered to be a potential impact of negligible magnitude.

13.4.21 On this basis the overall significance of potential impacts from blasting operations on solid geology is considered as Neutral.

Geotechnical Hazards

13.4.22 Earthworks are proposed in areas of existing geotechnical hazards. It is considered that there is potential for the failure of both natural and engineered slopes in the future if the hazard is not mitigated through implementation of good practice measures and design. Geotechnical hazards will be considered post DMRB Stage 3 within the specimen design and subsequent detailed design.

13.4.23 Erosion impacts and changes in fluvial geomorpohology along surface waters are assessed separately in Chapter 19 (Road Drainage and the Water Environment).

Groundwater

13.4.24 No discharge to groundwater is proposed as part of the design is for all SuDS ponds and associated infrastructure to be lined.

13.4.25 There are several ways that the proposed scheme may impact on groundwater features during construction and operation. These include:

- Through dewatering or aspects of infrastructure which may impede or alter local hydrological regimes and groundwater flows,
- Through creation of new vertical flow paths; and
- Through spillage or leakage of fuels or oils from storage tanks or construction plant which, without suitable mitigation measures can enter aquifers and subsequently migrate.

13.4.26 The Sichardt method (e.g. Preene et al., 2016) was used to estimate the zone of influence of dewatering around each of the proposed excavation areas, required for the proposed scheme which are considered likely to intercept groundwater, using the dimensions of the excavation and the estimated drawdown of groundwater levels. The potential impacts on groundwater and groundwater associated receptors within this zone of influence were then assessed for each proposed cutting.

Groundwater Flow

13.4.27 Table 13.14 indicates that 36 cuttings have the potential to intercept groundwater within the superficial deposits. Eight of these cuttings also have the potential to intercept groundwater within the bedrock. This is expected to create a local dewatering effect within the superficial and bedrock deposits of minor and negligible magnitude respectively within the context of the wider aquifer. The assessment of impact on groundwater from cutting dewatering effects is provided in Table 13.16.

Table 13.16: Potential Impact of Cutting Dewatering on Groundwater During Both Construction and Operation Phases.

Geological Unit	Value/ Importance	Magnitude of Impact	Impact Significance
Glaciofluvial Deposits	High	Minor	Slight

Geological Unit	Value/ Importance	Magnitude of Impact	Impact Significance
River Terrace Deposits and Alluvial Fan Deposits	Medium	Minor	Slight
Glacial Till, Peat/peaty soils and Made Ground	Low	Minor	Slight
Arbuthnott-Garvock Group	Medium	Negligible	Slight
Southern Highland Group	Low	Negligible	Slight

13.4.28 Retaining walls (including sheet pile walls) are also proposed at various locations across the scheme which could result in changes to groundwater flow paths if the sheet pile walls extend long enough or deep enough to present a significant barrier to groundwater movement. The available details regarding the proposed retaining walls are summarised in Table 13.17.

13.4.29 In general, the retaining walls are orientated perpendicular to the anticipated direction of groundwater flow but are less than circa 120m long and do not fully penetrate the superficial deposits and so would not create a full barrier to groundwater flow. Any impact is likely to be local to the retaining walls and of negligible magnitude. The only exception would be the Birnam retaining wall which is anticipated to fully penetrate the superficial deposits, keying into the underlying bedrock, with the wall extending to circa 350m in length. However, the deposits are anticipated to be predominantly coarse sand and gravel at this location and to have high hydraulic conductivity which is likely to permit groundwater flow to occur around the edges of the wall. Groundwater levels in proximity to the Birnam retaining wall are also relatively deep (circa 10mbgl) and so any local rise in water level as a result of construction of the sheet pile wall is likely to be minor in magnitude. Overall, impact significance from construction of the retaining walls is assessed as Slight.

Table 13.17: Potential Impact of Retaining Walls on Groundwater Flow During Both Construction and Operation Phases.

Retaining Wall Location	Chainage	Length (m)	Depth (mBGL)	Depth of superficials (mBGL)	Geology
Dunkeld and Birnam Car Park	3320-3350	30	11	>25	Gravel
Dunkeld and Birnam Station	3280-3380	100	14	>30	Sand
Birnam Retaining Wall	3500-3850	350	19	10.5	Gravel and Pelite
A822 Dunkeld Junction	A822 20-70	50	17.5	>27	Gravel
Inver Mill Lade Culvert	4870-4990	120	1.5	>22	Sand and Gravel

Groundwater Quality

13.4.30 The construction of sheet pile walls and other piles associated with structures could potentially create new flow paths for vertical migration of pollutants from the surface down to the underlying aquifers. However, the risk of vertical flow paths being created along the edge of the piles is limited as typically construction of piles results in lateral displacement of the material they pass through, thereby causing a local reduction in volume, increase in density and a decrease in vertical permeability. The magnitude of impact is expected to be minor resulting in an overall impact significance of Slight.

13.4.31 In the event of accidental spillage during construction or operation, potential contamination may migrate from the ground surface through the unsaturated zone, reaching the shallow superficial aquifers and impairing groundwater quality, unless appropriate measures for control of discharge and drainage are taken. Impacts on groundwater from land contamination sources is discussed in the following section.

13.4.32 The magnitude of potential impact from accidental spillages is considered to be moderate for superficial groundwater and minor for bedrock groundwater, because of the potential for attenuation and dilution of contamination before it reaches bedrock groundwater. The assessment of accidental spillage impacts on these aquifers is provided in Table 13.18.

Table 13.18: Potential impact of accidental spillages on groundwater aquifers during both construction and operation phases.

Groundwater Aquifer	Value/ Importance	Magnitude of Impact	Impact Significance
Isla and Lower Tay Sand and Gravel aquifer	High	Moderate	Large
Tummel and Tay Sand and Gravel aquifer	High	Moderate	Large
Bankfoot aquifer	High	Minor	Moderate
Killin, Aberfeldy and Angus Glens aquifer	Medium	Minor	Slight

13.4.33 Potential impacts of accidental spillages on surface water features are discussed in Chapter 19 (Road Drainage and the Water Environment).

Abstractions

13.4.34 No PWS have been identified in close proximity to the proposed scheme and therefore no PWS have been identified as at risk of water quality impairment due to accidental spillage.

13.4.35 One PWS (TB-PWS1, as detailed in Table 13.12), of High value, has been identified within the predicted zone of influence of dewatering of an excavation expected to intercept groundwater. The predicted potential magnitude of impact on groundwater level and flows at the location of the PWS is minor resulting in an impact significance of Slight/Moderate.

13.4.36 There are no other PWS located in the vicinity of the predicted zone of influence of dewatering for each of the cuttings or excavations which are expected to intercept groundwater as per Table 13.14. Therefore, no potential significant impacts to PWS with respect to dewatering effects are predicted.

Groundwater Effects on Surface Water

13.4.37 Potential surface water quality impairment or reduction in baseflow contribution, as a result of the potential impact on the groundwater environment, has been assessed based on the proximity of surface water features to areas where potential impacts on the groundwater environment could occur. It is assumed that a degree of hydraulic connectivity exists between the groundwater and surface water systems.

13.4.38 Surface water features are referenced as per the water feature (WF) numbering system presented in Chapter 19 (Road Drainage and the Water Environment). The sensitivity of each surface water feature follows the guidance provided in Table 13.3 and reflects the hydrological importance of that surface water feature in supporting sensitive ecosystems.

13.4.39 A tiered assessment of potential impacts on surface water features as a result of dewatering effects is provided within Appendix A13.3 (Surface Water Indirect Dewatering Assessment). The first tier of assessment adopted a conservative and generic approach, identifying surface water features within the calculated zone of influence and deriving the potential magnitude of impact based on the expected groundwater drawdown. Surface water features with a potential initial impact significance of Moderate or above then progressed to the second tier of assessment where a conceptual model specific to each cutting was established to inform an updated assessment.

13.4.40 The findings from this tiered assessment established that no significant potential impacts upon surface water features as a result of indirect dewatering effects were identified.

Geotechnical impacts on Groundwater

13.4.41 Where dewatering occurs in superficial deposits, there is a risk that additional and differential settlement could impact nearby infrastructure and properties, as well as listed buildings and scheduled monuments.

13.4.42 Potential settlement at these receptors was analysed using the Burland and Burbidge method, which is laid out in Foundation Design and Construction, 7th Edition (Tomlinson, 2001). This method of analysis was selected as the ground conditions throughout the site were generally consistent (i.e. predominately silty sands and gravels). The potential impacts due to settlement along the proposed scheme are summarised in Appendix A13.2.

13.4.43 For the settlement assessment, listed buildings and scheduled monuments have been attributed a very high sensitivity, the Highland Mainline railway has been attributed a high sensitivity, and the remaining infrastructure and properties are of medium sensitivity, considering the criteria in Table 13.3. The calculated settlement at each receptor has been assigned a magnitude criteria after Table 13.4.

13.4.44 Appendix A13.2 indicates that settlement within the sands and gravels due to the drawdown of groundwater is generally Negligible or Minor in magnitude, resulting in an overall impact significance of Neutral or Slight. However, there is a single impact significance of Moderate at Pond I due to the historic military bridge to the immediate north of the pond.

13.4.45 The construction of embankments may result in localised compaction of superficial deposits. This would result in localised impacts of negligible magnitude for groundwater flow and has therefore been assessed as being of Neutral significance on groundwater within the superficial deposits.

Ecological receptors with potential groundwater component

13.4.46 The potential GWTDE area of blanket bog and wet woodland identified at the Muir of Thorn, approximately 2km to the south of the scheme, is not expected to be impacted by construction activities due to its distance from the scheme. However, it is located within the area of the proposed ecological mitigation activities. The site is not designated but has been assumed to have a potentially moderate or high groundwater dependence and has therefore been attributed a Moderate sensitivity.

13.4.47 Considering that the proposed activities involve a reduction of the current coniferous tree cover in this area, no significant long term adverse impact on the groundwater environment is expected. Conversely, it is possible that the reduced tree cover would result in increased wetness in the area. Consequently, a Slight positive significance of impact on the potential GWTDE is expected. However, disturbance during the ecological mitigation activities could impact the GWDTE with a potential Moderate in magnitude, resulting in an overall impact significance of Moderate.

Land Contamination

13.4.48 The land contamination risk assessment within the draft GeAR (Jacobs, 2024a) and summarised in Appendix A13.1 (Land Contamination Supporting Information) has explored the plausible pollutant linkages associated with the proposed scheme. This risk assessment has informed the EIAR impact assessment. A key aspect of the impact assessment has been to consider the works proposed for the scheme in the context of the known or anticipated baseline conditions, identified receptors and how these may realistically interact.

13.4.49 It should be noted that septic tanks were originally included as potential sources of land contamination. However, although local occurrences of direct disturbance may occur, septic tanks are not considered to be a significant source of contamination and as such were screened out of the assessment.

Human Health

On-site

13.4.50 Disturbance of sub-surface material will be required during construction of the scheme, which will expose construction workers and maintenance workers (high value) to risk of dermal contact and inhalation at potentially unacceptable levels. Some elements of the proposed scheme will also involve excavation below groundwater levels, in addition to which local minor

perched groundwater bodies may be present, which present a potentially unacceptable risk to construction works via dermal contact and ingestion. Excavations below ground surface will create confined spaces within which ground gas could accumulate which may pose a potentially unacceptable risk of asphyxiation, explosion and poisoning for construction workers.

13.4.51 Based on the high likelihood of exposure, plausible pollutant pathways and the nature of potential contaminant sources, the impact magnitude is assessed as Moderate Adverse during construction and operation. The resultant impact significance is considered to be Moderate during construction and operation.

Future site users and off-site receptors

13.4.52 Adjacent residential, open space, commercial/industrial and road areas will have an indirect exposure pathway, ingestion, inhalation and dermal contact via the windblown soil dust and fibres from excavations and stockpiles of excavated contaminated materials during construction. The same pathway, inhalation and dermal contact via windblown soil dust and fibres related to potential re-use of contaminated materials within embankment soils exists for future site users (road users) and adjacent/neighbouring (off-site) human health during operation. The different receptor groups have been assigned a value reflective of the nature of typical land use (for example long-term exposure (residential) versus transient exposure (road)). Therefore, although the pathway is the same, the impact significance for each receptor group is different. The predicted impact significance prior to essential mitigation is presented in Table 13.19 and is based on the likelihood of exposure and the nature of the potential contaminant sources.

Table 13.19: Potential Impact to Off Site Human Receptors from Indirect Pollutant Pathway (windblown soil dust and fibres)

Receptor Group	DMRB Value	Magnitude		Significance	
		Construction	Operation	Construction	Operation
Residential	Very High	Minor Adverse	Minor Adverse	Moderate	Moderate
Open Space	High			Moderate	Slight
Commercial/ Industrial	Medium			Moderate	Slight
Road	Low	Minor Adverse	Negligible	Slight	Neutral

13.4.53 The proposed scheme is not expected to change the existing ground gas regime (made ground is fairly permeable with large areas of open ground allowing the natural venting of ground gas to atmosphere). Therefore, no change to existing ground gas pathways to residential occupants/buildings/services is predicted.

13.4.54 The proposed scheme is also considered unlikely to significantly alter existing groundwater flow patterns and so no change to existing groundwater pathways to residential occupants/buildings/services is predicted.

Water Environment

13.4.55 It is not anticipated that the proposed scheme will alter the existing baseline pollutant pathways; however, the scheme may introduce new potential pollutant linkages such as the leaching/migration/runoff from stockpiled excavated contaminated material and creation of new preferential pathways via construction activities such as piling.

13.4.56 As shown in Table 13.14, the proposed scheme is likely to intercept groundwater in 12 locations, which may cause minor changes to groundwater flow patterns, and discharge of active dewatering will be required.

Superficial Groundwater

13.4.57 There may be direct interaction with the superficial groundwater bodies (high value) comprised predominantly of glaciofluvial deposits, river terrace deposits and alluvial fan deposits. The land contamination risk assessment within Appendix A13.1 has identified a number of potential pollutant linkages with Low risk to the receptors. Based on the likelihood of exposure and the nature of the potential contaminant sources, the impact magnitude is assessed as Minor adverse during construction. The resultant impact significance is considered to be Slight during construction and during operation prior to essential mitigation.

Bedrock Groundwater

13.4.58 The land contamination assessment within Appendix A13.1 has identified a number of pollutant linkages with Low risk to bedrock groundwater (Bankfoot aquifer and Killin, Aberfeldy and Angus Glens aquifer) (medium and low value respectively), including from piling activities during construction and operation. Based on the pollutant linkages and the nature of potential contamination sources, the impact magnitude is assessed as Minor adverse. The resultant impact significance is considered to be Slight during both construction and operation prior to essential mitigation.

Surface Water

13.4.59 The land contamination assessment within Appendix A13.1 has identified low risks to surface water features via pollutant linkages associated with potential leaching of in-situ soils and construction material stockpiles.

13.4.60 It has however been assessed that the release of contaminants into the surface water at unacceptable concentrations is unlikely from in-situ materials given the limited leaching potential of the soils recorded in laboratory analysis and the dilution, dispersion and attenuation of contaminants within groundwater flow prior to discharge to surface water baseflow.

13.4.61 During construction works, based on the likelihood of exposure and nature of the potential contaminant sources, the impact magnitude for the River Tay and River Braan (Very High Value) is assessed as Minor adverse, resulting in an impact significance of Moderate prior to mitigation.

13.4.62 During operation, is unlikely that the soils will release any significant contamination via leaching on account of the reduction of infiltration/ percolation of rainfall through the soils beneath road construction materials. The impact magnitude to the River Tay and River Braan (Very High Value) is assessed as Negligible adverse, resulting in an impact significance of Slight.

Property

13.4.63 The land contamination assessment within Appendix A13.1 identified property (livestock) (low value) as a potential receptor. However, as no viable pathways were identified the impact has been assessed as negligible both during construction and operation. The resultant impact significance is considered to be Neutral during both construction and operation.

13.4.64 There is no change expected to existing ground conditions for existing structures on and off site. Therefore, no change is predicted for current residential (Very High Value) and commercial/industrial (Medium Value) during both construction and operation with respect to chemical attack via direct contact with contaminants in soil and groundwater.

13.4.65 Aggressive soil and groundwater conditions can affect the durability and design life of buried concrete where it is in direct contact via chemical attack. The new infrastructure and services included in the proposed scheme have been assigned a medium value. Based on likelihood of exposure and contaminant nature, the impact magnitude is assessed as Negligible during operation and construction. The resultant significance of effect is considered to be Neutral during operation prior to essential mitigation.

13.4.66 The proposed scheme is not expected to fundamentally change the existing ground gas regime, however, there remains a small potential for short term and/or permanent alterations in the ground gas regime. This could potentially allow migration and accumulation of ground gas within off-site properties (High Value). Based on the likelihood of exposure and the nature of potential contaminant sources, the impact magnitude is assessed as Minor adverse during both construction and operation. The resultant significance of effect is considered to be Slight during both construction and operation prior to essential mitigation.

Ecological

13.4.67 The River Tay is also considered an ecological receptor due to its designation as a SAC. The same risks identified for the surface water from the leaching of contaminated soils/ stockpiles apply to the identified environmentally sensitive area, with the resultant significance of effect considered to be Moderate during construction and Slight during operation prior to essential mitigation for the scheme. Risks to surface waters posed by sediment run off are discussed separately in Chapter 12 (Biodiversity)

13.5 Mitigation

13.5.1 Mitigation measures for the proposed scheme in relation to geology, soils, groundwater and land contamination are detailed below and take into account best practice, legislation, guidance and professional experience. Standard mitigation measures applying throughout the proposed scheme (prefixed G) and project specific measures (prefixed P02) are set out in Chapter 22 (Schedule of Environmental Commitments).

13.5.2 This chapter makes reference to overarching standard measures applicable across A9 dualling projects ('SMC' mitigation item references), and also to project-specific measures ('P02' mitigation item references). Those that specifically relate to geology, soils, land contamination and groundwater as assigned a 'G' reference. Additional mitigation measures relevant to Biodiversity, Material Assets and Waste, Road Drainage and the Water Environment that may be complementary to those set out below are detailed in Chapters 12, 14 and 19 respectively.

Embedded Mitigation

13.5.3 The DMRB Stage 3 design process has avoided or reduced many potential impacts by reducing land-take wherever possible.

13.5.4 With regards to groundwater quality, unless it can be demonstrated by the Contractor via a Quantitative Risk Assessment that no water quality impacts will occur due to leaching from Sustainable Urban Drainage System (SuDS) ponds, basins or wetland features, operational SuDS features and associated infrastructure are to be lined. Any potential water quality impacts due to leaching from SuDS features will be addressed through the Controlled Activities Regulations (CAR) process (Mitigation Item SMC-G13).

Standard Mitigation

Geology and Soils

13.5.5 Soil resources will be managed in accordance with the Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (Defra, 2009). This will include the careful excavation, storage and replacement of topsoil and subsoil (**Mitigation Item SMC-LU8**).

13.5.6 Reasonable precautions will be taken during construction to avoid spreading of soil-borne pests and diseases, animal and crop diseases, tree pests and diseases and invasive species. A biosecurity protocol will be developed by the contractor in consultation with the animal and plant health agency, the Scottish Government Environment and Forestry Directorate and the Scottish Government Agriculture, Food and Rural Communities Directorate, taking cognisance of relevant UK and Scottish Government biosecurity guidance including SEPA Guidance: Disposal of trees and plants infected with specific plant diseases (SEPA, 2013) (**Mitigation Item SMC-LU9**).

13.5.7 On completion of works, any land required for construction works will be reinstated as far as practicable and in line with mitigation plans. A record of condition survey is to be undertaken of any land to be returned to agriculture, to ensure all land is restored as near to its original condition as is reasonably practicable (**Mitigation Item SMC-LU14**).

13.5.8 Whilst no substantial peat horizons are expected to be encountered during construction of the scheme, there may be localised deposits encountered within the BotS. If peat is encountered during construction to avoid localised detrimental effects an outline Peat Management Plan (PMP) will be developed as part of the CEMP in accordance 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 Developments on Peat and Off-Site Uses of Waste Peat (SEPA, 2017c). The PMP (and CEMP) will comply with relevant waste management practices under The Waste Management

Licensing (Scotland) Regulations 2011 (Scottish Government, 2011b) (**Mitigation Item SMC-G10**). Peat will be extracted, excavated, stored, with any off-site removal undertaken with cognisance of the above.

13.5.9 Risk assessments will be undertaken before explosives can be used on site to minimise or control the impact of blasting on bedrock geology (**Mitigation Item SMC-G15**).

Groundwater Quality

13.5.10 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. This is to ensure that no polluted water percolates into the ground or contaminated run-off is generated (**Mitigation Item SMC-G14**).

13.5.11 Mitigation measures to address the potential impacts of accidental spillages on surface water features are discussed in Chapter 19 (Road Drainage and the Water Environment).

Land Contamination

13.5.12 Direct interaction is expected between construction of the proposed scheme and areas of land potentially affected by land contamination. This interaction could lead to direct and indirect impacts to human health and the water environment which have been predicted to range from Moderate to Slight significance. The standard mitigation items described below would be implemented to negate or minimise the predicted impacts and to minimise the contact with any potentially contaminated soil or groundwater.

13.5.13 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, 2017). Any remedial action undertaken in relation to land affected by contamination will be carried out under the appropriate remediation licencing (**Mitigation Item SMC-G1**).

13.5.14 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 (**Mitigation Item SMC-G2**).

13.5.15 Prior to construction, appropriate health and safety and waste management procedures for working with potentially contaminated soils will be established. Waste management procedures will take account of inter alia Waste Management Licence (Scotland) Regulations 2011 (as amended by the Waste Management Licensing (Scotland) Amendment Regulations 2016) (Scottish Government, 2011b), HSE Guidance Note MS31 (HSE, 2018), the Health and Safety Commission Approved Code of Practice and Guidance Note L143 (HSE, 2013) and Developments on Peat and Off-Site Uses of Waste Peat (SEPA, 2017c). These procedures will be implemented as appropriate during construction (**Mitigation Item SMC-G3**).

13.5.16 Risks to construction and maintenance staff working with/near land affected by contamination will be mitigated by the implementation of **Mitigation Item SMC-G3** in

combination with the adoption of appropriate systems of work, including personal protective equipment (PPE) as a last resort. In the event that unrecorded contamination is encountered, works should be stopped and the working procedures reassessed to confirm the working methods remain appropriate (**Mitigation Item SMC-G4**).

13.5.17 Appropriate training of personnel involved in earthworks activities to implement a watching brief to identify potential presence of previously unidentified contamination (**Mitigation Item SMC-G5**).

13.5.18 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 BotS they will be relocated and/or rebuilt subject to discussion and agreement with the affected landowner(s) (**Mitigation Item SMC-G6**).

13.5.19 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' (**Mitigation Item SMC-G7**).

13.5.20 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 scheme (**Mitigation Item SMC-G9**). Further information relating to material reuse is provided in Chapter 14: Material Assets and Waste.

13.5.21 If excavated soils are deemed unsuitable for reuse they 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, 2015) prior to disposal to determine whether they are hazardous or non-hazardous. This will establish the most appropriate and cost effective waste stream for the waste materials (**Mitigation Item SMC-G8**).

13.5.22 Where concrete materials are proposed to be used, appropriate guidance such as 'Building Research Establishment (BRE) SD1:2005' and 'British Standard (BS) BS8500' (BSI, 2023a and BSI, 2023b) should be followed to ensure that ground conditions are appropriate for the use of concrete at each given location (**Mitigation Item SMC-G11**).

13.5.23 Where potential pollutant pathways for ground gas have been identified, a ground gas monitoring programme 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 (**Mitigation Item SMC-G12**).

Cross-chapter Mitigation

13.5.24 In addition to the mitigation measures identified specifically with respect to geology, soils, land contamination and groundwater, standard mitigation items from Chapter 8 (Air Quality) Chapter 16 (Population – Land Use), Chapter 19 (Road Drainage and the Water Environment) and will offer additional protection.

Specific Mitigation

Agricultural Soils

13.5.25 Where areas of land within the Compulsory Purchase Orders are identified as being surplus following construction of the proposed scheme, former owners may, as a general principle, be offered the opportunity to repurchase the land previously in their ownership in accordance with normal procedures (Crichel Down Rules).

13.5.26 The full depth of topsoil would be stripped from areas to be disturbed by construction, such as haul roads, compounds subsoil stockpile locations, and from areas where topsoil would otherwise be sealed by permanent development (hardstanding). This soil should be sustainably reused on Site as far as possible, with any surplus material collected by a regional waste contractor for reuse or recycling (**Mitigation Item P02-G17**).

13.5.27 In addition to **Mitigation Item SMC-LU8**, the following measures apply to topsoils and subsoils to be restored to agricultural land or reused in shallow landscaping/ecological mitigation areas, to a maximum depth of 1.2m of the final landform:

- Appropriate supervision of soil management should be put in place to ensure that soils are handled in accordance with good practice and the soil management plan; and
- Topsoil and subsoil should only be handled or trafficked when the surface is free of standing water and not frozen. Soils should only be handled when they are in a reasonable dry and friable state, below the plastic limit (**Mitigation Item P02-G18**).

Geotechnical Hazards

13.5.28 Detailed assessment of slope stability will be required to determine the appropriate slope angles for the cuttings and embankments and to confirm that the works will have no detrimental effect on the existing geotechnical hazards (**Mitigation Item P02-G19**).

13.5.29 The angle at which rock slopes can be stable is dependent on various location-specific factors including the presence and nature of discontinuities (dip, dip direction, persistence, spacing, infill, etc.), and the interactions between the main discontinuity sets. It is critical that these factors are considered during rock slope design and that a kinematic analysis is undertaken to inform rock slope stability.

13.5.30 Blasting using pre-split techniques may reduce the potential for future slope instability; however, the effects of any proposed blasting operations should consider the potential for blast-induced damage to sensitive receptors. These could include existing services and the Highland Mainline railway; blast plans should be prepared to manage any blasting works. (**Mitigation Item P02-G20**).

13.5.31 Appropriate slope drainage should be given due consideration as an integral part of cutting design. These can include, but are not limited to, crest drainage, counterfort slope drainage and in-slope drainage comprising raking drains. Slope drainage should be tied-in to the road drainage, if possible (**Mitigation Item P02-G21**).

Groundwater Flow

13.5.32 Seventeen cuttings are expected to intercept groundwater as per Table 13.14. The potential volume of groundwater drainage will be considered in the context of potential groundwater abstraction CAR licences during construction, prior to works commencing (**Mitigation Item P02-G16**).

Abstractions

13.5.33 No abstractions have been identified to be at risk of significant impact from the proposed scheme, therefore no mitigation will be required.

Ecological receptors with potential groundwater component

13.5.34 Standard mitigation measures specified to protect groundwater and surface water would mitigate potential impacts on the area of blanket bog and wet woodland identified at the Muir of Thorn during implementation of the ecological mitigation activities proposed at this location.

13.6 Residual Effects

13.6.1 Residual effects on geology are expected to be of Neutral significance, with potential beneficial effects as a result of the exposure of new rock cuttings.

13.6.2 The implementation of a soils management plan and good practice soil management measures is expected to reduce the potential for soil degradation and sealing during construction resulting in residual effects on soils of Slight significance.

13.6.3 The implementation of mitigation measures in relation to land contamination issues and direct/indirect impacts is expected to reduce potential impacts to a residual effect of Slight significance during the construction phase and Neutral significance during the operational phase.

13.6.4 Localised residual effects of Slight significance are expected on groundwater flow within superficial deposits and bedrock deposits.

13.6.5 Residual effects on differential settlement are assessed as Negligible to Slight, with a single occurrence of Moderate.

13.6.6 The implementation of mitigation measures in relation to the protection of the water environment against pollution incidents is expected to reduce the potential impacts on groundwater quality and associated receptors to a residual effect of Slight and Neutral significance (respectively).

13.6.7 A residual effect of Slight/Moderate significance was identified on one PWS. No other PWS were identified as being at risk of impact, so residual risk is expected to be Neutral.

13.6.8 Residual effects on surface water receptors from indirect dewatering are expected to be Neutral to Slight or Moderate.

13.6.9 The implementation of mitigation measures in relation to the protection of the water environment is expected to reduce potential impacts on the potential GWTDE area of bog and bog woodland identified at the Muir of Thorn to a residual effect of Slight.

13.7 Compliance Against Plans and Policy

13.7.1 DMRB LA 104, Environmental Assessment and Monitoring, states that environmental assessment, reporting and monitoring shall meet the requirements of the national planning policy for each relevant Overseeing Organisation.

13.7.2 Appendix A3.1 (Assessment of Policy Compliance) identifies a topic specific review of national and local policy documents which are of relevance to the assessment undertaken and reported in this chapter in accordance with DMRB guidance. The compliance assessment undertaken in Appendix A3.1 focuses principally on the long term effects of the proposed scheme rather than the short term temporary effects from construction.

13.7.3 National policy objectives of relevance to this assessment are provided in the National Planning Framework 4 (Scottish Government, 2023) and good practice guidance in Planning Advice Note (PAN) 33 (Development of Contaminated Land). In addition, the Perth and Kinross Local Development Plan 2 (Perth and Kinross Council, 2019) Policies 51 (Soils), 52 (New Development and Flooding), 53 (Water Environment and Drainage), and 58A (Contaminated Land) are also applicable.

Summary of Policy Compliance

13.7.4 Overall, the design and assessment of the proposed scheme has had regard to, and is compliant with, policy objectives to minimise effects on geology, soils, groundwater and land contamination. A full policy compliance assessment can be found in Table A3.1-6 of Appendix 3.1 (Assessment of Policy Compliance).

13.8 Statement of Significance

13.8.1 Overall, the residual effects on geology, soils, groundwater and land contamination are predicted to be not significant.

13.9 References

National Legislation and EU Directives

European Commission (2000). Council Directive (2000/60/EC) Water Framework Directive. Available at: https://eur-lex.europa.eu/eli/dir/2000/60/oj/eng (Accessed February 2025).

European Commission (2006). Council Directive (2006/118/EC) Groundwater Directive. Available at: https://eur-lex.europa.eu/eli/dir/2006/118/oj/eng (Accessed February 2025).

European Commission (1991). Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources (Nitrates Directive). Available at: https://ec.europa.eu/environment/water/water-nitrates/index_en.html (Accessed February 2025).

Scottish Executive (2006). Environmental Protection Act 1990: Part IIA Contaminated Land – Statutory Guidance: Edition 2. Scottish Government. Available at: https://www.gov.scot/publications/environmental-protection-act-1990-part-iia-contaminated-land-statutory-guidance/pages/66/ (Accessed February 2025).

Scottish Government (2003). Water Environment Water Services (WEWS) (Scotland) Act 2003. Available at: https://www.legislation.gov.uk/asp/2003/3/contents (Accessed February 2025).

Scottish Government (2005). The Contaminated Land (Scotland) Regulations 2000 (as amended by the Contaminated Land (Scotland) Regulations 2005). Available at: https://www.legislation.gov.uk/ssi/2005/658/contents/made (Accessed February 2025).

Scottish Government (2011a). The Water Environment (Controlled Activities) (Scotland) Regulations 2011, (as amended 2021). Available at: https://www.legislation.gov.uk/ssi/2011/209/contents (Accessed February 2025).

Scottish Government (2011b). The Waste Management Licensing (Scotland) Regulations 2011. (as amended by the Waste Management Licensing (Scotland) Amendment Regulations 2016). Available at: https://www.legislation.gov.uk/sdsi/2011/9780111012147/contents (Accessed February 2025).

Scottish Government (2017a). The Roads (Scotland) Act 1984 (Environmental Impact Assessment) Regulations 2017. Available at: https://www.legislation.gov.uk/ssi/2017/137/contents/made (Accessed February 2025).

Scottish Government (2017b). The Water Environment (Miscellaneous) (Scotland) Regulations 2017. Available at: https://www.legislation.gov.uk/ssi/2017/389/contents/made (Accessed February 2025) (Accessed February 2025).

UK Government (1995). Environment Act 1995. Available at: https://www.legislation.gov.uk/ukpga/1995/25/contents (Accessed February 2025).

Documents and Reports

AECOM (2016). A9 Dualling: Pass of Birnam to Tay Crossing, Ground Investigation Report, Final Rev 03.

British Geological Society (BGS) (2025). BGS Onshore Geoindex. Available at: https://mapapps2.bgs.ac.uk/geoindex/home.html (Accessed March 2025).

British Geological Society (BGS) (1988). Hydrogeological Map of Scotland. Scale 1:625,000.

British Geological Society (BGS) (1995). Groundwater Vulnerability Map of Scotland. Scale 1: 625,000.

British Geological Society (BGS) (2006). Baseline Scotland: the Lower Devonian aquifer of Strathmore British Geological Survey Commissioned Report, CR/06/250N. 60pp.

British Standards Institution (BSI) (2017). BS10175:2011 Investigation of potentially contaminated sites – code of practice (+A2:2017). Available at: https://knowledge.bsigroup.com/products/investigation-of-potentially-contaminated-sites-code-of-practice-code-of-practice (Accessed February 2025).

British Standards Institution (BSI) (2023a). BS8500-1:2023 Concrete – Complementary British Standard to BS EN 206 – Part 1: Method of Specifying and guidance for the specifier.

British Standards Institution (BSI) (2023b). BS8500-2:2023 Concrete – Complementary British Standard to BS EN 206 – Part 2: Specification for constituent materials and concrete.

Building Research Establishment (BRE) (2005). SD 1 Concrete in aggressive ground. Available at: https://bregroup.com/documents/311572/1990118/189849.pdf/8c07e3b0-0dc6-ebf3-c5c8-ea8b27a28db4?version=1.0&t=1732260706991 (Accessed February 2025).

CIRIA (2001a). CIRIA Report C532: Control of water pollution from construction sites: Guidance for consultants and contractors. Available at: https://www.ciria.org/CIRIA/CIRIA/Item_Detail.aspx?iProductCode=C532&Category=BOOK (Accessed February 2025).

CIRIA (2001b). CIRIA Report C552: Contaminated Land Risk Assessment: A guide to good practice. Available at: https://www.ciria.org/CIRIA/CIRIA/Item_Detail.aspx?iProductCode=C552&Category=BOOK#:~:text=This%20book%20examine%20the%20risk%20assessment%20of%20contaminated,common%20level%20so%20as%20to%20promote%20industry-wide%20consistency. (Accessed February 2025).

Mining Remediation Authority (2025) Interactive Map Viewer Available at: https://datamine-cauk.hub.arcgis.com/ (Accessed February 2025).

DEFRA (2012). Environmental Protection Act 1990: Part 2A - Contaminated Land Statutory Guidance. Available at: https://www.gov.uk/government/publications/contaminated-land-statutory-guidance (Accessed February 2025).

Environment Agency (EA) (2023). Land Contamination: Risk Management. Available at: https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm (Accessed February 2025).

Fugro (2016a). A9 Dualling Southern Section Pass of Birnam to Tay Crossing Report on Ground Investigation without Geotechnical Evaluation, G151043UA.

Fugro (2016b). A9 Dualling Southern Section Tay Crossing to Ballinluig. Report on Ground Investigation without Geotechnical Evaluation, G151043UB.

Fugro (2018). A9 Dualling Tay Crossing to Killiecrankie. Preliminary Ground Investigation. Tay Crossing to Ballinluig Report on Ground Investigation Without Geotechnical Evaluation, G161021UA.

Fugro (2019). Report on Ground Investigation without Geotechnical Evaluation. A9 Dualling: Tay Crossing to Ballinluig – Detailed GI, G181001U.

Health and Safety Executive (HSE) (2018) Control of Asbestos Regulations 2012. Guidance for appointed doctors on medical surveillance of workers doing licensed work with asbestos. Health and Safety Executive, Publication MS31 (rev 2). Available at: https://www.hse.gov.uk/pubns/ms31.htm (Accessed March 2025).

Health and Safety Executive (HSE) (2013), Managing and working with asbestos, Control of Asbestos Regulations 2012, Approved Code of Practice and guidance L143. Available at: https://www.hse.gov.uk/pubns/books/l143.htm (Accessed March 2025).

Highways England, Transport Scotland, Welsh Government and the Department for Infrastructure Northern Ireland (2020a). DMRB LA 104 – Environmental assessment and monitoring. Available at: https://www.standardsforhighways.co.uk/search/0f6e0b6a-d08e-4673-8691-cab564d4a60a (Accessed February 2025).

Highways England, Transport Scotland, Welsh Government and the Department for Infrastructure Northern Ireland (2019). DMRB LA 109 – Geology and soils. Available at: https://www.standardsforhighways.co.uk/search/adca4c7d-4037-4907-b633-76eaed30b9c0 (Accessed February 2025).

Highways England, Transport Scotland, Welsh Government and the Department for Infrastructure Northern Ireland (2020b). DMRB LA 113 – Road drainage and the water environment. Available at: https://www.standardsforhighways.co.uk/search/d6388f5f-2694-4986-ac46-b17b62c21727 (Accessed February 2025).

Jacobs (2013a). A9 Dualling Perth to Inverness, Geotechnical Preliminary Sources Study Report, Tay Crossing to Pitlochry, Chainage 22800 to 36300m, B1557620/GEO/PSSR/02, Revision 3.

Jacobs (2013b). A9 Dualling Perth to Inverness, Geotechnical Preliminary Sources Study Report, Birnam, Chainage 13000 to 14700m, B1557620/GEO/PSSR/13, Revision 3.

Jacobs (2019). A9 Dualling: Pass of Birnam to Tay Crossing. DMRB Stage 2 EIA.

Jacobs (2024a). A9 Dualling: Pass of Birnam to Tay Crossing. Geo-environmental Assessment Report (GeAR).

Jacobs (2024b). A9 Dualling: Pass of Birnam to Tay Crossing. Ground Investigation Report (GIR).

Landmark Information Group (2015). Envirocheck Report, Order Number 65915015_1_1.

National House Building Council (NHBC) and Environment Agency and the Chartered Institute of Environmental Health (CIEH) (2008). Guidance for the Safe Development of Housing on Land Affected by Contamination, 2008 Volume 1. Available at: https://www.nhbc.co.uk/binaries/content/assets/nhbc/products-and-services/tech-advice-and-guidance/guidance-for-the-safe-development-of-housing-on-land-affected-by-contamination.pdf (Accessed February 2025).

Natural Resources Wales, SEPA, Northern Ireland Environment Agency, Environment Agency (2015) Waste Classification: Guidance on the classification and assessment of waste (1st Edition v1.2 GB) (Technical Guidance WM3). May 2015. Available at https://assets.publishing.service.gov.uk/media/6152d0b78fa8f5610b9c222b/Waste_classification_technical_guidance_WM3.pdf (Accessed February 2025).

NatureScot (2016). (Previously Scottish Natural Heritage (SNH)). Carbon-rich soils, deep peat and priority peatland habitat mapping, Consultation analysis report. https://www.nature.scot/professional-advice/planning-and-development/natural-heritage-advice-planners-and-developers/planning-and-development-soils/carbon-and-peatland-2016 (Accessed February 2025).

NatureScot (2023). Advising on peatland, carbon-rich soils and priority peatland habitats in development management.Available at: https://www.nature.scot/doc/advising-peatland-carbon-rich-soils-and-priority-peatland-habitats-development-management (Accessed May 2025).

NatureScot (2025). NatureScot data services, SiteLink interactive map. Available at: https://sitelink.nature.scot/map (Accessed March 2025).

Perth & Kinross Council (2019). Adopted Perth and Kinross Local Development Plan 2. Available at: https://www.pkc.gov.uk/ldp2 (Accessed March 2025).

Preene M, Roberts T O L, Powrie W and Dyer M R (2016). Groundwater control: design and practice. CIRIA, Second Edition Publication C750, London.

Scotland's Soils (2018) Part of Scotland's Environment. Soil Survey of Scotland 1:250 000 Scanned maps (1980s). Available at: https://soils.environment.gov.scot/maps/scanned-soil-maps/soil-survey-of-scotland-1250-000-scanned-maps/ (Accessed March 2025).

Scotland's Soils (2023) Part of Scotland's Environment. Carbon and Peatland 2016 Map. Available at: https://map.environment.gov.scot/Soil_maps/?layer=10 (Accessed March 2025).

Scott Wilson (2011). A9 Pass of Birnam to Tay Crossing Preliminary Sources Study Report.

Scottish Environment Protection Agency (SEPA) (2013). SEPA Guidance: Disposal of trees and plants infected with specific plant diseases. WST-G-037, Version 1, March 2013. Available at: https://www.sepa.org.uk/media/154389/wst-g-037-disposal_of_trees_plants_with_specific_diseases.pdf (Accessed April 2025).

Scottish Environment Protection Agency (SEPA) (2014). Position Statement: Assigning Groundwater Assessment Criteria for Pollutant Inputs. WAT-PS-10-01, Version 3.0, August 2014. Available at: https://www.sepa.org.uk/media/152662/wat_ps_10.pdf#:~:text=This%20document%20describes%20how%20the%20prevent%20and%20limit,where%20a%20quantitative%20assessment%20is%20being%20carried%20out. (Accessed March 2025).

Scottish Environment Protection Agency (SEPA) (2017a) Regulatory Method (WAT-RM-11) Licensing Groundwater Abstractions including Dewatering. V6. Available at: https://www.sepa.org.uk/media/151997/wat-rm-11.pdf#:~:text=This%20regulatory%20method%20sets%20out%20SEPA%E2%80%99s%20process%20for,Water%20Environment%20%28Controlled%20Activities%29%20%28Scotland%29%20Regulations%202011%20%28%E2%80%9CCAR%E2%80%9D%29. (Accessed February 2025).

Scottish Environment Protection Agency (SEPA) (2017b) Land Use Planning System Guidance Note 31: Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems. Scottish Environment Protection Agency, LUPS-GU31, Version 3, 11 September 2017. Available at: https://www.sepa.org.uk/media/143868/lupsgu31_planning_guidance_on_groundwater_abstractions.pdf (Accessed February 2025).

Scottish Environment Protection Agency (SEPA) (2017c) Developments on Peat and Off-Site Uses of Waste Peat. WST-G-052, Version 1, May 2017. Available at: https://www.sepa.org.uk/media/287064/wst-g-052-developments-on-peat-and-off-site-uses-of-waste-peat.pdf#:~:text=SEPA%20has%20a%20supportive%2C%20considered%20and%20consistent%20approach,of%20management%20options%20in%20relation%20to%20excavated%20peat. (Accessed April 2025).

Scottish Environment Protection Agency (SEPA) (2020). Supporting Guidance WAT-SG-53 Environmental Quality Standards and Standards for Discharges to Surface Waters, Version 7.1. Available at: https://www.sepa.org.uk/media/152957/wat-sg-53-environmental-quality-standards-for-discharges-to-surface-waters.pdf#:~:text=Always%20refer%20to%20the%20online%20document%20for%20accurate,the%20environmental%20and%20discharge%20standards%20for%20surface%20waters. (Accessed February 2025).

Scottish Environment Protection Agency (SEPA) (2024). The Water Environment (Controlled Activities) (Scotland) regulations 2011 (as amended) A practical Guide, Version 9.4, July 2024. Available at:

https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.sepa.org.uk%2Fmedia%2Fcd3doeli%2Fcar-a-practical-guide.docx&wdOrigin=BROWSELINK (Accessed February 2025).

Scottish Environment Protection Agency (SEPA) (2024). Water Environment Hub (Now Superseded with Water Classification Hub). Available at: https://www.sepa.org.uk/data-visualisation/water-environment-hub/ (Accessed June 2024).

Scottish Environment Protection Agency (SEPA) (2025). Water Classification Hub. Available at: https://www.sepa.org.uk/data-visualisation/water-classification-hub/ (Accessed February 2025).

Scottish Government (2017). Planning Advice Note (PAN) 33: Development of Contaminated Land. Available at: https://www.gov.scot/publications/pan-33-development-of-contaminated-land/ (Accessed February 2025).

Scottish Government (2024). National Planning Framework 4. Available at: https://www.gov.scot/publications/national-planning-framework-4/ (Accessed February 2025).

Scottish Government (2024). Scotland's Environment Web. https://www.environment.gov.scot/ (Accessed February 2025).

Scottish Renewables and SEPA (2012). Developments of Peatland: Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste. Version 1. Available at: https://www.gov.scot/binaries/content/documents/govscot/publications/advice-and-guidance/2014/07/assessment-of-peat-volumes-reuse-of-excavated-peat-and-minimisation-of-waste-guidance/documents/guidance-on-the-assessment-of-peat-volumes-reuse-of-excavated-peat-and-the-minimisation-of-waste/guidance-on-the-assessment-of-peat-volumes-reuse-of-excavated-peat-and-the-minimisation-of-waste/govscot%3Adocument/Guidance%2Bon%2Bthe%2Bassessment%2Bof%2Bpeat%2Bvolumes%252C%2Breuse%2Bof%2Bexcavated%2Bpeat%252C%2Band%2Bthe%2Bminimisation%2Bof%2Bwaste.pdf (Accessed February 2025).

Soil Engineering Geoservices Limited (2015). TA7397 Report on a Ground Investigation for the A9 Dualling: Birnam to Tay Crossing.

Soil Engineering Geoservices Limited (2019). TC8191A- Report on the A9 Dualling, Project 2, Birnam Additional Boreholes.

Soil Engineering Geoservices Limited (2021). TC8191, A9 Dualling: Tay Crossing to Ballinluig, Supplementary Ground Investigation.

Soil Engineering Geoservices Limited (2023). TE8258, Report on a Ground Investigation for A9 Dualling- Birnam to Tay Crossing Supplementary Ground Investigation.

The James Hutton Institute (1982). Macaulay Institute for Soil Research, Aberdeen 1981, Soil Survey of Scotland Map, Sheet 5, Eastern Scotland. Available at:

https://www.hutton.ac.uk/sites/default/files/files/soils/Soil250k_5_Eastern_Scotland_A4.pdf (Accessed March 2025).

The James Hutton Institute (2025). Land Capability for Agriculture (LCA). Available at: https://www.hutton.ac.uk/land-capability-for-agriculture-lca/ (Accessed March 2025).

Tomlinson, M.J. (2001). Foundation Design and Construction, 7th Edition. March 2001.

Transport Scotland (2011). A9 Route Improvement Strategy – Dualling of Birnam to Tay Crossing, Stage 2 Options Assessment Report, Part 2 Environmental Assessment; Volume 1 Environmental Report; Volume 2 Figures; Volume 3 Appendix.

Transport Scotland (2013a) A9 Dualling Strategic Environmental Assessment (SEA). June 2013.

Transport Scotland (2013b). A9 Dualling Programme: Strategic Environmental Assessment – Environmental Report (June 2013). Non-technical Summary available at: https://www.transport.gov.scot/media/13023/a9_-_sea_-er_-_non-tech_summary_for_publication.pdf (Accessed February 2025).

Transport Scotland (2014a) A9 Dualling SEA Addendum Environmental Report. March 2014.

Transport Scotland (2014b). A9 Dualling Programme: Strategic Environmental Assessment (SEA) – Post Adoption Statement (September 2014). Available at: https://www.transport.gov.scot/media/35682/tssea9-dualling-sea-pas-appdx-a-eradd-rspns-final-sept2014.pdf (Accessed February 2025).

Transport Scotland (2024) Pass of Birnam to Tay Crossing Scoping Report for DMRB Stage 3 EIA.

UK Soil Observatory (2025). Map Viewer. Available at: http://mapapps2.bgs.ac.uk/ukso/home.html. (Accessed February 2025).

UKTAG (2005B). UK Technical Advisory Group on the Water Framework Directive - Draft Protocol for Determining 'Significant Damage' to a Groundwater Dependent Terrestrial Ecosystem. Available at: https://www.wfduk.org/sites/default/files/Media/Characterisation%20of%20the%20water%20environment/Determining%20significant%20damage%20to%20a%20groundwater%20dependent%20terrestrial%20ecosystem_Draft_011205.pdf (Accessed February 2025).

Winter, M.G., MacGregor, F., Shackman, L. (2008). Scottish Road Network Landslides Study: Implementation. Transport Scotland.