13. Geology and Soils

13.1. Introduction

13.1.1. Geological strata directly influence the geomorphological character of an area, through the evolution of landforms. Soils are derived from the underlying geology and the composition of the bedrock and superficial deposits are reflected in the chemistry and structure of the soil. These in turn contribute to the type of vegetation, to biodiversity, to the habitat type and its potential for agriculture and/or horticulture.

13.1.2. The soils and underlying geology are important factors in determining many physical attributes of an area, such as physical appearance of the environment, local fauna, water quality and land use. Soils and the underlying bedrock from which they derive can provide valuable resources, from fertile land for food production and agriculture, to being economically valuable as mineral and water resources.

13.1.3. Any proposed works have the potential to impact on geological or geomorphologic features, which are considered valuable in their own right. Protected sites – Sites of Special Scientific Interest (SSSI) and Regionally Important Geological Sites (RIGS), would require measures to be taken to avoid or minimise impacts.

13.1.4. Deep and shallow excavations, associated with construction works may result in the destruction or loss of geological strata and/or soils. In some instances opportunities may arise for the creation of new and valuable geological exposures that can be used for scientific and educational purposes. Soils adjacent to construction works and the road, once completed, may also be affected by spray or airborne pollutants. Previous land uses on a site may have led to ground contamination which may determine what developments and working methods are appropriate for the site and how it must be treated.

13.1.5. This report assesses the preferred route for the A77 Maybole Bypass. Potential key issues relating to the preferred route option are:

- Direct impact on the underlying geology as a result of the scheme
- Direct impact on geological features which carry specific importance
- Direct impact to soils through loss and destruction of agricultural soils
- Direct impact on rock formations through areas of cuttings
- Impacts arising from the disturbance of contaminated land

13.1.6. The report provides an impact assessment of the geology, soils and ground conditions of the area using assessment guidance from the DMRB Volume 11 Section 3 Part 11. The chapter also draws on assessment guidance from the following sources.

- BS 10175:2001 Investigation of Contaminated Sites Code of Practice
- Contaminated Land Report (CLR 11)

- Scottish Environment Protection Agency (SEPA) Guidance on Dealing with Land Contamination in Scotland, 2009.

13.1.7. The chapter refers to all geotechnical investigations which have been undertaken in the area including:

- Preliminary Sources Study Report. 2006 (Atkins)
- DMRB Stage 2 Report, Oct 2007 (Atkins)
- Geology and Environmental Datasheets, July 2012 (Envirocheck)
- Geotechnical Statement of Intent, Oct 2012 (Amey)
- Geotechnical Desk Study Report, Oct 2012 (Amey)
- Ground Investigation Pre-construction Information, Oct 2012 (Amey)
- WYG – Ground Investigation Factual Report, May 2013
- Geotechnical Report, 2013 (Amey)

13.1.8. The reports listed above are useful in providing baseline geological information and a background to the historical contamination of the area.

13.1.9. Outline quantities of material to be brought to and cut from site are provided in the Table 13.1:

Table 13.1 Earthworks Quantities Summary

Strata	Approximate Volume Cut (m^3)	Approximate Volume Fill (m^3)	Approximate Volume Surplus (m^3))
Gross	545,000	475,000	70,000

13.2. Legislative and Policy Context

Legislation

13.2.1. The following legislation, guidance, standards and planning policies (national, regional and local) were consulted for this assessment.

The Environmental Protection Act 1990

13.2.2. This Act established businesses' legal responsibilities for the duty of care of waste, contaminated land and statutory nuisance.

The Contaminated Land (Scotland) Regulations 2000

13.2.3. A statutory regime for cleaning up contaminated land came into force in Scotland on July 14 2000.

13.2.4. The main responsibility for enforcing the regime lies with local authorities, but there is also a major role for the Scottish Environment Protection Agency (SEPA) in dealing with "special sites" and pollution of controlled waters. Legislative provision for the new regime was made in the Environment Act 1995 through a new Part IIA of the Environment Protection Act 1990 (EPA).

13.2.5. This legislation introduces a risk assessment methodology to be used in assessing whether a site is contaminated or 'suitable for use'. Within this legislation contaminated land is defined in s78 A (2) of EPA 1990 as "any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in , on or under the land, that-

- A. significant harm is being caused or there is a significant possibility of such harm being caused, or
- B. significant pollution of the water environment or a possibility of such pollution being caused

13.2.6. To determine that significant harm is being caused, and therefore if the land is to be classified as contaminated, a significant pollutant linkage must be recognised using a site specific source pathway receptor model. All three must be present for any harm to exist.

- *Source* – The presence of contaminant / contaminants in, on or under any land
- *Receptor* - People, living organisms, ecological systems or buildings which are or can be subject to harm by contaminants. Includes the water environment which is or may be polluted by contaminants present on, in, or under land.
- *Pathway* - One or more routes or means, by which a receptor is exposed to a contaminant, or could be exposed.

<u>The Water Environment and Water Services (Scotland Act) 2003 (WEWS)</u>

13.2.7. To protect the wider water environment, the Water Framework Directive (WFD) 2000 was introduced in 2000 to establish systems to manage the water environment, and was transposed into Scots Law in 2003.

13.2.8. Under the Act, Scottish Ministers introduced requirements for SEPA to establish a register of protected areas. This was taken forward in 2004. The Register presents information on the following types of protected areas as designated by Scottish Ministers:

- Shellfish waters
- Freshwater fish waters
- Bathing waters
- Drinking Water Protected Areas
- Nutrient sensitive areas such as Nitrate Vulnerable Zones (NVZs) and Urban Waste Water Treatment (UWWT) sites
- Nature conservation sites for the protection of habitats and birds

13.2.9. In addition, the Directive incorporates guidance on Sustainable Urban Drainage Systems (SuDS), which have a direct impact on the flood risk. Flood Risk and the Water Environment is discussed within Chapter 12.

Water Environment (Controlled Activities) (Scotland) Regulations 2011

13.2.10. These regulations provide SEPA with the authority to serve (an) enforcement notice(s) either to control or to stop an activity which poses a significant risk to the water environment and/or which may cause discharge to groundwater of any substances listed in the CAR (Controlled Activity) Regulations (Schedules 1 or 2). The 2011 Regulations increased the number of controlled activities which can be carried out under general binding rules. General Binding Rules provide a statutory baseline of good practice and their implementation will help to improve water quality.

National Planning Policy

13.2.11. National planning policy guidance on development involving agricultural land is now set out in the Scottish National Planning Policy Framework, Feb 2010. In paragraph 97, this states that:

13.2.12. 'Prime quality agricultural land is a finite national resource. Development on prime agricultural land should not be permitted unless it is an essential component of the settlement strategy or is necessary to meet an established need, for example for major infrastructure development, where no other suitable site is available. When forming the settlement strategy, planning authorities should consider the impact of the various options on prime quality agricultural land and seek to minimise its loss.'

PAN 33 – Development of Contaminated Land, October 2000

13.2.13. Planning Advice Note states that the planning system has a key part to play in addressing the problem of historical contamination. In pursuing policies to re-use and redevelop sites, developers and planning authorities need to be aware of contamination issues and the role of the planning system in dealing with them.

The Soil Strategy for Scotland, March 2011

13.2.14. The Scottish Government aims to promote the sustainable management and protection of soils, consistent with the economic, social and environmental needs of Scotland.

13.2.15. It recognises soils are a valuable but 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.

13.2.16. 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 on soils.

Local Planning Policy

South Ayrshire Local Plan, April 2007

13.2.17. The plan features a number of policies which would apply to geology, soils, ground conditions and contaminated land. These are listed below;

- RE 3 – Safeguarded Mineral Deposits

" *The Council will seek to ensure that known mineral deposits are not permanently sterilised by development proposals, unless significant economic benefits would be prejudiced by any future extraction operations.* "

" *Minimising the production of waste and encouraging the efficient use of minerals by promoting design solutions and construction methods which minimise mineral use* "

- Env 13 – Protection of Prime Quality Agricultural Land

" *There will be a presumption in favour of protecting prime quality agricultural land (defined as grade 1, 2 or 3.1 in the Macauley Land Classification system), where an alternative location for development may exist* "

- SERV 15 Waste Disposal Facilities

" *In line with National Guidance, the Council's Waste Disposal Strategy and Area Waste Plan seek to promote the principles of waste minimisation, prior to its eventual disposal. As such, an increase in the recycling of wastes forms an integral element of the Strategy, with the ultimate aim of reducing the burden on disposal facilities and potential problems of pollution.* "

13.3. Study Area

13.3.1. For geotechnical engineering purposes, the area of interest of the preferred route is largely within, or close to, the footprint of the preferred route. However, for geo-environmental studies, where significant sources of contamination or receptors may lie outside the footprint of the scheme, a wider area has been considered. Use has been made of information gained when a wider route corridor was under consideration at earlier stages of design. Historic maps and other environmental data were acquired beyond the original route corridor. For some aspects, such as regional hydrogeology (discussed in Chapter 12) and the importance of geological exposures, a wider study area has been considered.

13.3.2. The scheme generally passes through undulating agricultural land. From the southern tie-in with the existing A77, the proposed A77 route trends north-eastwards, cutting through the centre of Gallow Hill and Kirkland Hill. The recorded elevations along this section, taken from the OS plans, vary from between 90mAOD at the start of the route to a maximum of 139mAOD and 110mAOD at the top of Gallow Hill and Kirkland Hill respectively.

13.3.3. The proposed route continues north-eastwards cutting through the side of several unnamed hills, with recorded elevations of around 85mAOD to 100mAOD. The natural topography then falls rapidly towards the tie-in, which is recorded at an elevation of 60mAOD.

13.3.4. The scheme intersects four minor roads, the B7023 Culzean Road, Kirklandhill Path, Gardenrose Path and the B7024 Alloway Road, all of which trend southwards into Maybole. The route also passes over three small watercourses which are described in Chapter 12..

13.3.5. To the southeast of the proposed route, the Glasgow to Stranraer railway line runs generally parallel with the existing A77. The railway is constructed in cutting and embankment and is approximately 100m from the proposed route at its closest point.

- Overhead electricity pylons and telephone poles are present along the scheme

13.4. Methodology

13.4.1. The geology and soils assessment has been undertaken in accordance with Transport Scotland's guidance in the Design Manual for Roads and Bridges, Volume 11, Section 3, Part 11 Geology and Soils.

13.4.2. Geotechnical investigations were carried out by Amey in 2012 and 2013 specifically to investigate the geological ground conditions along the route of the preferred alignment under Stage 3. These included a Geotechnical Desk Study Report (Amey, 2012), an intrusive investigation by White Young Green documented in a Factual Ground Investigation Report (WYG, 2013), and a Geotechnical Design Report (Amey 2013). Historic maps and environmental database information were appended to the geotechnical desk study report in its Appendix I.

13.4.3. Published geological maps, geological memoirs and soil survey records have been consulted, along with the on-line records from the British Geological Survey (BGS). There has also been liaison with Scottish Natural Heritage, who is the regulator of geological sites of special scientific interest (SSSI) and regionally important geological sites (RIGS).

13.4.4. The purpose of Amey's geotechnical investigations was to determine the ground conditions underlying the proposed scheme and derive geotechnical parameters and recommendations for design. For this reason the exploratory holes were logged to recognised geotechnical standards (BSI, 2002; BSI, 2004).

13.4.5. A ground investigation was also carried out by Norwest Holst in 1986 on behalf of Strathclyde Regional Council to explore the suitability of various bypass routes north and south of Maybole. Ten of their exploratory holes were close to the preferred alignment and provide useful supplementary information.

13.4.6. The preferred route for Maybole Bypass is now established, and, there are sufficient boreholes, trial pits, cone penetration tests and test data for the purposes of geotechnical design and contaminated land risk assessment.

13.4.7. For the purposes of this section of the Environmental Statement, contamination levels were assessed using data produced by the 2013 ground investigation in accordance with the requirements of DMRB standard HD22/08 Managing Geotechnical Risk (2008).

13.4.8. To meet the requirements of the Scottish National Planning Policy Framework (Department for Communities and Local Government, 2010) and Contaminated Land Report CLR11 (Defra/Environment Agency, 2004), a Phase I contaminated land section was included in the geotechnical desk study report (Amey, 2012). The findings of the desk report and assessment of ground investigation contamination levels are summarised in this chapter.

13.4.9. Hydrology and hydrogeology, including drinking water protected areas and aquifer designations, which are sensitive issues in this area, are discussed in Chapter 12 which covers Road Drainage and the Water Environment.

13.4.10. The following consultations were undertaken

- British Geological Survey
- Scottish Natural Heritage

13.4.11. Consultation produced the following information;

'*Thank you for the opportunity to comment on the above road improvement proposal at Maybole.*

We have looked at the preferred route on the map you supplied and note that the route is underlain by Devonian Swanshaw Formation sandstone covered by glacial till, hummocky glacial deposits and alluvium. We are not aware of any geological features of interest along this route.

However, we would be grateful for any site investigation information that may be generated by this scheme – BGS 2013.'

13.4.12. The relative sensitivity and magnitude for Geology, Soils and Contaminated Land are included within the relevant tables 13.2 to 13.6.

Table 13.2 Sensitivity Criteria – Geological Features, Groundwater and Mineral Resources	
Sensitivity	**Typical Criteria Descriptors**
Very High	Areas containing geological and geomorphological features of International interest, Sites of Special Scientific Interest (SSSI) and designated sites of nature conservation. Nationally important mineral deposits.
High	Areas containing geological and geomorphological features of national interest, Sites of Special Scientific Interest (SSSI) and designated sites of nature conservation. Deposits of minerals suitable as a National resource.
Medium	Areas containing geological features of designated regional importance for example geological SSSI, Regionally Important Geological Sites (RIGS), considered worthy of protection for educational and research purposes. Regionally important mineral deposits. Mineral resources of Regional importance
Low	Geological features not currently protected and not considered appropriate for future protection. Absence of mineral deposits or deposits only considered to be of local value.
Negligible	Limited geological features not currently protected and not considered appropriate for future protection. No mineral deposits.

Table 13.3 Magnitude of Impact on Geological Features, Groundwater and Mineral Resources	
Impact Magnitude	**Typical Criteria Descriptors**
Major	Partial up to 50% or total loss of a geological site or where there would be complete severance of a site such as to affect the value of the site. Existing resource use is irreparably impacted upon. Significant usage of on-site mineral deposits or large importation of mineral resources.
Moderate	Loss of between 15 to 50% of a geological site, major severance, major effects to the setting or disturbance such that the value of the site would be affected but not to a major degree. Moderate usage of on site or external mineral resources.
Minor	Minimal effect on the geological site, up to 15%, or a medium effect on its setting, or where there would be a minor severance or disturbance such that the value of the site would not be affected. A small quantity of on site or external mineral resources will be required for construction.
Negligible	Very slight change from baseline condition. Change hardly discernible equates to a 'no change' condition. Very small quantity of mineral deposits are required for construction. This may be for minor landscape or drainage works.
No Change	There will be no change to geology magnitude. No extraction of on-site minerals.

Table 13.4 Sensitivity Criteria - Impact on Geological Features, Groundwater and Mineral Resources from Contaminated Land	
Likelihood	**Definition**
Very High	There is 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.
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 shorter term.
Low	There is a complete pollution linkage but circumstances are such that it is unlikely that a pollution event could 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.

Table 13.5 Magnitude Criteria Contaminated Land	
Magnitude	**Definition**
Major	Short term (acute) damage to human health (significant harm) Pollution of sensitive water resources as a result of short term exposure. Damage to a particular ecosystem as a result of acute exposure. Catastrophic damage to buildings / property.
Moderate	Long Term (chronic) damage to human health (significant harm) Pollution of sensitive water resources as a result of short term exposure. A significant change in a particular ecosystem, or organism forming part of such an ecosystem.
Minor	Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services Damage to sensitive buildings / structures / services or the environment.
Negligible	Harm which may result in financial loss or expenditure Non-permanent health effects Easily repairable damage to buildings, structures and services
No Change	No impact expected as a result of contaminated land being present, within a site.

Table 13.6 Criteria for Assessing Soil Sensitivity	
Sensitivity	**Typical Criteria Descriptors**
Very High	Land is classified as Class 1 to 3.1, suitable for intensive cropping. This land is highly flexible for other uses as well, such as for biofuel crops and woodland, although current management may make other options, such as heathland restoration, difficult in the short term.
High	Land is classified as Class 3.2 to 4.2 Land in these classes is capable of being used to grow a moderate range of crops including cereals (primarily barley), forage crops and grass. Grass becomes predominant in the rotation in Class 4.2 whilst other more demanding crops such as potatoes can be grown in Class 3.2
Medium	Land classified as 5.1 to 5.3 Land in this class has the potential for use as improved grassland. A range of different limitation types, either operating singly or in combination, can restrict the land capability to this class. These limitations include climate, slope, wetness, and often a heterogeneous pattern of conditions that render even occasional cultivation unsuitable.
Low	Land classified as 6.1 to 7. This land has very severe limitations that prevent sward improvement by mechanical means. This land is either steep, very poorly drained, has very acid or shallow soils and occurs in wet, cool or cold climates zones. In many circumstances, these limitations operate together. The existing vegetation is assessed for its grazing quality (Class 6.1 is of high grazing value for example) but Class 7 land is of very limited agriculture value.
Negligible	Land classified as Urban (non-agricultural)

13.4.13. The sensitivity of soils is assessed using the Macaulay Land Classification system. If soils are classed as 1-3.1 then it will have a very high sensitivity. Class 3.2-4.2 will be assessed as high sensitivity. Grades 5.1-5.3 are assessed as having a medium sensitivity. Class 6.1-7 assessed as having a low sensitivity, whilst non-agricultural and land not designated will be assessed as having a negligible sensitivity. This is illustrated in the table above.

Table 13.7 Magnitude of Impact on Soils	
Magnitude	**Definition**
Major	A large volume of high quality soil will be required to be used for construction purposes. The area of land take will equate to greater than 5ha
Moderate	A medium volume of soil is required for construction. The area of land take equates to between 1 and 5 ha.
Minor	A minor volume of earthworks is required, less than 1ha of land take.
Negligible	A small area of soil is required for construction purposes. This will not have a noticeable impact on the land
No Change	There will be no impact on the soils of the site.

13.5. Baseline Conditions

Mineral Resources

13.5.1. A review of available information indicates that the site lies outwith any areas of underground mining in coal or other minerals and therefore the mineral stability of the site is considered to be satisfactory. The site has been assessed a sensitivity of 'low' in accordance with Table 13.2.

13.5.2. A historic sandstone quarry (named as Kirklandhill) was recorded 80m north of the proposed route adjacent to Kirklandhill Path Road. The operator of the quarry is unknown. The quarry was recorded on OS plans between 1859/60 up until 1971-1978 where it appeared to be in-filled. A number of other historic quarries were noted both on the historic OS plans and Envirocheck reports, all more than 300m from the scheme extents.

Geology and Groundwater

13.5.3. The following information has been referenced:

- Geological Survey of Great Britain (Scotland) 1:50,000 Ayr, Sheet 14W Drift Edition (1978) and Sheet 14W Solid Edition (1978)
- BGS website www.bgs.ac.uk online maps and records

13.5.4. A figure showing drift and solid geology along the path of the proposed route is included as DWG 25000182/ENV/13.1.

- Published geological information indicates Made Ground is generally not present on-site

Superficial Deposits

13.5.5. The geology maps show the superficial deposits underlying the proposed route to be predominately glacial till. This is described as comprising tenacious brown or blue-grey clay with variable sand and gravel content and many rounded cobbles and boulders mostly of local rock types but including some far travelled erratics. Marine shells are present in the boulder clay with the exception of Brown Carrick Hill and southern areas.

13.5.6. Along the western half of the route (to the north of the B7024 Alloway Road), the maps record the glacial till to occur as glacial moraines described as mounds or ridges of boulder clay, sand and gravel possibly laid down at the margins of a wasting mass of ice. Two drumlins were also noted on the map immediately to the north of the proposed route, one near the centre of the route and one towards the northern extent. The drumlins were described as ice-moulded mounds of boulder clay elongated in the direction of ice flow.

13.5.7. A band of alluvium was recorded close to the northern tie-in with the existing A77. The alluvium is described as mixed silt, sand and gravel deposited in former river valleys and often forming a series of terraces. Some may be lacustrine, laid down in ice-dammed lakes during late glacial times.

13.5.8. The recent ground investigation undertaken in 2013 established variable depths of drift deposits ranging from very thin layers close to surface (approx. 2m thickness) in the south western vicinity of the scheme to thicknesses of around 20m directly underlying topsoil traveling north east to the eastern extent of the scheme. The drift deposits encountered largely agreed with the descriptions given on published geological maps and mainly consisted of firm to stiff brown boulder clays.

Solid Geology

13.5.9. The underlying bedrock shown along the route is the Swanshaw Sandstone Formation, part of the Siluro-Devonian Lower Old Red Sandstone. The formation comprises up to 750 m of red-brown, grey-green and chocolate-brown, medium and coarse-grained terrestrial sandstones with subordinate pebble beds and conglomerates, minor sandstones, siltstones and mudstones.

13.5.10. The formation is continuous along the scheme and dips were noted to the north and northwest. Inclined strata are identified around the area, with dips ranging from 2 to 20 degrees.

13.5.11. The recent ground investigation undertaken in 2013 established variable depths of bedrock ranging from very close to surface (<0.2m bgl) to around 2.0mbgl in the south western vicinity of the scheme becoming much deeper (proven >20mbgl) traveling north east to the eastern extent of the scheme. The bedrock composition was fairly consistent across the scheme with the shallower layers consisting of a weak grey purple medium grained sandstone becoming medium strong with depth.

13.5.12. A single dyke of crianite (an analcite olivine dolerite) and allied basalt was shown intruding into the Old Red Sandstone immediately to the south east of the route, to the north east of Maybole town centre. The presence of this dyke was confirmed by the 2013 investigation at approximate grid reference (231399, 611410) where a thin layer of material described as 'strong dark grey dolerite' was encountered between 75.46m and 75.36mAOD.

13.5.13. There are no Geological Sites of Special Scientific Interest (SSSIs) or Regionally Important Geological and Geomorphological Sites (RIGS) as confirmed by the BGS.

Groundwater

13.5.14. Contamination of soils can inadvertently impact upon groundwater, therefore although groundwater quality is discussed in detail in Chapter 12, a short summary of relevant details is provided in this section to highlight any impacts associated with contamination.

13.5.15. Historical ground investigations undertaken by Norwest Holst along the route corridor indicate groundwater levels to vary from less than 2m bgl to 10m bgl within the drift deposits and underlying bedrock. In general, recorded groundwater levels become shallower from the south-west towards the north-east of the study area.

13.5.16. The recent ground investigation undertaken in 2013 has generally agreed with historical records. Nineteen groundwater monitoring wells were installed along the route with groundwater levels varying from 0.86m bgl to 18.54m bgl. Further information on groundwater conditions is provided in Section 12.

Topsoil and Made Ground

13.5.17. The artificial ground and landslip map contained within the Envirocheck report recorded a small area of Made Ground at the southern tie-in with the A77. This is likely to have been placed during the construction of the existing A77. Several other small areas of Made Ground were also recorded to the south and west of the route, predominately at the intersection with the B7024 Alloway Road and close to Smithston Railway Bridge, south of the northern tie-in.

13.5.18. Intrusive investigations undertaken in 2013 have established areas of topsoil are present along the majority of the route and a small area of Made Ground to be present approximately 0.5km to the north-east of the A77 and B742 junction. For topsoil, the stratum at the exploratory hole locations ranged from 0.0m to a maximum depth of 0.60m bgl with an average thickness of 0.27m. It is described as firm brown slightly gravelly sandy clay topsoil. Gravel is angular to sub-rounded fine to coarse sandstone.

13.5.19. The materials described as Made Ground were confined to one agricultural field to the north east of the route in seven exploratory positions only. The Made Ground deposits ranged from 0.0m-0.2m to 0.0m-0.5m and were described as dark brown slightly gravelly sand topsoil with abundant straw, rare fragments of glass and pottery and frequent fragments of plastic bags. The area where Made Ground was encountered is associated with a cutting section and will require removal of this area of Made Ground which is considered will enhance the geological profile in this area.

13.5.20. The sensitivity of the Geology and Groundwater at the site is assessed as low in accordance with Table 13.2. This is due to the absence of SSSI's or Regionally Important Geological Sites (RIGS).

Ground Stability

13.5.21. An examination of the Envirocheck Mining and Ground Stability Report (Amey Geotechnical Report, 2013) indicates that several geo-hazards associated with the underlying geology may be present beneath the site as shown below.

Table 13.8 Summary of Potential Geo-hazards (west of B7024)

Geo-hazards	Nil	Very Low	Low
Compressibility Potential		√	
Collapsibility Potential		√	
Landslides		√	

Table 13.9 Summary of Potential Geo-hazards (east of B7024)

Geo-hazards	Nil	Very Low	Low
Compressibility Potential		√	
Collapsibility Potential		√	
Running Sand			√
Swell – Shrink Potential			√
Landslides		√	

13.5.22. A localised area of moderate potential of compressibility strata was recorded in the geotechnical desk study (Amey, Oct 2012) at the northern tie-in, probably associated with the area of alluvium.

Contaminated Land

13.5.23. Whilst the site is predominantly agricultural land and therefore considered to present a low risk in terms of contaminated land, the geotechnical desk study report (Amey, Oct 2012) indicated potential sources of contamination associated with the route of the scheme may include:

- Hydrocarbon contamination of soils associated with vehicles using the A77 carriageway at the tie-in locations along with the B7024 Alloway Road, Kirklandhill Path, Gardenrose Path and B7023 Culzean Road heading north from Maybole town centre;
- Made Ground deposits associated with the construction of the A77 carriageway and B7024 Alloway Road, Kirklandhill Path, Gardenrose Path and B7023 Culzean Road may contain heavy metals, sulphates and sulphides, poly-aromatic hydrocarbons and petroleum hydrocarbons;
- Contaminants associated with the site's historic use as agricultural land including a range of pesticides and herbicides.

13.5.24. Environmental databases do not indicate other significant contaminative uses near the route.

Conceptual Site Model

13.5.25. The following potential site specific Pathway- Receptor Linkages have been identified within the site;

- Human health receptors – construction workers and future site users through dermal contact, ingestion and inhalation;
- Shallow groundwater in the superficial deposits via leaching and downward migration of contaminants;
- Surface watercourses via lateral migration of contaminants; and
- Building materials – pavement construction through chemical attack of sulphates, unfavourable pH conditions and hydrocarbons, if present in Made Ground deposits.

13.5.26. The sensitivity of contaminated land is assessed as 'low' in accordance with Table 13.4. There are pollution linkages present however the construction activities on the site are unlikely to have the potential to lead to a pollution incident. This is both in the short and long term.

Soil Analysis

13.5.27. To make a formal assessment of risks posed to human health, a number of shallow soils samples recovered from the recent ground investigation (Amey, 2013) were subject to chemical analysis. The testing undertaken in terms of location, depth, number and analysis of the samples tested adequately addressed pollutant linkages with respect to the defined conceptual site model (CSM) for the site.

13.5.28. Out of 55 samples tested for a general contamination suite including asbestos, and 20 for pesticides/herbicides, no samples were in exceedance of Human Health Generic Assessment Criteria (GAC) for an industrial/commercial land-use. The industrial/commercial criteria are considered to be appropriate given the proposed development of the site as a road.

13.5.29. No organics in the form of Phenol, PAH or TPH were encountered above laboratory detection limits at any of the locations tested.

13.5.30. No samples were tested deeper than 1m bgl, however in the absence of any identifiable contamination source, and on the assumption that no Made Ground is present at any area below this depth; the testing was considered to be representative with respect to the development. In conclusion, the magnitude of an impact to human health from the presence of contaminated land is assessed to be negligible with respect to Table 13.5.

Risks to Groundwater

13.5.31. To make a formal assessment of risks posed from leaching to groundwater, a number of shallow soils samples recovered from the recent ground investigation (Amey, 2013) were subject to leachability chemical analysis.

13.5.32. Out of 19 samples tested for a general contamination suite and four for pesticides/herbicides, six samples were in minor exceedance of Environmental Quality Standards (EQS) for saltwater surface water bodies which is considered to be an appropriate standard for assessment given the relative proximity of Maybole to the coast. The magnitude of an impact to groundwater from the presence of contaminated land is assessed to be negligible with respect to Table 13.5.

Materials Characterisation and Re-use

13.5.33. All materials at the site are considered to represent non-hazardous waste and in most instances would further be categorised as inert waste, subject to a WAC test, should they require removal from the site and subsequent disposal.

13.5.34. Where it is the intention to re-use the material within the scheme, it would be considered as 'material suitable for re-use' rather than 'waste'. Re-use can be undertaken outside the waste management regime after demonstration that it is not a waste, i.e. it is both structurally suitable and does not possess any characteristics that would cause harm to the environment. This approach would need to be agreed in association with SEPA. Common practice on road schemes such as this would be to store stripped or excavated materials from cut areas in bunds or soil mounds for re-use. These features should be illustrated on design drawings to demonstrate planning of the works rather than unplanned waste storage.

13.5.35. With the exception of soils where exceedance of EQS in leachate have been observed, from a contamination perspective, all materials are considered to be suitable for re-use at any location in the scheme. This may include using it to fill areas to form embankments or for general use in site re-profiling. The soils showing elevated levels of leachable contaminants could be placed under areas of hard standing such as the road itself as this would break the applicable pollutant linkages in question or be disposed of as non-hazardous waste.

Soils

13.5.36. To the west and north of Maybole the preferred route is predominantly underlain by Maybole soils of the Maybole association and to the northeast of Maybole predominantly by Glenalmond soils of the Glenalmond association. Localised occurrences of the Meadownay and Altiwan soils of the Glenalmond association are also present along the route.

13.5.37. The Maybole and Meadownay soils are recorded as iron podzols and the Glenalmond soils brown forest soils. The Altiwan soils are non-calcareous gleys (Atkins, 2007).

13.5.38. The predominant land use within the scheme extents is agricultural. The agricultural land is classified as Class 3.2 on the MLURI Land Capability Classification. According to the land capability map 'It is capable of producing a moderate range of crops with an increasing trend towards grass within the rotation'. The majority of the land is freely draining with only small areas of soils being classed as poorly drained.

13.5.39. The land sensitivity of the soils is assessed as high, in accordance with Table 13.6.

13.6. Project Proposals Including Mitigation

13.6.1. Geology and agricultural soils may be lost, destroyed or otherwise affected as a result of constructing this road.

13.6.2. The preferred route requires the following construction:

- Single carriageway and three roundabouts
- Three tie-ins with existing roads
- Significant areas of cut and fill

13.6.3. The earthworks proposals include a number of embankments and cuttings along the route. For constructing the embankments, there is expected to be no shortfall in earthworks general fill. Soils which are stripped and set aside for re-use will be stockpiled in a controlled manner in accordance with the Environmental Protection Act 1990, section 34, 'Waste Management a Duty of Care.

13.6.4. Areas where geology and soils would be affected include those where permanent excavations are proposed for road cuttings, and temporary excavations for the construction of foundations, culverts, and other structures. Soils adjacent to construction works and the road, once completed, may be affected by spray, runoff or airborne pollutants.

13.6.5. Temporary excavations and cuttings will be inspected to identify geological exposures of scientific interest, although given the information recorded by the BGS and recent ground investigations this is considered to be of low likelihood.

13.6.6. Site-won topsoil and subsoil would generally be retained on site and re-used in the scheme landscape works were required. The exception to this would be Made Ground encountered approximately 0.5km to the north-east of the A77 and B742 junction which exhibited concentrations of contaminants in exceedance of applicable Environmental Quality Standards. This will be described in detail in the contract drawings and the Specification Series 600 appendices which will be prepared as part of the detailed design for the scheme. Topsoil stripping would be undertaken in the presence of archaeologists to identify anything of archaeological importance.

13.6.7. In accordance with best practice, a Soil Resource Plan should be produced to require that:

- Vegetation will be removed from topsoil before stripping and stockpiling.

- Topsoil will be stripped in the driest condition possible.
- Stripping and mixing less fertile subsoil with topsoil will be avoided.
- Tracked equipment will be used wherever possible, to reduce compaction of subsoil in landscape areas.
- Movement of trucks or dumpers will be confined to designated temporary haul routes.
- No topsoil will be removed from below the spread of retained trees.
- Temporary stockpiles are of appropriate dimensions and geometry to maintain the condition of the topsoil and avoid instability.
- Stockpiles are not positioned within the root or crown spread of trees, or adjacent to ditches, watercourses or existing or future excavations.
- Stockpiles are seeded with a grass/clover mix to minimise soil erosion and help reduce infestation by nuisance weeds that might spread seed onto adjacent land.
- Completed stockpiles are cordoned off with secure fencing to prevent any disturbance or contamination by other construction activities.
- Weeds that do appear are either sprayed with herbicide, mown or strimmed to prevent their seeds being shed.

13.6.8. Several geo-environmental reports including a Geotechnical Desk Study and Geotechnical Design Report have been undertaken to support this assessment. Although impacts associated with contaminated land are considered to be minimal for this scheme, there may still be potential for some contaminated ground to be present due to the presence of Made Ground.

13.6.9. This may occur at the southern tie-in with the A77, the intersection with the B7024 Alloway Road and close to Smithson Railway Bridge, south of the northern tie. Where any unidentified areas of contamination are suspected or encountered along the scheme during construction they should not be reused until they have been demonstrated as suitable for use through chemical testing.

13.6.10. Some materials may not be suitable for re-use and require treatment prior to off-site disposal. Using the methodology detailed in WM2 (SEPA, July 2013) chemical test results obtained during the geotechnical ground investigation (Amey, 2013) indicate that materials would not generally be classified as special waste if they become surplus to requirements and require removal from the site. As such, they could be disposed of to a non-hazardous landfill site. Any receiving landfill will need to satisfy itself that it is able to receive such waste and chemical results should be made available. If any future classification determines that waste materials arising from the road construction site contain hazardous properties they would require a waste acceptance criteria (WAC) test prior to acceptance at a licensed landfill.

13.6.11. Where contaminated materials can be placed under the proposed impermeable barriers of the development such as road pavements or hard-standing, those materials can be considered treated and acceptable for use, as relevant pollution transport and exposure pathways will have been broken. The acceptability of this approach to risk management and materials use should be agreed in advance with the SEPA and South Ayrshire Council Environmental Health Department.

13.6.12. In a similar regard, human health receptors should remain vigilant to any areas of unidentified contamination during construction activity through appropriate use of PPE.

Assessment of Effects

13.6.13. The scheme may lead to impacts on the material and mass characteristics of geology and soil assets and/or affect their geomorphological setting.

13.6.14. The significance of environmental effects is determined using Table 2.4 of DMRB HA 205/08.

13.6.15. As there are no designated geological sites along the preferred route, no adverse effects on geological sites are identified. Due to the nature of geological designated sites (about 1 in 3 geological SSSI's are man-made); the potential for exposing strata of scientific interest should be considered as anecdotal information suggests estates in the Maybole area have been approached in the past by Historic Scotland to determine if there were any exposures which could be studied in relation to provenance of materials suited to potential restoration work at Culzean Castle.

13.6.16. The potential impact on Agricultural Land Class 3.2 soils, which are of high value, would have a moderate adverse magnitude and slight or moderate adverse significance. However, given the proposed Soil Resource Plan, this potential impact would be mitigated by careful handling of topsoil during construction, and any effects would be no more than slight adverse. These effects would be direct and permanent.

13.6.17. Amey's contamination investigations (Amey, 2012 & 13) have identified no risks to human health or groundwater with the exception of Made Ground encountered between approximately 0.5km to the north-east of the A77 and B742 junction exhibiting concentrations of contaminants in slight exceedance of applicable Environmental Quality Standards.

13.6.18. Given the level of intrusive investigation carried out in 2013, it is considered unlikely that any significant unidentified soil or groundwater contamination will be found during construction. Furthermore, construction of the carriageway for the new road would effectively create a barrier which would considerably reduce any residual risks to human health, and would minimise infiltration, mobilisation of soluble contaminants and risk to the underlying sandstone bedrock. This is a slight to moderate beneficial effect, and would be indirect and permanent.

Construction Stage Effects

13.6.19. The construction stage activities that could potentially impact on the geology and soils include:

- Groundworks for structures, carriageway, utilities and compounds.
- Landscaping and earthworks including cuttings and embankments.

- General movement of construction plant.

13.6.20. It is anticipated that only conventional earthmoving plant and techniques would be employed.

13.6.21. Construction stage effects may potentially include erosion due to rainfall on disturbed ground, erosion by vehicle movements, and the possibility of spills causing contamination of soil and/or the underlying bedrock. Mitigation would be seasonal working, adequate temporary drainage, pollution prevention measures such as spill kits and designated, surfaced refuelling areas, and best-practice management of temporary topsoil stockpiles.

13.6.22. Given this proposed mitigation, it is expected that there would be no additional temporary effects during the construction stage.

Potential Effects on Health

13.6.23. The above assessment of soil and groundwater contamination, and the associated geotechnical report series have shown that, based on the existing contamination levels encountered and the generic assessment criteria applied, there is no risk to human health identified along the line of the scheme. However, it is recommended that during the construction phase, ground workers remain vigilant to the possibility of encountering discreet areas of contamination that have not been identified by the recent ground investigation. The main way to ensure protection to human health in this regard is to employ appropriate PPE as standard.

Assumptions and Limitations

13.6.24. There have been no difficulties encountered in assessing the effects of the construction phase, or of the long term effects.

13.7. Conclusions

13.7.1. There will be no adverse effects on geology arising from the proposed Maybole Bypass as there are no existing designated geological sites in the study area. During the earthworks phase of construction, geologically important strata may be exposed in cuttings and excavations.

13.7.2. If geologically important strata are identified, their potential value should be assessed. Geological monitoring would be undertaken during the earthworks phase of construction as appropriate. This may include the creation of new permanent exposures, and/or the allocation of time and resources to geological experts for the recording of temporary exposures.

13.7.3. The potential loss of some agricultural soils and potential loss of quality in any soils which are retained for re-use would be an impact of slight or moderate adverse significance. However, careful soil handling would ensure that there should be no absolute loss of agricultural soils and that any loss of quality would be minimised, reducing effects to no more than slight adverse.

13.7.4. A review of soil and groundwater contamination has been undertaken and a Geotechnical Desk Study and Geotechnical Design report have been produced to support this assessment. Based on the existing contamination levels encountered and the generic assessment criteria, there is no risk to human health identified along the line of the scheme, and a low risk of contamination of controlled waters due to the presence of Made Ground at one location approximately 0.5km to the north-east of the A77 and B742 junction. This risk will effectively be removed during construction as the Made Ground lies within an area of proposed cutting. Furthermore in general terms, by creating a barrier that reduces exposure to potential contamination and mobilisation of soluble contaminants, Maybole Bypass would have a minor to moderate beneficial effect in terms of contaminated land.