



13.0 GEOLOGY AND SOILS

13.1 INTRODUCTION

13.1.1 This section presents an assessment of the geology and soils in and around the proposed realignment works on the A737 at The Den.

13.1.2 A desk top study was undertaken based upon information obtained from various sources including:

- The British Geological Survey (BGS)
- BGS GeoIndex Maps¹
- The Coal Authority²
- Records from North Ayrshire Council (NAC) including previous ground investigation reports³
- Envirocheck Report

13.2 METHODOLOGY

13.2.1 This assessment was carried out in accordance with the Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 11, Geology and Soils. The study area for this chapter comprises a 500m corridor either side of the road alignment.

13.2.2 The determination of impact significance considers sensitivity of existing resources to change as represented by the value or importance of the feature and the magnitude of change.

13.2.3 The method of classifying geological sensitivity is assessed using their national, regional or local value. The sensitivity is determined using a five-point scale, as outlined in Table 13.1 – Determination of Receptor Sensitivity.

¹The British Geological Survey Geoindex Maps. Available from: http://www.bgs.ac.uk/geoindex/index_arcims.htm

²The Coal Authority (April 2007), Coal Mining Report at The Den, Dalry, North Ayrshire

³Supplementary Geotechnical Interpretative Report (September 2004 (Revision 1 – July 2006)), A737 Re-alignment at 'The Den', Dalry



Table 13.1 – Determination of Receptor Sensitivity

Sensitivity	Typical Criteria Descriptors
Very High	Areas containing geological and geomorphological features of international interest, for example Geoparks, Wetlands of International Importance, Special Protection Areas and Sites of Special Scientific Interest. Nationally important mineral deposits.
High	Areas containing geological and geomorphological features of national interest for example National Nature Reserves.
Medium	Areas containing geological features of designated regional importance for example Regionally Important Geological and Geomorphological sites, considered worth of protection for educational and research purposes. Regionally important mineral deposits.
Low	Geological features not currently protection 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.

13.2.4 The assessment of contamination risk supports the use of a conceptual risk assessment model in an attempt to establish connecting links between a hazardous source and a sensitive receptor via an exposure pathway. The reasoning for this approach is that without each of the three elements (source, pathway and receptor) there can be no contamination risk. The presence of a contamination hazard at a site does not necessarily imply the existence of associated risks.

13.2.5 The magnitude of potential effects on geology and soils caused by the route alignment has been rated using the classifications and criteria outlined in Table 13.2 – Determination of Impact Magnitude.

Table 13.2 Determination of Impact Magnitude

Impact Magnitude	Typical Criteria Descriptors
Major	Total loss or major alteration to key elements of the baseline conditions such that the post development character will be fundamentally changed
Moderate	Loss or alteration to one or more key elements of the baseline conditions such that post development character of the baseline will be materially changed
Minor	A minor shift away from baseline conditions. Change arising from the alteration will be detectable but not material. The underlying character of the baseline conditions will be similar to the post development character
Negligible	Very minor loss or detrimental alteration to one or more characteristics, features or elements
No Change	No loss or alteration of characteristics, features or elements, no observable impact in either direction

13.2.6 Impact significance is determined using a combination of receptor sensitivity and magnitude of change. Five levels of significance were defined which



apply equally to beneficial and adverse impacts. Table 2.4 Determination of Impact Significance of Chapter 2 illustrates the significance of impacts matrix which is used to derive the overall impact.

13.3 BASELINE CONDITIONS

Geology

13.3.1 Based on a review of available data from BGS and NAC, the likely succession of deposits, in order of superposition anticipated 500m either side of the existing alignment, are described in Table 13.3 – Geological deposits.

Table 13.3 Geological deposits

Deposit	Description
Made Ground	Waste and natural earth materials (deposited on the ground surface or filled in former opencast excavations).
Peat	An accumulation of variable thickness of wet, dark brown partially decomposed vegetation.
Till (Boulder Clay)	Clay with variable sand and silt content. Reddish brown or blue-grey with many rounded and striated pebbles and boulders mainly of local derivation but included some far travelled erratics.
Limestone Coal Formation	General: Mudstone, siltstone, sandstone with coal seams, seastrock and ironstone. Kilbirnie Mudstone Member: Mudstone, dark grey with ironstone and shelly marine bands. Includes the Dalry Clayband Ironstone Seam

13.3.2 A number of phases of ground investigation have been carried out for and on behalf of North Ayrshire Council between 1989 and 2004. From these investigations, the following key points are noted:

- In some sections a layer of peat was encountered at up to 1m below existing ground level. The peat was found to be between 1.0m and 2.5m in thickness and underlain by a thin layer of silty clay which was in turn underlain by firm to stiff glacial till
- In some sections peat was encountered at or near surface, ranging from 0.75m to 2m thickness
- Made ground comprising colliery spoil or soft sandy clay with occasional gravel and cobbles was identified at or immediately below ground level. This deposit extended to a maximum thickness of around 3m and was generally underlain by glacial till although isolated pockets of peat, up to 1m in thickness were encountered in some locations above the glacial till
- In some sections the sequence of deposits encountered comprised soft to firm brown sandy clay with gravel overlying firm to stiff grey sandy clay with gravel. Peat was not encountered in any of the exploratory locations where clay was found.
- In some sections an average thickness of 4m of very soft to soft deposits was encountered, comprising peat, soft grey organic clay and very soft silty clay. Pockets of sand and gravel were also identified in this area.



- 13.3.3 No statutory or non-statutory designations for geological or geomorphological characteristics were identified around the site.
- 13.3.4 Groundwater levels were noted as being 1m to 3m below the existing ground level. It is not clear whether these levels relate to strikes or standing water levels. More information on water can be found within Chapter 12 Road Drainage and Water Environment.
- 13.3.5 According to the Scottish Natural Heritage (SNH) interactive map⁴, the geology within the area is not currently protected and is not considered appropriate for future protection and therefore is assigned a low sensitivity.

Mining

- 13.3.6 There is one recorded mineral working mine within the scheme extents and eight within 500m. Underground and opencast operations are recorded, however all operations have now ceased. These sites and their distances from the existing alignment are summarised in Table 13.4 BGS Recorded Mineral Sites.

Table 13.4 BGS Recorded Mineral Sites

Name	Distance from existing alignment	Type	Commodity
Kersland No.1	On-site	Underground	Iron Ore - Ironstone
The Den	115m	Opencast	Sandstone
Crossroads	130m	Opencast	Sandstone
Muirhouse No.3 Pit	130m	Opencast	Iron Ore - Ironstone
Muirhouse Coal Pits	414m	Underground	Coal
Kersland No.2	414m	Underground	Iron Ore - Ironstone
Barcosh No.1	419m	Opencast	Iron Ore - Ironstone
Todhills No.3	483m	Underground	Iron Ore - Ironstone
Nuirhouse No.1	497m	Underground	Iron Ore - Ironstone

- 13.3.7 There are a further 32 recorded mineral sites between 500m and 1km of the scheme, however all operations have now ceased. These comprise a mixture of type and commodity and three quarry waste tips approximately 850m to the west.

⁴ SNH, Interactive Map (2012), available from: <http://www.snh.gov.uk/publications-data-and-research/snh-information-service/map/>



- 13.3.8 Kersland No.1 pit is identifiable on historical maps and appears to be opencast. However as shown in Table 13.4, records suggest that the pit may have been an active mine.
- 13.3.9 The historical mining in the area is of regionally important mineral deposits and therefore mining is assigned a medium sensitivity.
- 13.3.10 Within The Coal Authority report, it is noted that within 20m of The Den, there are two mine entries. There are no known faults or other lines of weakness due to coal mining. More information on the details of the findings from The Coal Authority can be found within Appendix H.

Contaminated Land

- 13.3.11 The majority of the land within 500m of the existing alignment has been used as agricultural land since the mid 1800's; however, several possible areas of quarrying have been identified on historical maps Historical maps consulted: Ayrshire, Published 1857, Source map scale – 1:2500; Ayrshire, Published 1897, Source map scale – 1:2500; Ayrshire, Published 1910, source map scale – 1:2500; Ordnance Survey Plan, Published 1965-1966, Source map scale 1:2500; and the Large-Scale National Grid Data, Published 1993, Source map scale – 1:2500. It is likely that these areas have been subject to infilling and consequently there is a potential for harmful or contaminated materials to present.
- 13.3.12 The predominant land use surrounding the existing road is agricultural and is classed as grade 4.2 (Land capable of producing a narrow range of crops) on the Macaulay Land Use Research Institute (MLURI) Land Capability Classification⁵. More information on the land use and classification can be found within the Land Use Chapter 8.
- 13.3.13 Previous industrial uses of the site include a smithy, a petrol station as detailed in Table 13.5, mine workings and quarrying as detailed in Table 13.4. These could potentially have contaminated soils or been in-filled with contaminated material from elsewhere.

Table 13.5 Contemporary Trade Directory Entries

Name	Location	National Grid Reference	Classification	Status
Barkip Garage, Smithy	1-5 Crossroads, Dalry	232171, 651159	Gas Suppliers	Inactive
Barkip Filling Station	Beith Road, Dalry	232171, 651158	Petrol Station	Closed

- 13.3.14 A smithy and garage existed adjacent to the site boundary at the junction with Brownhill Road near the western scheme extents. The former petrol station has been built upon and is now a café (The Graze Restaurant). As stated within Royal Haskoning's Contaminated Land Assessment⁶, there was no evidence of any underground storage tanks and through

⁵ Soil Survey for Scotland, Land Capability for Agriculture (1986) Firth of Clyde. The Macaulay Institute for Soil Research, Aberdeen.

⁶ Contaminated Land Phase 1 Desk Based Assessment, A737 Beith to Dalry Realignment at The Den, July 2008, Royal Haskoning.



correspondence with North Ayrshire Council, the tanks have been decommissioned.

- 13.3.15 These areas could potentially contain contaminated soils or may have been in-filled with contaminated material from elsewhere.
- 13.3.16 A geotechnical investigation has been carried out in which soil and water samples were submitted for environmental testing. A report was produced by Land Services Geotechnical Unit (September 2004)⁷ and Revised 2006. This report tested three soil and three water samples, which were then tested against guideline values. Soil values were calculated using the Contaminated Land Exposure Assessment (CLEA) model. Water values were compared to Water Supply (Water Quality) (Scotland) Regulations 2001 where applicable.
- 13.3.17 Both the tests of the soil and water were below the relevant assessment criteria and were not considered to be a source of potential contamination.
- 13.3.18 The investigations undertaken are considered to provide an adequate assessment of the potential sources on site. No changes have occurred since these tests were undertaken. Therefore, as all three elements of the conceptual risk assessment model are not present, the sensitivity of contaminated land is assessed as low.

13.4 IMPACT ASSESSMENT

During Construction

Geology

- 13.4.1 Peat will be removed during the construction phase and may be reused on site or replaced with a fill material.
- 13.4.2 In accordance with the SEPA publication “Developments on Peatland – Guidance on the assessment of peat volumes, reuse of excavated peat and the minimisation of waste” (January 2012) an assessment of the peat material has been undertaken.
- 13.4.3 A description of previous ground investigation undertaken is provided in paragraph 13.3.2. This includes details of the depth where peat was encountered, however this was generally found to be of variable thickness and between 0.75m to 2.5m deep.
- 13.4.4 From the eastern scheme extents to Fernside, peat is present under the road and in the adjacent fields. The peat to the south of the road between the eastern extents and Brownhill Road has been subject of regrading by others, and is now saturated causing occasional flooding of the A737 as far as Fernside.
- 13.4.5 Between Fernside and a further 100m to the east, the peat has been overlain with colliery spoil which has compressed it marginally. Further east along the new alignment, peat is not encountered again until Auchengree Road. From the Auchengree Road until the western scheme extents the peat is under the existing A737 and is also at surface level in the adjacent fields. This peat is not fully saturated.

⁷ Supplementary Geotechnical Interpretative Report (September 2004 (Revision 1 – July 2006)), A737 Re-alignment at 'The Den', Dalry, Glasgow City Council Land Service Geotechnical Unit.



- 13.4.6 As there are properties close to the proposed road, and to reduce the amount of peat excavation required, sheet piling is proposed. Peat will not be excavated to full depth below side roads as traffic loading on these roads is considerably less than the main A737.
- 13.4.7 It is proposed to reuse peat in up-fill and landscaping as described in Table 13.6 Peat Management Plan.
- 13.4.8 A total of 21,074m³ of peat requires to be excavated to create a foundation for the proposed road. 5475m³ of this will be reused on site. The remaining peat cannot be used on site and will require to be classed as waste. No temporary storage of peat is proposed.
- 13.4.9 It should be noted that the depth of the peat was not sufficient to consider the viability of floating/piled solutions. In addition to this the contractor for the works may opt for an alternative solution which will require to be reassessed at that time.
- 13.4.10 The above information forms part of the Peat Management Plan which is detailed in Table 13.6.
- 13.4.11 The replacement of removed soils with fill will result in localised reduction in infiltration of surface water into the surrounding ground. The magnitude of impact on geology during the construction is assessed as minor, with an overall impact significance of neutral as there will be no perceived impact.

Mining

- 13.4.12 In the absence of detailed information regarding the mine workings, the effects of the proposed scheme are unknown. Reducing the depth of cover to the workings or by driving in sheet piling during the construction of the scheme could potentially increase the likelihood of collapsing underlying workings. The magnitude of impact on mining during the construction is assessed as moderate resulting in an overall impact significance of moderate.



Table 13.6 Peat Management Plan

Subject	Excavation of, reuse of and disposal of peat from a road realignment scheme
Peat Conditions	<p>Between chg 0 and chg 180 peat is present to the underside of road formation and to existing ground levels in the adjacent fields. The peat lying to the south of the Trunk Road between chg 0 and chg 100 has been the subject of regrading by others in the recent past and is now saturated and causing occasional flooding of the road and as far as Fernside Cottage.</p> <p>Between chg 180 and 280 the outcropping peat has been overlain with colliery spoil which has compressed it marginally.</p> <p>There is no peat encountered again until chg 680 at the Auchengree Road. This continues till the end of the scheme at chg 940. The peat here has been overlain by the existing Trunk Road but is at surface level in the adjacent fields. This peat is not fully saturated.</p>
Excavation and Reuse Volume Estimates and Reuse Requirements	<p>21074 m³ of peat requires to be excavated to create a foundation for the proposed road realignment. 5475 m³ of this will be reused to upfill to existing ground level on the formed road embankment. The remainder cannot be reused on site and will require to be classed as waste. The use of sheet piling (see below) will considerably reduce the volume of peat requiring to be removed. It is not proposed to excavate the peat to full depth below the side roads as the traffic loading is considerably less. Sufficient excavation will be required to permit the installation of two layers of geogrids and a geotextile layer.</p>
Use of Peat in Borrow Pit Restoration	<p>Not applicable</p>
Use of Peat for other Restoration Purposes	<p>It is proposed to use peat in upfill and landscaping as detailed below.</p>
Handling Excavated Materials	<p>There are properties close to the proposed road scheme and in order to eliminate the effect of the peat replacement in their proximity, it is the intention to use sheet piling to contain the excavation. Sheet piling will also be used to permit the excavation to proceed whilst allowing the traffic using the road to continue albeit as a single lane. The excavation and upfilling will require to be staged</p> <ol style="list-style-type: none"> 1. The piling will be installed; 2. Excavation of the peat will commence and this material will be removed to tip; 3. Excavation of the colliery spoil will commence and this will be deposited in the peat excavation site immediately following the peat removal; 4. Suitable material will be deposited on top of the placed colliery spoil up to road formation; 5. Peat from under the insitu colliery spoil will be excavated and placed on top of the side slopes of the embankment formed and will be brought up to existing ground level; 6. Shallow ditches will be excavated to act as cut off adjacent to the new road verge. These ditches will feed the drain which passes through The Den "village" as agreed with SEPA . Of necessity these operations will be bulk removal and replacement. The site is constricted and lends itself to having haul roads within the works.
Temporary Storage	<p>It is not intended to have temporary storage.</p>
Limitations	<ol style="list-style-type: none"> 1. The depth of the peat was not sufficient to consider the viability of using floating/piled solutions. 2. The Contractor for these works may opt for an alternative solution which will require to be reassessed at that time.

Contaminated Land

13.4.13 Along the route of the proposed alignment, topsoil will be removed and stockpiled for reuse upon completion of the scheme. This is only possible



where the soil is not found to be contaminated, to reduce the spread of contamination. It is the responsibility of the contractor to carry out further testing on any new suspected areas of contamination.

13.4.14 As there is a history of industrial workings in and around the existing and proposed route, there is a potential for uncovering contaminated soils. The risk is considered to be low as previous investigations (detailed in paragraph 13.3.16) have found samples of both soil and water to be below the relevant assessment criteria.

13.4.15 During the construction phase a range of materials may be used on site which has the potential to contaminate soils and water through leaks and accidental spillage, e.g. fuels and concrete. There is the potential for surface water run-off from the development to carry sediment and leachable pollutants from ground materials including disturbed ground, exposed stockpiles, un-surfaced / un-seeded surfaces, wheel washing areas and dust suppression zones.

13.4.16 The testing previously undertaken has shown soil levels to be below the relevant assessment criteria for a source of contaminated land. However, as during the construction there is the potential for contaminated soils to be uncovered, the magnitude of impact on contaminated land during construction is assessed as moderate, resulting in an overall impact significance of slight.

Post Construction

Geology

13.4.17 The bedrock geology will be unaffected by the scheme proposals and underlying peat may be reused onsite. The magnitude of impact on geology post construction is assessed as negligible resulting in an overall impact of neutral.

13.4.18 Some soil will be lost as a result of the realignment will more information contained within the Land Use Chapter.

Mining

13.4.19 The operation of the new alignment will not impact on mining within the area and there is no expectation for future mining works in the area. Therefore the magnitude of impact post construction is assessed as no change, resulting in an overall impact of neutral.

Contaminated Land

13.4.20 The operation of the new alignment will not impact on contaminated land within the area. Therefore the magnitude of impact post construction is assessed as no change, resulting in an overall impact of neutral.



Table 13.7 Summary of Geology and Soils Impacts

Receptor	Sensitivity	Magnitude of Change		Significance of Impact	
		Construction	Post Construction	Construction	Post Construction
Geology	Low	Minor	Negligible	Neutral	Neutral
Mining	Medium	Moderate	No Change	Moderate	Neutral
Contaminated Land	Low	Moderate	No Change	Slight	Neutral

13.5 MITIGATION

During Construction

Geology

- 13.5.1 The drainage system for the road should be designed sufficiently to compensate for the loss of infiltration capacity which may take place as a result of the peat removal. Surface water run-off from the realigned road must be drained via a suitably designed sustainable urban drainage (SUD) system, see Chapter 12 Road Drainage and the Water Environment for more information.

Mining

- 13.5.2 The contractor would be required to produce a method statement identifying mining stability during construction.
- 13.5.3 Any soil or other materials excavated and requiring disposal off-site will require being characterised and disposed of in accordance with the Landfill (Scotland) Amendment Regulations 2003.
- 13.5.4 Mining is primarily a geotechnical issue which could impact on construction methodologies and is therefore not further assessed within this report.

Contaminated Land

- 13.5.5 Stripped topsoil should be stored in a manner to allow it to be re-used in the final works. The area for the site compound should be topsoil stripped prior to establishment. The contractor will be responsible for the development of any site waste management plan, although this is not a legal requirement in Scotland.
- 13.5.6 Method statements should be prepared by the contractor, identifying procedures to be followed should areas of contamination be encountered.
- 13.5.7 Contractors will ensure that environmental practices, e.g. wheel washing, are adopted. Pollution Prevention Guideline (PPG) 1⁸ should be referred to.

⁸ General Guide to the Prevention of Pollution: PPG1, May 2001, SEPA, EA & EHS.



- 13.5.8 Care will be taken during the works to prevent run-off of waters, and in accordance with SEPA advice, surface water run-off will require to be treated via a SUD system. More information on proposed SUD system can be found within Chapter 12 Road Drainage and the Water Environment. The contractor will be responsible ensuring for the SUDs systems implemented during construction accords with the relevant SEPA requirements.

Post Construction

- 13.5.9 The impacts on geology, mining and contaminated land post construction are assessed as being acceptable and therefore no mitigation measures are required.

13.6 RESIDUAL IMPACTS

During Construction

- 13.6.1 Following implementation of the mitigation measures identified in section 13.5, the residual impact assessment is summarised and contained within Table 13.8.

Geology

- 13.6.2 As a drainage system for the road will be designed to compensate for the loss of infiltration capacity, the magnitude is reduced from minor to negligible, with an overall impact significance of neutral.

Mining

- 13.6.3 It is considered that mining will have no residual impact during construction and therefore the magnitude will remain moderate, with an overall impact significance of moderate.

- 13.6.4 The contractor would be required to produce a method statement identifying mining stability during construction.

Contaminated Land

- 13.6.5 It is considered that the mitigation identified within paragraphs 13.5.5 – 13.5.7 will reduce the impact magnitude from moderate to minor. The residual impact significance is determined to be neutral as suitable guidelines and method statements will be followed. The magnitude cannot be reduced further, as there is a risk previously unknown areas of contaminated land may be encountered.



Table 13.8 Summary of Geology and Soils Impacts during Construction with Mitigation

Receptor	Sensitivity	Magnitude of Change	Significance of Impact
		Construction	Construction
Geology	Low	Negligible	Neutral
Mining	Medium	Moderate	Moderate
Contaminated Land	Low	Minor	Neutral

Post Construction

13.6.6 As no mitigation is proposed for geology and soils post construction the residual impact will remain neutral, as defined within Chapter 2 Environmental Impact Assessment Methodology.

13.7 CONCLUSIONS

13.7.1 A number of ground investigations have been carried out over a number of years at this site. Made ground, peat, boulder clay and limestone coal formation have been found. There is one recorded mineral working mine within the scheme extents and eight within 500m. The land surrounding the scheme is predominately agricultural however; previous land uses of the site include a smithy, petrol station, mine workings and quarrying. Tests of the soil and water were below the relevant assessment criteria and not considered to be a source of potential contamination.

13.7.2 Following implementation of the identified mitigation measures during construction, no significant impacts are predicted.