13 Geology and Soils

13.1 Introduction

13.1.1 This chapter provides an assessment of the impacts for the scheme in terms of geology, soils and contaminated land. Potential impacts and mitigation measures associated with the scheme in relation to geology, geomorphology and contaminated land are identified and discussed.

13.1.2 This assessment is undertaken in accordance with the Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 11 Geology and Soils, 1993 (Ref 13.1) methods for a Stage 3 assessment. The aims of this assessment are to:

- Outline the baseline conditions;
- Assess the impact of the scheme on baseline conditions;
- Where appropriate, propose mitigation measures to address any potential significantly adverse impacts upon geology, soils and contaminated land; and
- Assess the residual impact of the scheme upon the baseline conditions with the proposed mitigation in place in relation to geology and soils.

13.2 Policy and Legislative Background

13.2.1 A desktop review of current legislation, planning policy and technical guidance was carried out to identify all relevant information to the project in relation to geology and geomorphology, soils and contaminated land. Legislation was reviewed by checking the following websites:

- www.legislation.gov.uk (Ref 13.2);
- www.gov.uk/government/collections/land-contamination-technical-guidance (Ref 13.3);
- www.netregs.org.uk/ (Ref 13.4);
- www.gov.scot/Publications/Recent (Ref 13.5); and
- www.sepa.org.uk/library/ (Ref 13.6).

13.2.2 Quality schemes such as CEEQUAL or BREEAM, encourage schemes to have a focus on sustainability, particularly through reuse of materials. In addition, the Scottish Government also encourages materials reuse through, for example, the Scottish Government Zero Waste Plan.

13.2.3 There are several policy and legislative instruments in the UK relating to contaminated land, the protection of geological resources as well as policy and guidance documents. The most relevant are summarised in Table 13.1.

Table 13-1: Regulatory and policy framework

Legislative / policy	Description
Legislation and policies	
Environmental Protection Act 1990 (Ref 13.7)	This act established businesses' legal responsibilities for the duty of care of waste, contaminated land and statutory nuisance.
The Environment Act 1995 (Ref 13.8)	An act of parliament enacted to set up the Environment Agency and the Scottish Environment Protection Agency.
Contaminated Land (Scotland) Regulations 2000 (Ref 13.9)	These regulations provide legislation for cleaning up contaminated land with the main responsibility for enforcing the regime lies with the local authority. This legislation introduces a risk assessment methodology to be used in assessing whether a site is contaminated or suitable for use.
National	
National Planning Framework 3 2014 (NPF) (Ref 13.10)	The NPF sets out a long-term vision for development and investment across Scotland over the next 20 to 30 years. It brings together plans and strategies in economic development, regeneration, energy, environment, climate change, transport and digital infrastructure to provide a coherent vision of how Scotland should evolve over the next 20 to 30 years.
Land Use Strategy 2016 – 2021, 2016 (Ref 13.11)	The Scottish Government sets out three main objectives relating to the economy, environment and communities; and the Principles for Sustainable Land Use to guide policy and decision making.
Scottish Government Scottish Planning Policy, 2014 (Ref 13.12)	This sets out national planning policies which reflect Scottish Ministers' priorities for operation of the planning system and for the development and use of land. Policies relevant for geology and soils include: Rural Development, Natural Environment, Minerals and Flooding & Drainage
The Scottish Soil Framework (Ref 13.13)	The Scottish Government aims to promote sustainable management and protection of soils, consistent with the economic, social and environmental needs of Scotland. It recognises soils are valuable but a vulnerable natural asset, requiring sustainable and effective management. Soils contribute to both economic and environmental functions, with many industries, including farming and food production, forestry and tourism, depending on their use. Soil management also plays an important role in sustainable flood management. Environmental impacts such as climate change and soil organic matter loss can cause soil degradation, leading to erosion, compaction, loss of biodiversity and nutrient leaching. Rising demand for locally produced Scottish food, increasing infrastructure development, forestry cover and renewable energy production can also impact soils.
Local	
Aberdeen City and Shire Strategic Development Plan 2014 (Ref 13.14)	The development plan contains plans for developing and using land. It addresses a wide range of issues such as housing, shopping, industry, transport and the environment. The development plan guides other people's plans and investment strategies and is used to assess planning applications. The following sections identified in the Strategic Development Plan will be relevant to geology and soils in the area: Sustainable development and climate change Quality of the environment Sustainable mixed communities

Legislative / policy	Description
Aberdeenshire Local Development Plan (ALDP) 2017 (Ref 13.15)	The ALDP, Policy PR1 Layout, siting and design identifies the following: Important mineral safeguarded sites, where other forms of development should not generally be allowed, and wider areas of search where mineral reserves should not be sterilised by inappropriate developments. This is further developed within Supplementary Guidance 6, Areas Safeguarded or Identified as Areas of Search for Minerals Development. 'Measures require to be identified to enhance biodiversity or geodiversity in proportion to the opportunities available and the scale of the development opportunity and to accord with the Zero Waste Plan, a Site Waste Management Plan will be submitted to demonstrate that developers have minimised the generation of waste during the construction and operational phases of new development.' 'All developments should identify measures that will be taken to improve biodiversity and geodiversity in proportion to the potential opportunities available and the scale of the development.' Policy P4 Hazardous and potentially polluting developments and contaminated land, states that AC 'will refuse development if there is a risk that it could cause significant pollution, create a significant nuisance, or present an unacceptable danger to the public or the environment.' Policy E1 Natural heritage: Wider biodiversity and geodiversity states that 'A baseline ecological survey should be prepared for all major developments and for smaller proposals where there is evidence to suggest that a habitat, geological feature or species of importance may exist on the site'.

13.3 Methodology

Defining the study area

13.3.1 As the DMRB guidance on geology and soils does not provide a description of relevant buffer zones or study area guidelines, the following study areas were used for the scheme, based on professional judgement and the distance over which potential impacts could occur related to geology and ground conditions:

- 2km either side of the existing roads and proposed scheme was used to identify any designated sites for geological interest. This buffer was selected as, if any sites are identified within 2km, it is likely that the geological or geomorphological resources beneath the scheme are worthy of further study; and
- 200m either side of the existing roads and proposed scheme was used for identified bedrock and superficial strata, for soils, for land capability for agriculture and to identify any potentially contaminated land in the vicinity of the scheme. These buffers were chosen as they represent the likely zones of influence posed by the scheme.
- For groundwater, in accordance with Chapter 11 'Road Drainage and Water Environment', a study area of 600m of the centreline of the scheme was selected, extending where appropriate to include features within the broader catchment.

13.3.2 These buffers are shown in **Figure 13.1** to **Figure 13.6**.

Determining the baseline

Desk study

13.3.3 A desk top review of available geological, soils, historical ordnance survey and land capability maps along with previously published reports and ground investigations regarding the scheme and its vicinity have been reviewed along with previous site walkover information. The reports reviewed are as follows:

- Amey Stage 2 Environmental Impact Assessment Report;
- Access to Laurencekirk STAG Report, CH2MHILL, June 2015 (Ref 13.16);
- A90 (T) Laurencekirk Junctions, NESTRANS, October 2012 (Ref 13.17); and
- Amey Preliminary Sources Study Report, January 2019.

13.3.4 A Complete Insight Scotland Report covering the three junctions was obtained in February 2017, from Groundsure Ltd (Ref 13.18) and is included as Appendix 13.1. This report contained historical Ordnance Survey (OS) sheets which provided sufficient detail to allow review of the historical development of the area.

13.3.5 Additional information has been obtained from online mapping tools and websites as follows:

- BGS Borehole viewer (Ref 13.19);
- BGS Mining Plan Portal (Ref 13.20);
- BGS Geoindex (ref 13.21);
- Coal Authority Online Gazetteer (ref 13.22);
- The Multi-Agency Geographic Information for the Countryside (MAGIC) online database (Ref 13.23);
- Geological Conservation Review (Ref 13.24);
- SNH Sitelink (Ref 13.25);
- Scotland's Environment (Ref 13.26);
- James Hutton Institute, Soil map of Scotland (Ref 13.27), and Land Classification maps for Capability for Agriculture (Ref 13.28); and
- National Land Use Database of Previously Developed Land (NLUD-PDL) (Ref. 13.29).

Consultation

13.3.6 The following statutory and non-statutory bodies were consulted to obtain available information regarding the scheme. Consultation responses are summarised in Chapter 5 and are also provided in Appendix 5.1:

- British Geological Survey (BGS);
- Aberdeenshire Council regarding:
- Petroleum sites;
- Contaminated Land; and
- Private Water Supplies (PWS).
- Scottish Natural Heritage (SNH); and
- Scottish Environment Protection Agency (SEPA).

Assessment method

Geology and geomorphology and soils

13.3.7 The sensitivity of geology and soils has been based on Table 2.1 of DMRB Volume 11, Section 2, Part 5, Assessment and Management of Environmental Effects, Chapter 2 Determining the significance of environmental effects (Ref 13.30). The sensitivity of the geological and hydrogeological resources, in conjunction with the magnitude of the impact of the scheme, is combined to determine significance of effect. The ability of the soils for carbon storage has been assessed based on professional judgement.

13.3.8 The method of classifying sensitivity is defined in Table 13-2.

Table 13-2: Determination of geological receptor sensitivity

Sensitivity	Typical criteria descriptors
Very High	• Areas containing geological or geomorphological features of international interest for example, Geoparks, Wetlands of International Importance and Special Protection Areas. • Internationally important mineral deposits. • Area is capable of supporting arable agricultural (Class 1, Class 2, and Class 3.1). • Peat Soils – High potential for carbon storage. • Groundwater: • Major aquifer providing a regionally important resource or supporting site protected under EC and UK habitat legislation. • Aquifer used as a resource for public, private domestic (i.e serving >10 properties) or agricultural/industrial use.

Sensitivity	Typical criteria descriptors
High	• Areas containing geological or geomorphological features of national interest, for example Sites of Special Scientific Interest and National Nature Reserves. • Nationally important mineral deposits. • Area is capable of supporting mixed agricultural land (Class 3.2). • Slightly peaty and organic soils with potential for carbon storage. • Groundwater: • Major aquifer providing locally important resource or supporting river ecosystem. • Aquifer used as a resource for private domestic and/or agricultural supply serving <10 properties
Medium	• Areas containing geological or geomorphological features of designated regional importance, for example County Geodiversity Sites or Regionally Important Geological Sites worthy of protection for educational and research purposes. • Regionally important mineral deposits. • Area is capable of supporting mixed agriculture (Class 4.1, Class 4.2). • Agricultural land with potential for carbon storage. • Groundwater: • Aquifer providing water for agricultural or industrial use with limited connection to surface water. • Exploitation of groundwater is not extensive.
Low	• Geological and geomorphological features not currently protected and not considered appropriate of future protection. • Absence of mineral deposits or deposits of local value. • Area is capable of supporting improved grassland (Class 5.1, Class 5.2, Class 5.3). • Low quality agricultural land with potential for carbon storage. • Groundwater • Unproductive strata • Exploitation of groundwater is unlikely and/or unfeasible.
Negligible	• Limited geological features not currently protected and not considered appropriate for future protection. • No mineral deposits. • Area is capable of supporting only rough grassland (Class 6.1, Class 6.2, Class 6.3, Class 7) or lies within an urban or unclassified area. • Urban land with little potential for carbon storage. • Groundwater: • unproductive strata.

13.3.9 The magnitude of impact was assessed with the criteria for assessment set out in Table 13-3.

Table 13-3: Criteria for assessing magnitude of impacts

Impact magnitude	Typical criteria descriptors
Major	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements (Adverse). Large scale or major improvement of resource quality; extensive restoration or enhancement; major improvement of attribute quality (Beneficial).
Moderate	Loss of resource, but not adversely affecting the integrity; partial loss of/damage to key characteristics, features or elements (Adverse). Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality (Beneficial).
Minor	Some measurable change in attributes, quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements (Adverse). Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of negative impact occurring (Beneficial).
Negligible	Very minor loss or detrimental alteration to one or more characteristics, features or elements (Adverse). Very minor benefit to or positive addition of one or more characteristics, features or elements (Beneficial).
No Change	No loss or alteration of characteristics, features or elements; no observable impact in either direction.

13.3.10 Once the receptor's sensitivity and impact magnitude were determined, Table 2.3 (Chapter 2 Environmental Assessment), was used to determine the overall significance of effect.

Determination of risk of contaminated land

13.3.11 The assessment of geo-environmental risks follows the recommendations given with the 'Model Procedures for the Management of Land Contamination' (CLR11) published by DEFRA (Ref 13.31) and the Environment Agency and in CIRIA's Contaminated Land Risk Assessment – A Guide to Good Practice (CIRIA 552) (Ref 13.32) which recommends the development of a Conceptual Site Model (CSM).

13.3.12 The CSM presented in this report represents the Preliminary Risk Assessment component of this approach. The CSM represents a network of relationships between potential hazards from within and adjacent to the scheme and the receptors that may be exposed to the hazards through linking pathways. Fundamental to the identification and management of land contamination risks is the concept of the Source-Pathway-Receptor (S-P-R) pollutant linkage, comprising:

- A contaminant source – a substance that is in, on or under the land and has the potential to cause harm or to cause pollution;
- A pathway – a route or means by which a receptor can be exposed to or affected by a contaminant.

- A receptor – in general terms, something that could be adversely affected by a contaminant, such as people, an ecological system, property or a water body.

13.3.13 Each of these elements can exist independently, but only create a risk when they are linked together, so that a contaminant can affect a receptor via a particular pathway. A key element of a CSM is that not only does it examine the range of potential exposure pathways that are present; it also eliminates those pathways that are incomplete, and therefore cannot pose a risk.

Identification of potential contaminated land sources

13.3.14 Potential sources within a study area of 200m of the scheme were identified through a review of historical maps and of public online resources, and a site walkover. Contamination sources are further defined by their potential to present a risk to receptors as shown in Table 13-4.

Table 13-4: Potential contaminated land sources

Type of Source	Definition
High Potential Source	Land contamination is on site and associated with major potential sources e.g. waste disposal/ treatment sites, process industry sites (e.g. gas works, iron works) or oil pipelines and quarries infilled with materials of unknown composition.
Moderate Potential Source	Land contamination is on site and is associated with moderate potential sources (e.g. garages, quarries, railway land and engineering works).
Mild Potential Source	Land contamination is off site or associated with land uses with low potential for significant contamination e.g. construction fill materials.
Minor Potential Source	Land contamination is off site or associated with localised land uses with low potential for significant contamination e.g. domestic fuel tanks

Receptors

13.3.15 The scheme comprises a new upgraded junction with associated infrastructure and drainage, and as such the sensitivity of a number of potential receptors is likely to be reduced compared to a residential or commercial/industrial development. The potential receptors and contaminant pathways identified are summarised in Table 13-5.

Table 13-5: Potential contaminated land receptors

Receptor
Human Health (site workers during construction) - Workers taking part in the construction works including general earthworks. During construction, short term exposure of workers may occur from contaminants present within soils and shallow groundwater through dermal contact, ingestion or inhalation of dust, vapours and ground gas.
Human Health (Adjacent Residents / Workforce - off site receptors during construction) – off site receptors include those people living or working close to the site or using the area for recreational activities such as walking, cycling, etc. Local residents and workers could potentially become exposed to wind-blown dust / fibres or vapours during construction works.
Human Health (end users) – Whilst future road users are unlikely to be affected due to the short residence time in the area, people using parking / leisure landscaped areas may be exposed to soil via accidental ingestion, inhalation or dermal contact with soil or soil derived dust.

Receptor
Human Health (maintenance workers) – post construction, maintenance workers may be required to undertake below ground maintenance works on site, such as attending to services. Workers may potentially be exposed to soils and groundwater via ingestion, inhalation or dermal contact.
Water Environment (Surface Waters including the surface water drainage system and surface waters used as discharge points) – although the watercourses along the route are minor, they may be affected via direct discharge from site drainage systems, leaching of contaminants and transport via shallow groundwater. Surface waters within close proximity (50m) will be particularly sensitive to surface water and sediment run off from the road both during and post construction.
Water Environment (Groundwater in superficial deposits) – Any groundwater present within the made ground is likely to be laterally discontinuous and locally perched where the underlying natural superficial deposits are more cohesive. Groundwater within the made ground (MG) is not classified as an aquifer but may influence or form part of the aquifer within the alluvium in certain areas. In accordance with the SEPA guidance, Assigning Groundwater Assessment Criteria for Pollutant Inputs (Ref 13.26), groundwater within superficial deposits is considered to constitute a groundwater body and therefore a receptor if it has a groundwater resource potential, i.e. is capable of supporting an abstraction of 10m3/d or more. Groundwater may be affected by the migration of waters impacted by potential contamination sources within the site boundary either via leaching or the dissolution of free phase hydrocarbons. The superficial aquifers may also act as a pathway for migration of contaminants to bedrock aquifers or to nearby surface water. There is also potential for piling or deep excavations or unlined utility services/ surface water drainage trenches to create preferential pathways to the superficial deposit's aquifers.
Water Environment (groundwater in bedrock groundwater) – The bedrock beneath the site could be affected by leaching of contaminants and vertical migration. In accordance with the SEPA guidance, Assigning Groundwater Assessment Criteria for Pollutant Inputs, all bedrock groundwater is considered to have resource potential and hence is considered a receptor. Groundwater may be affected by the migration of waters impacted by contamination sources within the site boundary either via leaching or the dissolution of free phase hydrocarbons to the bedrock groundwater at depth where the pathway is not impeded by the presence of cohesive strata acting as a hydraulic barrier or aquitard between the superficial deposits and bedrock. There is potential for piling or deep excavations to create preferential pathways to the bedrock aquifer.
Property (Livestock) – Surrounding agricultural areas could be exposed to windblown dusts and fibres generated by construction works. These could potentially expose livestock to risks associated with dermal contact, ingestion or inhalation of dust. Whilst the route is adjacent to agricultural land, it is anticipated that measures taken to protect the construction workers e.g. management of dust generation will also manage the risks to livestock.
Buried concrete and services – Buried concrete (including piling) and water supply pipes could be affected by direct contact with aggressive ground conditions / chemical attack on susceptible materials. Buildings/ structures and services could theoretically be at risk of explosion if ground gas accumulates in confined spaces. Road drainage infrastructure will be susceptible to the infiltration of potentially contaminated groundwater, carriageway surface water and associated sediments following construction.
Ecologically Sensitive Receptors – Any designated areas or protected species in the area that could potentially be exposed to potential contamination within soil / soil derived dust, groundwater and soil gas via dermal contact, ingestion or inhalation.

13.3.16 The significance and classification of risk from contaminated land can be assessed in terms of the pollutant linkage and the likelihood of such a pollutant linkage occurring as shown in Table 13-6.

Table 13-6: Determination of risk from contaminated land

Risk	Typical criteria descriptors
Very High	There is a complete pollution linkage of an event that either appears very likely in the short-term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution.

Risk	Typical criteria descriptors
High	There is a complete pollution linkage and all the elements are present and available. This means it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short-term and likely over a long term.
Medium	There is a complete pollution linkage and the circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such an event would take place and is less likely in the short-term.
Low	There is a complete pollution linkage, but circumstances are such that it is unlikely that a pollution event would occur. This is both in the short and long term.
Negligible	There is a complete pollution linkage, but circumstances are such that it is improbable that an event would occur, even in the very long term.

Land contamination risk matrix

13.3.17 Amey's Preliminary Sources Study Report (2019) – A90/A937 Laurencekirk Junction Improvement scheme (Ref 13.33) identifies that the key to the classification is that the designation of risk is based upon the consideration of both:

- The magnitude of the potential consequence (i.e. severity), taking into account both the potential severity of the hazard and the sensitivity of the receptor
- The magnitude of probability (i.e. likelihood) taking into account both the presence of the hazard and receptor and the integrity of the pathway.

13.3.18 The severity is defined within Table 13-7, taken from the 'Guidance for the Safe Development of Housing on Land Affected by Contamination' (Ref 13.34).

Table 13-7 Classification of consequence

Consequence	Definition
Severe	Highly elevated concentrations likely to result in "significant harm" to human health as defined by the EPA 1990, Part 2A, if exposure occurs. Equivalent to Environment Agency (EA) Category 1 pollution incident including persistent and/or extensive effects on water quality; leading to closure of a potable abstraction point; major impact on amenity value or major damage to agriculture or commerce. Major damage to aquatic or other ecosystems, which is likely to result in a substantial adverse change in its functioning or harm to a species of special interest that endangers the long-term maintenance of the population. Catastrophic damage to crops, buildings or property.
Medium	Elevated concentrations which could result in "significant harm" to human health as defined by the EPA 1990, Part 2A if exposure occurs. Equivalent to EA Category 2 pollution incident including significant effect on water quality; notification required to abstractors; reduction in amenity value or significant damage to agriculture or commerce. Significant damage to aquatic or other ecosystems, which may result in a substantial adverse change in its functioning or harm to a species of special interest that may endanger the long-term maintenance of the population. Significant damage to crops, buildings or property.

Consequence	Definition
Mild	Exposure to human health unlikely to lead to "significant harm". Equivalent to EA Category 3 pollution incident including minimal or short-lived effect on water quality; marginal effect on amenity value, agriculture or commerce. Minor or short-lived damage to aquatic or other ecosystems, which is unlikely to result in a substantial adverse change in its functioning or harm to a species of special interest that would endanger the long-term maintenance of the population Minor damage to crops, buildings or property.
Minor	No measurable effect on humans. Equivalent to insubstantial pollution incident with no observed effect on water quality or ecosystems. Repairable effects of damage to buildings, structures and services.

13.3.19 The classification of probability is summarised in Table 13-8, also taken from the 'Guidance for the Safe Development of Housing on Land Affected by Contamination' (Ref 13.34).

Table 13-8: Classification of probability

Risk	Definition
High likelihood	Circumstances are such that an event either appears very likely in the short term and almost inevitable in the long term or there is evidence of currently harm occurring.
Likely	Circumstances are such that an event, whilst not inevitable, is possible in the short term and is likely to occur over the long term.
Low likelihood	Circumstances are such that it is possible an event could occur, but it is by no means certain to occur even over a longer period, and it is less likely in the shorter terms.
Unlikely	Pollutant linkage may be present, but the circumstances under which harm would occur are improbable even in the long term.

13.3.20 The resultant potential pollutant linkages can then be assigned qualitative risk ratings in line with Table 13-9 with regards their probability and consequence.

Table 13-9: Qualitative risk assessment

		Consequence			
		Severe	**Medium**	**Mild**	**Minor**
Probability (Likelihood)	**High Likelihood**	Very High	High	Moderate	Moderate to Low
	Likely	High	Moderate	Moderate to Low	Low
	Low Likelihood	Moderate	Moderate to Low	Low	Very Low
	Negligible Unlikely	Moderate to Low	Low	Very Low	Very Low

13.3.21 The risk rating is considered to be significant for very high, high and moderate, and not significant for low or very low.

13.4 Baseline Conditions

Geology and geomorphology

13.4.1 Extracts of published bedrock geology and superficial geology maps are presented in **Figure 13.1** Bedrock Geology Map and **Figure 13.2** Superficial Geology Map, with **Figure 13.5** showing known areas of anthropogenic or artificial geology.

Designated sites

13.4.2 A review of the SNH Sitelink website, the MAGIC website and the JNCC Geoconservation website indicates that there are no areas designated for their geological features within 2km of the study area. Accordingly, areas designated for their geological or geomorphological importance have been scoped out of this assessment and are not considered further.

Geomorphology

13.4.3 The study area runs through a wide flat glacial valley with arable agriculture on the valley floor and pastoral grazing activities on the surrounding hills. The geomorphological landscape has been shaped by glacial activity, with the current study area highly modified by human activity.

Published bedrock geology

13.4.4 The BGS indicates the underlying solid stratum within the study area as the Cromlix Mudstone Formation, a sedimentary bedrock formed approximately 398 to 407 million years ago, in the Devonian Period, in a local environment previously dominated by rivers.

13.4.5 The geology is described as “characteristically soft, bright red to dull brownish-red, maroon or purplish-brown, with green reduction spots in the north-eastern Midland Valley, generally massive but often thinly laminated, poorly-sorted, fine-grained silty sandstones, sandy siltstones, siltstones and mudstones, which lithologies may be locally interbedded with thin lenses of medium to coarse-grained pebbly sandstone”.

Published superficial geology

13.4.6 Superficial deposits to the north of the scheme comprise the Mill of Forest Glacial Till Formation and is described by the BGS as “sandy diamicton, red-brown with clasts predominantly of Devonian rocks”. This can be seen in Photo 13-1.

Photo 13-1: Superficial Mill of Forest till formation deposits

13.4.7 There are also localised pockets of alluvium recorded along Gaugers Burn. The deposit has been described by the BGS as "normally soft to firm consolidated, compressible silty clay, but can contain layers of silt, sand, peat and basal gravel. A stronger, desiccated surface zone may be present".

Anthropogenic or artificially modified geology

13.4.8 Artificial ground is described as "an area where the pre-existing (natural) land surface or geological succession is modified by anthropogenic processes of material removal or deposition and may include Made Ground, Worked Ground, Disturbed Ground, Landscaped Ground and Infilled Ground". The BGS maps do not show any artificial ground within the study area; however, there is likely to be made ground deposits associated with the current A90 and local roads.

Geology encountered during ground investigations

13.4.9 In addition to the information provided by geology maps, several intrusive historic investigations have also been undertaken in the area by BGS. A Ground Investigation undertaken by Amey was completed in July 2019. Historical exploratory hole positions are shown in Figure 13.5 Geological and Contaminated Land Constraints and exploratory hole logs are presented within Appendix 13.2.

13.4.10 These confirm the expected sequence of deposits to comprise Topsoil, Glacial Till (generally sandy clay with gravel) and bedrock (Red Sandstone). Made ground was identified at one

location (TP05, south of the south junction, where the railway line crosses the A90), however, it can be assumed that further made ground will be present throughout the study area associated with the construction of the A90.

13.4.11 The made ground identified at TP05 comprised 1.70m of rock overlying 0.10m topsoil and 1.50m alluvium. This is likely to be associated with the construction of the railway embankment.

13.4.12 Shallow bedrock (i.e. less than 5.00m below ground surface) was recorded across the scheme. Depths to bedrock below the existing route are anticipated to be approximately 0.8mbgl to 1.2mbgl in vicinity of the north junction, approximately 0.8mbgl to 2.3mbgl (below ground level) at the central junction and 0.9mbgl to 1.8mbgl at the south junction. Highly weathered red sandstone is present throughout the study area with recorded thicknesses between 0.4m to 1.0m.

13.4.13 The BGS Geoindex recorded 21 historical exploratory holes (BH) within the site and immediately surrounding the area. All the exploratory holes were undertaken along the length of the existing A90, with 19 installed in 1983 and two installed in 1973. General ground conditions were encountered as Topsoil underlain by firm, stiff and very stiff sandy silty CLAY (Glacial Till) and/or bedrock. Within the Glacial Till, BH11 (1983) encountered a thin layer of sandy GRAVEL (0.4m thick). The material was described as sand and gravel with traces of clay in BH11 (1973). Within BH13 (1983) and BH14 (1983), the superficial deposits were described as sandy Topsoil, GRAVEL and COBBLES between 0.85m and 0.9m thick. TP11 (1983) recorded Topsoil directly onto “highly weathered” rock at 0.5mbgl. All three exploratory holes were located near to the Gaugers Burn. Table 13-10 records the anticipated geological sequence.

Table 13-10: Summary of ground conditions

Stratum	Depth to base of strata (mbgl)	Thickness (m)
Topsoil	0.30 - 0.90	0.30 - 0.90
Gravel and Cobbles (BH13 and BH14 only)	0.85 – 0.90	0 – 0.90
Glacial Till	1.00 – 2.80	0 – 2.45
Bedrock Slightly to moderately weathered moderately strong silty fine-grained SANDSTONE	Encountered between 0.5mbgl and 2.8mbgl. Proven to 6.0mbgl by rotary coring.	

13.4.14 Amey completed additional intrusive ground investigations which took place in June/July 2019 to confirm the ground conditions and enable sampling of materials for classification for reuse and / or off-site disposal if deemed necessary. The accompanying report and data analysis was not available at time of writing.

Paleogeology

13.4.15 Chapter 7 Cultural heritage primarily assesses the impacts on human cultural heritage, with Chapter 8 Landscape and visual regarding the historical landscape in which it sits whereas consideration of impacts on pre-human geological deposits is minimal. The impacts on the geological heritage are considered within the Geology and Soils chapter by assessing the potential of the scheme to destroy, damage or limit the discovery and study of geological formation and paleo-environmental remains. For example, those impacts on paleosols (fossil soils found buried within either sedimentary or volcanic deposits) other natural soil remains; fossils of prehistoric flora and fauna and soil and rock strata and variations which hold information on the formation of bedrock and superficial geology.

13.4.16 The BGS Geoindex indicates that there are no sites noted for their fossils within the study area.

Hydrogeology

13.4.17 Chapter 11, the Road Drainage and the Water Environment, considers groundwater quantity – the issues of groundwater levels, flow and supply along with water quality impacts from road drainage in line with DMRB volume 11 section 3 part 10 (HD45/09) (Ref. 13.35). However, HD45/09 does not consider the wider impacts on groundwater and hydrogeology from broader pollution sources such as contaminated soils.

13.4.18 Within the geology and soils chapter, hydrogeology is considered in terms of the risk potential for contaminated land to impact groundwater as a receptor and to consider the impacts on Groundwater Dependant Terrestrial Ecosystems (GWDTE). It should be noted that there are no designated sites within the study area which are designated for groundwater. Habitat surveys have also confirmed that there are no areas of wetland within the study area. It is therefore unlikely that groundwater within the area support any GWDTE. Further information on the types of habitat within the study area is available in Chapter 10 Nature Conservation.

13.4.19 The scheme lies within the vicinity of two moderately productive aquifers, the Strathmore Group and the Arbuthnott-Garvock Group. These are both moderately productive aquifers with ground water flow virtually all through fractures and other discontinuities. They are formed from sandstones, in places flaggy, with siltstones, mudstones and conglomerates and interbedded lavas. They are locally important aquifers which yield moderate amounts of groundwater. Historic ground investigation data within the study area is available from BGS. There over 50 borehole records within the study area, many of these having been undertaken along the alignment of the existing A90 or slightly adjacent to it. The records reveal that the majority of the boreholes were drilled to depths varying between 1-5m and the majority of these revealed no groundwater present. Only two of the boreholes undertaken along the alignment of the A90 close to the southern junction struck groundwater below 1m, and these only recorded ‘slight seepage’ and ‘damp’ conditions. The remaining boreholes were recorded as dry. A further two

borehole records are available within the study area close to Mains of Newton. Both of these were drilled to a depth of 120m. Groundwater at this location was struck at 4m, 18m, 27m, 48m and 88m.

13.4.20 As per Table 13-4 and in accordance with SEPA guidance 'Assigning Groundwater Assessment Criteria for Pollutant Inputs', all bedrock groundwater is considered to have resource potential and hence is considered to represent a contaminated land receptor. Further details on groundwater abstractions can be found in Chapter 11 Road drainage and water environment.

13.4.21 Chapter 10 Ecology and nature conservation indicates that there are no groundwater dependant habitats within 2km of the scheme.

Mining (current / historic)

13.4.22 The Coal Authority interactive map was accessed in July 2018 and indicated that the study area is not within a coal mining reporting area.

13.4.23 The Groundsure Complete Insight Report has also recorded no coal mining within the area. Limited information is available on such mine workings, however, the Groundsure Report states "sporadic underground mining of restricted extent may have occurred. Potential for difficult ground conditions are unlikely and localised and are at a level where they need not be considered".

13.4.24 The BGS Geoindex indicates that there are no active mineral extraction sites within 200m of the scheme. The nearest mineral extraction sites lie at 7.4km south west at Dalladies Farm sand and gravel quarry and the Capo sand and gravel quarry, both at Edzell.

13.4.25 The Aberdeenshire Council Local Development Plan, Supplementary Guidance 6, areas safeguarded or identified as areas of search for minerals development; has indicated that there are no sites identified or safeguarded within the study area. A review of historical maps has found no historical mineral extraction features within the study area.

13.4.26 As there are no current or historical mineral abstraction sites within 200m of the scheme, therefore sensitivity has been assessed as being negligible and they have been scoped out of the assessment

Soils

13.4.27 The James Hutton Institute Soil map of Scotland indicates the majority of soils within the study area to be either noncalcareous gleys poorly drained soils, or iron podzols freely drained soils, both derived from a parent material of a water-modified topsoil layer, generally >60cm thick, overlying till derived from sediments, mainly marls and fine-grained sandstones, of Lower Old Red Sandstone age.

Agriculture (land capability for agriculture classification)

13.4.28 The land capability for agricultural land maps (extracts reproduced as Figure 13.3) show much of the land within the study area to be class 2, arable agriculture, land capable of producing a wide range of crops; with class 3.2, mixed agriculture, land capable of average production though high yields of barley, oats and grass, which is found along Gaugers Burn.

Photo 13-2: Agricultural land south-east of Laurencekirk showing class 3.2 field

13.4.29 Additional assessment on agricultural land is provided in Chapter 12 People and Communities in relation to farming.

Soil and climate change

13.4.30 Worldwide soil carbon stocks represent major carbon sinks and their destruction signifies a significant potential source for the release of carbon equivalent greenhouse gases. Activities such as vegetation clearance, development and construction destroys soil structures and releases stored soil carbon as well as eliminating areas of potential soil carbon storage.

13.4.31 The United Nations Framework Convention on Climate Change ratified the Paris Agreement (Ref 13.36) on 4 November 2016 in which all countries ratifying the agreement, agreed to take measures to reduce the impact of climate change. Part of the agreement was the “4/1000 Initiative: Soils for Food Security and Climate” which aims to ensure that agriculture plays its part in combating climate change. A 0.4% annual growth rate of the soil carbon stock intends to

show that even a small increase in the soil carbon stock (agricultural soils, notably grasslands and pastures, and forest soils) is crucial to improve soil fertility and agricultural production and to contribute to achieving the long-term objective of limiting the temperature increase to +1.5/2°C.

13.4.32 The current agricultural, woodland and naturalised areas surrounding the scheme have potential to store carbon as would the road side verges and hedgerows. The developed areas have a negligible potential, as once land has been developed, it is likely to remain in use through redevelopment which would prevent the soil carbon stock being increased.

Contaminated land

Historical map review

13.4.33 A review of historical OS maps obtained from the Groundsure report, has been undertaken. This indicates that the area has had a mainly agricultural history.

Radon and ground gas

13.4.34 All parts of the study area are in the lowest band of radon potential - less than 1 % of homes above the Action Level.

Unexploded ordnance

13.4.35 The Groundsure Complete Insight Report has found no record of ordnance sites within 500m of the site boundary.

SEPA registers and landfill sites

13.4.36 The SEPA and Scotland's Environment Waste Sites Data tool has indicated that there are no current or historic (since 2011) landfill sites within the study area.

13.4.37 The Groundsure report has indicated there are no historic refuse tips within the study area.

Petroleum sites

13.4.38 The Groundsure report has indicated that there are no petroleum sites within the study area.

Invasive plant species

13.4.39 Under Section 33 of the Environmental Protection Act, 1990 "any soil and waste containing propagules of a plant species listed in Schedule 9 of the Wildlife and Countryside Act 1981 (as amended) that you discard, intend to discard or are required to discard are considered to have the potential to cause ecological harm and hence deemed "Controlled Waste" or "Directive Waste".

13.4.40 Chapter 10 Nature conservation and biodiversity indicates that any invasive species will be within private residences and will have no impact on the scheme.

Sources of potentially contaminated land

13.4.41 From the site walkover, historical map review and public database searches, it is possible to assemble a list of potential contamination sources within 200m of the study area, from which the potential contamination can be assessed as summarised in Table 13-11. These are also presented in Figure 13.5.

Table 13-11 Contamination sources

No	Source	Description
S1	Mill pond	Mill pond at Mains of Newton, shown until 1924 maps. Likely infilled with unknown materials.
S2	Skate pond	Skate pond, shown until 1924 maps. Likely infilled with unknown materials.
S3	Reservoir	Shown on all maps from 1904 onwards, still in current use.
S4	Cemetery	Shown on all maps from 1904 onwards, still in current use. Extended circa 1987.
S12	Current roads infrastructure (not shown in Figure 13.3)	The A90 Laurencekirk Bypass was opened in 1985, diverting the A90 around the village. It is unlikely to have been constructed using contaminated material, e.g. colliery spoil; however, the potential remains for contaminants to be present in the made ground.
S13	East coast railway line	Shown on all historical maps with Laurencekirk station opened in November 1849 by the Aberdeen Railway company.
S14	Made ground identified in exploratory positions	Made ground was recorded in one position (TP05), described 1.70m of rock infill overlying 0.10m old topsoil and 1.50m alluvium. This is likely to be associated with the construction of the railway embankment and may contain contaminated material.

13.4.42 No visual or olfactory indications associated with potential contamination were noted in the trial pit or borehole logs from the previous investigations.

Summary of receptor sensitivities

13.4.43 A review of the baseline has shown that there is a range of geology and soils receptors which could be affected by the scheme. In line with section 13.3, Table 13-1, the sensitivity of each receptor has been defined using the baseline information and is summarised in Table 13-12.

Table 13-12 Summary of receptor sensitivities

Receptor		Sensitivity
Geology	Geomorphology	Negligible – The geological landscape is highly modified by human activity.
	Bedrock Geology	Medium – resources are not rare or unique
	Superficial Geology	Low – resources are not rare or unique

Receptor		Sensitivity
	Paleogeology	Low – In areas of development and intensive agriculture, the likelihood of encountering palaeoenvironmental remains is negligible. However, deeper deposits are likely to be undisturbed and have a low sensitivity as they may be worthy of future study.
	Hydrogeology	High – aquifer used for potable water
Soils	Soils	Very High – most of the land use with the study area is good quality agricultural land (class 2 to 3.2)
	Soil and carbon storage	Medium –Agricultural land has potential for soil carbon storage.

13.5 Impact Assessment

Construction

13.5.1 The magnitude of impact and significance of effect related to construction are assessed in the following sections.

Magnitude of impacts

Geology

13.5.2 Geomorphology: The geomorphology in the study area is generally flat and the scheme will impact the geomorphology through excavations and creation of embankments for the junction. The embankments will create a new feature in the landscape and there is potential for localised compaction below the embankments. As the geomorphological landscape is already heavily modified by human activity, the proposed scheme impact has been assessed as negligible.

13.5.3 Anthropogenic Ground: There is limited anthropogenic or made ground within the study area. Made ground is most likely to be encountered:

- in the footprint of the current A90;
- the railway line where it crosses the A90 at the south junction;
- the realigned A937; and
- the location of below ground services and utilities.

13.5.4 During construction there is potential for excavations to encounter made ground. There is potential for exposure to impact human health of construction workers through direct contact or inhalation of contaminants. There is also potential for pollutants to enter groundwater or enter runoff to surface waters, adversely affecting water quality. No visual or olfactory indications relating to the presence of potential contamination were noted during previous investigations. Given the nature and scale of the works and that exposure will be localised, the magnitude of impact on human health and water quality has been assessed as negligible.

13.5.5 Bedrock Geology: Bedrock was encountered during previous investigations at depths ranging from 0.8 and 2.80mbgl. Areas where bedrock geology is likely to be encountered and potentially impacted include temporary excavations for the construction of foundations, culverts, and other structures. Any works within the bedrock would damage the geological strata resulting in the damage of the resource. However, given the scale of the scheme and that excavations are likely to encounter bedrock in a highly localised area, the magnitude of impact would be minor adverse.

13.5.6 Superficial geology: The earthworks data provided in Table 13-13 indicate that there would be substantial alteration to the superficial geology for the scheme. Areas where superficial geology are likely to be impacted are temporary excavations for the construction of foundations, culverts, and other structures. Impacts to superficial geology include potential pollution to soils and compaction of the soil resource during earthworks affecting its structure. The magnitude of impact has therefore been assessed as minor adverse.

13.5.7 Paleogeology: The deepest cutting is estimated to be approximately -3.5mbgl and based on the depths of bedrock encountered, any paleogeological features encountered are likely to be damaged or lost. No known areas of paleogeology are present in the study area, however there is potential for previously unknown areas to be encountered. Impacts on paleogeology will be localised to areas where bedrock will be encountered and likely to be small in scale. The magnitude of impact on paleogeology would therefore be negligible.

13.5.8 Hydrogeology: There is potential for contaminated land to impact groundwater as a receptor, affecting water quality. Earthworks will result in sediment production which may enter groundwater, affecting its quality and capability to be used for potable water. The magnitude of impact would be negligible adverse.

Soils

13.5.9 The earthworks data provided in Table 13-13 indicate that there would be substantial alteration to the soils with impacts including loss of soil structure from excavations and potential pollution from construction during earthworks. The magnitude of impact on soil would therefore be minor adverse. The projected volumes of material likely to be impacted by the scheme are shown in Table 13-13.

Table 13-13 Earthworks quantities for the scheme

Feature	Height of earthwork (m)		Land take (m^2)		Volume of material (m^3)	
	Cutting	Embankment	Total	Agricultural	Cut	Fill
The scheme	-3.5	10.0	208,873.2	196,281	16,249.02	300,471.80

Soils and carbon storage

13.5.10 The removal of soil to accommodate hard-standing will lead to the release of carbon dioxide which is being stored in the soil. The movement and storage of soils during earthworks will also result in release of carbon dioxide. The soils ability to store carbon will be removed along with the removal of soil. The overall impact for this is negligible.

Significance of Effects

13.5.11 The significance of effects associated with construction works has been determined utilising the receptor sensitivities presented in Table 13-12 and combined with the magnitude of impacts listed above. These have been combined to determine the significance of effects as presented in Table 13-14. This indicates the adverse effects on the identified receptors during construction.

Table 13-14 Significance of effects during construction

Receptor		Receptor sensitivity	Magnitude of impact	Significance of effect
Geology	Bedrock	Medium	Minor	Slight
	Superficial geology	Low	Minor	Slight
	Geomorphology	Negligible	No change	Neutral
	Paleogeology	Low	Negligible	Slight
	Hydrogeology	High	Negligible	Slight
Soils	Soils	Very high	Minor	Moderate
	Soils and carbon storage	Medium	Negligible	Slight

Contaminated Land Risk

13.5.12 Only contamination sources S12, existing roads and infrastructure and S14, were assessed as having a source potential of moderate as these are likely to be encountered during construction. Those of minor or mild potential are not considered to be significant potential sources of contamination and are not considered further. The impact of the scheme will be exposure of small areas of land contamination, creation of pathways to groundwater, and impacts on health of construction workers.

13.5.13 Table 13-15 provides the Conceptional Site Model for construction from these contamination sources.

Table 13-15: CSM for construction

Source	Receptors	Pathways	Probability	Consequence	Risk
Made ground	Human health (site workers during construction)	Direct contact, Ingestion, Inhalation	Likely	Mild	Moderate
	Human Health (adjacent residents / workforce - off site receptors during construction)	Direct contact, Ingestion, Inhalation	Low	Mild	Low
	Water Environment (groundwater in superficial deposits)	Lateral and / or vertical migration of water from the made ground via groundwater flow, surface water drainage system or creation of new pathway via piling	Low	Mild	Low
	Water Environment (groundwater in bedrock)		Low	Mild	Low
	Water Environment (Surface Waters)	Surface run-off, horizontal migration of impacted groundwater	Low	Minor	Very low
	Buried concrete and services	Migration and accumulation of gases/vapours, direct contact with services.	Unlikely	Minor	Very low
	Ecological Receptors (including plants and animals)	Vegetative uptake of leached contaminants, ingestion	Unlikely	Minor	Very low
Current roads infrastructure It is unlikely to have been constructed using contaminated material, e.g. colliery spoil; however, the potential remains for contaminants to be present in the made ground.	Human health (site workers during construction)	Direct contact, Ingestion, Inhalation	Likely	Mild	Moderate
	Human Health (adjacent residents / workforce - off site receptors during construction)	Direct contact, Inhalation	Low	Mild	Low
	Water Environment (groundwater in superficial deposits)	Lateral and / or vertical	Low	Mild	Low

Source	Receptors	Pathways	Probability	Consequence	Risk
	Water Environment (groundwater in bedrock)	migration of water from the made ground via groundwater flow, surface water drainage system or creation of new pathway via piling	Low	Mild	Low
	Water Environment (Surface Waters)	Surface run-off, horizontal migration of impacted groundwater	Low	Minor	Very low
	Buried concrete and services	Migration and accumulation of gases/vapours, direct contact with services.	Unlikely	Minor	Very Low
	Ecological Receptors (including plants and animals)	Vegetative uptake of leached contaminants, ingestion	Unlikely	Minor	Very Low

Operation

13.5.14 The operational magnitude of impact and significance of effects are assessed in the following sections. The operational risks from contaminated land are assessed after the geological and soils operational impacts.

13.5.15 All maintenance works post operation are likely to result in a magnitude impact of no change or negligible. Such works will include maintenance works which may include but is not limited to: road resurfacing and sign installation / replacement.

Magnitude of impacts

Geology

13.5.16 Geomorphology: The creation of the embankments for the grade separated junction have potential to adversely affect the geomorphology through compaction or consolidation of the land beneath them. However, the footprint of the embankments relative to the surrounding lands is small and any impacts will be localised. The magnitude of impact has been assessed as no change.

13.5.17 Bedrock geology: The scheme is unlikely to have an impact at the operational stage and on-going maintenance is unlikely to impact bedrock due to the depth of rock below the surface. The magnitude of impact would be no change.

13.5.18 Superficial geology: There is potential for compaction of soils below the new embankments. This affects the soils natural drainage and can result in ponding. There is also potential for consolidation beneath the embankments which may affect the stability of the banks. It is assumed however, that the design of the embankments has been such as to minimise the risk of localised consolidation. The magnitude of impact on soils from compaction or consolidation is negligible.

13.5.19 Anthropogenic ground: It is possible thin deposits of made ground may be encountered during maintenance works, resulting in exposure to workers and potential runoff to water. Any areas will be localised in nature and the magnitude of impact would be negligible.

13.5.20 Paleogeology: Post operation and maintenance works are unlikely to affect paleogeology. The magnitude of impact for all sections would therefore be no change.

13.5.21 Hydrogeology: The road drainage will not affect hydrogeology. Maintenance works are unlikely to encounter groundwater given that excavations for resurfacing or minor verge maintenance will be in shallow ground. Operational impacts on hydrogeology are assessed to be no change.

Soils

13.5.22 The earthworks data provided in Table 13-13 indicate that there would be loss of agricultural soils as a result of the scheme. Operational impacts also include compression or compaction of soils below the embankments for the grade separated junction. The magnitude of impact for soil loss is assessed to be minor adverse. The scheme design is such that any compression of soils below the embankments will be negligible.

Soils and carbon storage

13.5.23 The removal of soil to accommodate hard-standing will result in less soil being available for carbon storage. The overall impact for this is negligible adverse.

Significance of effects

13.5.24 The significance of effects associated with the operational phase of the scheme has been determined utilising the receptor sensitivities presented in Table 13-12 and combined with the magnitude of impacts listed above. These have been combined to determine the significance of effects presented in Table 13-16.

Table 13-16: Significance of effects during operation

Receptor		Summary of receptor sensitivity	Magnitude of impact	Significance of effect
Geology	Geomorphology	Negligible	No change	Neutral
	Bedrock geology	Medium	No change	Neutral
	Superficial geology	Low	Negligible	Slight
	Paleogeology	Low	No change	Neutral
	Hydrogeology	High	No change	Neutral
Soils	Soils	Very High	Minor	Moderate
	Soil and carbon storage	Medium	Negligible	Slight

Contaminated land Risk

13.5.25 The main sources of potential contamination within 200m of the scheme once operational are summarised in Table 13-17.

Table 13-17: Potential sources of contamination

No	Source	Potential contamination source distance (m) from feature and source potential – For the Scheme
S1	Mill pond	Minor, <100m to SuDS access track
S2	Skate pond	Minor, source is <100m
S3	Reservoir	Minor, source is >100m
S4	Cemetery	Minor, source is <100m
S12	Current roads infrastructure	Moderate, the junction will tie into existing A90.

No	Source	Potential contamination source distance (m) from feature and source potential – For the Scheme
S13	East coast railway line	Mild, contaminants may be present within ballast but will not be encountered during operation.
S14	Made ground identified in exploratory positions	Mild, TP05, where made ground was encountered lies west of the junction. No visual or olfactory indications of contamination were noted during previous investigations.

13.5.26 Source S12 and S14 were assessed as part of a CSM as summarised in Table 13.18. The remaining sources (S1, S2, S3, S4 and S13) were not considered as no pathways were identified.

Table 13-18: Summary of conceptual site model - Operation

Source	Receptors	Pathways	Probability	Magnitude	Risk
Made ground	Human health (site workers during maintenance)	Direct contact, Ingestion, Inhalation	Low	Mild	Low
	Human Health (adjacent residents / workforce - off site receptors during maintenance)	Direct contact, Ingestion, Inhalation	Unlikely	Minor	Very Low
	Human Health (end users)	Direct contact, Ingestion, Inhalation	Unlikely	Minor	Very Low
	Water Environment (groundwater in superficial deposits)	Lateral and / or vertical migration of water from the made ground via groundwater flow, surface water drainage system	Unlikely	Minor	Very Low
	Water Environment (groundwater in bedrock)		Unlikely	Minor	Very Low
	Water Environment (Surface Waters)	Surface run-off, horizontal migration of impacted groundwater	Unlikely	Mild	Very Low
	Buried concrete and services	Migration and accumulation of gases/vapours, direct contact with services.	Unlikely	Minor	Very Low
	Ecological Receptors (including plants and animals)	Vegetative uptake of leached contaminants, ingestion	Unlikely	Minor	Very Low
Current roads infrastructure It is unlikely to have been constructed using contaminated material, e.g. colliery spoil; however, the potential remains for	Human Health (maintenance workers)	Direct contact, Ingestion, Inhalation	Low	Mild	Low
	Human Health (adjacent residents / workforce - off site receptors during construction)	Direct contact, Inhalation	Unlikely	Minor	Very Low
	Human Health (end users)	Direct contact, Ingestion, Inhalation	Unlikely	Minor	Very Low

Source	Receptors	Pathways	Probability	Magnitude	Risk
contaminants to be present in the made ground.	Water Environment (groundwater in superficial deposits)	Lateral and / or vertical migration of water from the made ground via groundwater flow, surface water drainage system or creation of new pathway via piling	Unlikely	Minor	Very Low
	Water Environment (groundwater in bedrock)		Unlikely	Minor	Very Low
	Water Environment (Surface Waters)	Surface run-off, horizontal migration of impacted groundwater	Low	Minor	Very Low
	Buried concrete and services	Migration and accumulation of gases/vapours, direct contact with services.	Unlikely	Minor	Very Low
	Ecological Receptors (including plants and animals)	Vegetative uptake of leached contaminants, ingestion	Unlikely	Minor	Very Low

13.6 Impacts on Policy and Legislation

13.6.1 Following the assessment of impact above, the scheme has been assessed against the various relevant policies. The results are shown in Table 13-19.

Table 13-19: Impacts on policies and legislation

Legislative Instrument	Relevance to the assessment	Achieves objectives
Legislation and policies		
Environmental Protection Act 1990	Scheme will comply with required duty of care responsibilities regarding waste and land contamination	Yes
The Environment Act 1995	Scheme will reuse materials generated on site within the scheme. Pollution control measures will be implemented to minimise pollution of soils and water.	Yes
Contaminated Land (Scotland) Regulations 2000	Pollution control measures will be implemented to minimise pollution of soils and water.	Yes
National		
National Planning Framework 3, 2014	Soils will be reused within the scheme where possible to increase sustainability and protect natural resources.	Yes
Land Use Strategy 2016 – 2021, 2016	The loss of high-quality agricultural soils is contrary to the framework where a change in food production land should be recognised in decision making. However, in the wider agricultural landscape the loss of high-quality land is relatively small.	No
Scottish Government Scottish Planning Policy, 2014	The scheme aims to maintain soil quality through application of pollution prevention measures during construction. It will result in loss of high-quality agricultural land.	No
The Scottish Soil Framework	The scheme aims to maintain soil quality through application of pollution prevention measures during construction. It will result in loss of high-quality agricultural land.	No
Local Policy		
Aberdeen City and Shire Strategic Development Plan 2014 (Ref 13.14)	Soils will be reused where possible within the scheme to encourage sustainable development.	Yes
Aberdeenshire Local Development Plan 2017	Soils will be reused where possible within the scheme to encourage sustainable development.	Yes

13.7 Mitigation Measures

Construction

Geology

13.7.1 One of the main ways to reduce the impact on geology is to reuse excavated material on site to reduce the requirement for importing virgin materials.

13.7.2 However, not all cut material will be suitable for reuse from an engineering and / or chemical perspective. It is estimated that approximately 60% to 70% of material will be suitable for reuse on site (BREEAM target rates for diversion from landfill within Waste 01 Construction waste management guidance (Ref 13.37) and the Scottish Government Zero Waste Plan), although considering that 97 to 98% of land take is from agricultural land, this figure is likely to be much higher.

13.7.3 Consideration during construction will be given to the guidance provided within the Department for Environment, Food and Rural Affair guidance, Planning for Biodiversity and Geological Conservation – A Guide to Good Practice Geological conservation a guide to good practice (Ref. 13.38) and Natural England's Geological conservation: a guide to good practice (Ref. 13.39) to protect the underlying bedrock and superficial deposits. Should paleogeology remains be encountered these will be recorded.

13.7.4 All excavated material reuse will be undertaken in accordance with guidelines provided within the Department for Environment, Food and Rural Affair's, Construction Code of Practice for the Sustainable Use of Soils on Construction Sites, (Ref. 13.40); and SEPA guidance 'Promoting the sustainable reuse of greenfield soils in construction' (Ref. 13.41).

13.7.5 A Site Waste Management Plan (SWMP) will be developed by the contractor, to maximise use of existing resources and reduce waste. This approach will also reduce costs associated with transport and sourcing fill materials.

Soils

13.7.6 The impact on soil structure during construction will be minimised through best practice measures so as suitable storage to minimise impact upon soil structure and enable reuse in landscaping.

13.7.7 Adherence to good practice measures and pollution prevention measures will ensure any impacts on soils from pollution will be minimised.

Contaminated land

13.7.8 The primary mitigation methods to reduce the risk from contaminated land comprise either reducing the impact of the source or to break the pollutant pathway linkage. Techniques used will include catching any surface water run off before it enters ground/surface water drains to full soils and groundwater geochemical classification and utilising safe systems of work.

13.7.9 Once the nature of the made ground, natural soils, groundwater and soil gas regime has been characterised a more detailed Qualitative Risk Assessment will be undertaken and the preliminary CSM will be refined to enable assessment and identification of potential risks as well as classification of materials for reuse / disposal.

13.7.10 Contingency measures will be put in place to manage any localised hotspots of land contamination and other as yet unidentified areas of land contamination during earthworks including safe working practices and materials reuse/ disposal assessments.

13.7.11 In addition, the risk from contaminated land will be further reduced through the use of safe working practices such as the use of Personal Protective Equipment or site inductions.

Operation

13.7.12 The only effect is the loss of high-quality agricultural soils. As the land will be permanently removed from agriculture, there is no mitigation that can be provided for operational effects.

13.8 Residual Effects

Construction

Geology

13.8.1 Geomorphology: Residual effects from construction are the same as pre mitigation as the effects are not significant.

13.8.2 Anthropogenic ground: With best practice measures in place and workers apprised of locations of potential made ground, impacts will remain negligible and the residual effect will be slight. Pollution prevention measures will ensure impacts to water from made ground will be minimised and the impact remains negligible and of slight significance.

13.8.3 Bedrock geology: Impacts on bedrock remain minor adverse following mitigation and of slight significance.

13.8.4 Superficial geology: Best practice measures will be implemented during soil storage to ensure soil structure remains suitable for reuse. Adherence to pollution prevention measures will ensure no pollution of soils. The magnitude of impact is reduced to negligible and residual effects remain of slight significance.

13.8.5 Paleogeology:The magnitude of impact on any paleogeological remains will remain negligible and of slight significance.

13.8.6 Hydrogeology: Pollution prevention measures will ensure that impacts on hydrogeology from earthworks and potential pollutants will be minimised. Impacts remain negligible and of slight significance.

Soils

13.8.7 The residual impacts during construction will reduce to negligible adverse, with Pollution Prevention Measures in place, as well as mitigation to minimise vehicle movement and protect

against adverse weather conditions which may damage the soil. The significance of effect will be slight.

Soils and carbon storage

13.8.8 No mitigation can be applied to minimise the loss of soil carbon storage during construction, impacts will remain negligible of slight significance.

13.8.9 Construction effects for soils and geology are summarised in Table 13-20.

Table 13-20: Summary of residual effects – construction

Receptor		Summary of receptor sensitivity	Magnitude of impact	Significance of effect
Geology	Bedrock geology	Medium	Minor	Slight
	Superficial geology	Low	Negligible	Slight
	Geomorphology	Negligible	No change	Neutral
	Paleogeology	Low	Negligible	Slight
	Hydrogeology	High	Negligible	Slight
Soils	Soils	Very High	Negligible	Slight
	Soil and carbon storage	Medium	Negligible	Slight

Contaminated land

13.8.10 The key risks from contaminated land during construction are impacts on construction workers, and pathways to water. With appropriate mitigation measures in place to characterise areas of potential contamination and construction workers supplied with appropriate PPE, the risk is reduced to low.

Operation

13.8.11 Operational residual effects remain the same as before mitigation, as summarised in Table 13-21. The only effect is the permanent loss of high-quality agricultural soil.

Table 13-21: Residual significance of effects - operation

Receptor		Summary of receptor sensitivity	Magnitude of impact	Significance of effect
Geology	Geomorphology	Negligible	No change	Neutral
	Bedrock geology	Medium	No change	Neutral
	Superficial geology	Low	Negligible	Slight
	Paleogeology	Low	No change	Neutral
	Hydrogeology	High	No change	Neutral
Soils	Soils	Very High	Minor	Moderate
	Soil and carbon storage	Medium	Negligible	Slight

13.9 Limitations

13.9.1 The current earthwork volumes are preliminary and are subject to revision based upon the results of the ground investigation. As such, the impacts upon geology and soils may change as more information becomes available.

13.9.2 At present no information is available regarding soil quality, and whilst significant contamination is not anticipated the following uncertainties remain:

- the geochemical makeup and distribution of potential contaminants within made ground and natural deposits;
- the quantity, quality and flow characteristics of surface water and groundwater regime; and
- the soil gas regime.

13.10 Conclusions

13.10.1 The scheme will result in the permanent loss of agricultural land, resulting in a moderate adverse effect upon high quality agricultural soils.

13.10.2 There remains a low risk to the receptors during construction associated with potential contamination of soil and groundwater associated with the existing A90 and associated infrastructure.