

# 11. Geology, Soils & Contamination

## 11.1. Introduction

This section considers the environmental issues associated with ground conditions relating to GARL. For the purposes of the ES, the term "ground conditions" is used to cover geology and soils, hydrogeology (groundwater), ground contamination and waste management related issues.

The current ground conditions within the proposed route corridor are described below and the likely impacts of GARL on potentially sensitive receptors assessed.

The assessment includes a description of the potential impacts of the scheme and the mitigation measures proposed for each parameter within each segment of the GARL scheme. However, only the residual impacts, those that are likely to remain after mitigation measures have been put in place, are specifically identified and assessed.

Impacts, both potential and residual, have been divided into two categories:

- Short-term construction impacts, and
- Permanent and operational impacts.

Note that some of the conditions and effects described, particularly with regard to contamination and hydrogeology, may interact with other parameters such as surface water (dealt with in Chapter 10). Such interactions are described where appropriate.

## 11.2. Methods

### 11.2.1. Assessment Scope

This section of the ES primarily considers potential impacts associated with ground conditions within the LOD and LLAU (i.e. the 'limits') of the scheme. These impacts include those associated with the construction and operational phases of the scheme. Impacts assessed include any impacts that existing ground conditions may have on the scheme itself as well as potential future impacts of the scheme on off-site receptors, i.e. those receptors that lie outwith the scheme's limits.

### 11.2.2. Baseline Methods

A desktop study and ground investigation was undertaken to collect geo-environmental and geotechnical information. This was combined with a walkover survey to visually inspect the route corridor. As with other elements of the EIA, the emphasis of this study was on the Glasgow Airport and St James' Park sections of the route as these are the areas where works will be undertaken outwith the existing rail corridor. However, as much as possible of the mainline where works will take place was viewed from adjacent land where access allowed.

Geological and soils information was determined from geological maps published by the British Geological Survey (BGS). In addition, where available, the extensive borehole records held by the BGS library were consulted in order to supplement the findings from the intrusive ground investigation. Information on the presence of sites designated for geological reasons, including Sites of Special Scientific Interest (SSSI) and Regionally Important Geological Sites (RIGS), was sought from SNH.

Information on hydrogeology was collected from maps published by the BGS. In addition, information from SEPA and the BGS was used to identify known water abstractions, the presence of any Groundwater Source Protection Zones and groundwater quality.

In order to identify potentially contaminated sites on or close to the route, historical Ordnance Survey maps held by the National Library of Scotland were consulted. In addition an Envirocheck Report was commissioned for the Glasgow Airport/St James' Park area in order to identify potentially contaminated sites, holders of Waste Management Licences, existing and former waste management sites and any other potentially contaminating uses. Where appropriate, details of these sites were confirmed with Renfrewshire Council and/or Glasgow City Council. A copy of the Envirocheck report is included in Volume 4 of the ES. In addition, the waste management implications of removing and disposing of areas of potentially contaminated soil within the scheme limits were considered.

### 11.2.3. Assessment Methods

Once the information was collected it was necessary to assess the impact of the proposed development on each of the parameters in a consistent way. This section sets out how these impacts were assessed.

The assessment took into account guidance set out in Part 10, Water Quality and Drainage, and Part 11, Geology and Soils, of the Design Manual for Roads and Bridges (DMRB) Volume 11: Environmental Assessment and BS10175:2001 Investigation of Contaminated Sites, Code of Practice.

#### 11.2.3.1 Geology and Soils

The main issues for impacts on geology and soils include damage to areas designated for their geological interest or zones where the development may affect active or potential mineral extraction activities. In addition, other potential issues, such as those associated with loss or damage to soils, have been considered. Assessment of the impact of the scheme on geology and soils is based on the criteria shown in Table 11.1 below.

**Table 11.1 Criteria for Assessing Impact on Geology and Soils**

| Impact Assessment | Definition  |
|-------------------|---|
| Major             | <p>An internationally or nationally designated site, such as a SSSI, designated or proposed on the basis of geological interest, that is located within or immediately adjacent to the scheme limits and that would be damaged or destroyed by the proposed development. Also a significant area of high quality or rare soil type that would be destroyed or damaged by the development.</p> <p>A significant or active mineral resource, such as an open-cast mine or quarry, that lies within the limits that would be sterilised by the proposed development.</p> |
| Moderate          | <p>A locally designated or proposed site of geological interest, such as a RIGS, that is located within or adjacent to the scheme limits and that would be damaged or destroyed by the proposed development. Any area of high quality or rare soil type that would be destroyed or damaged by the development.</p> <p>An identified but unexploited mineral resource that would be sterilised by the development.</p>   |
| Minor             | <p>A designated site of geological interest, such as a SSSI or RIGS, located within or adjacent to the scheme limits, that would not be damaged or destroyed by the proposed development. Also damage to or loss of any soils within the limits.</p> <p>Any other prominent but undesignated geological feature that would be destroyed or damaged by the proposed development. In addition, a potential mineral resource or soils close to the limits that may be affected by the development.</p>   |
| Negligible        | <p>Any other site of geological interest that is in the vicinity of the limits but would not be affected by the development. Also any mineral resource in the vicinity of the limits that would not be affected by the development.</p>   |

#### 11.2.3.2 Hydrogeology

Aquifers are likely to be the main groundwater receptor for any pollutants emanating from the GARL development, either during construction or operation. Groundwater is defined in the Water Environment and Water Services (Scotland) Act 2003, which enacts the Water Framework Directive (2000/60/EC), as "water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil". Groundwater is considered to be 'Controlled Water' as defined by the Control of Pollution Act 1974 (as amended).

Aquifers that are a source of public water supply, or that connect directly to surface water bodies, are particularly sensitive to pollution incidents. The significance of potential impacts on the hydrogeological resources that may be affected by the development is based on the criteria shown below in Table 11.2.

**Table 11.2 Criteria for Assessing Impact on Groundwater**

| Impact Assessment | Definition  |
|-------------------|---|
| Major             | Where construction and/or operation of the scheme would result in pollution, damage or destruction of an aquifer that is within a Groundwater Source Protection Zone (GSPZ) and/or is used for public water supply.                 |
| Moderate          | Where construction and/or operation of the scheme would result in polluting, damage or destruction of any aquifer that is not used for public water supply and/or is not in a GSPZ.   |
| Minor             | Where construction and/or operation of the scheme may result in polluting, damage or destruction of any aquifer that is not used for public water supply or is not in a GSPZ and/or where impermeable deposits overlie the aquifer. |
| Negligible        | Where construction and operation of the scheme would not result in pollution of groundwater and/or where there is no significant groundwater resource in the vicinity of the development.   |

### 11.2.3.3 Contaminated Land

The contaminated land risk assessment has been undertaken in accordance with the guidance contained within CLR 6<sup>1</sup> and BS10175:2001. The impact assessment uses a risk-based approach following the source-pathway-receptor methodology promoted by SEPA, which considers the nature of the potentially contaminated site in relation to the proximity of any sensitive receptors such as controlled waters or residential developments. The identification of potentially contaminated land has been based on a review of historical and current land uses and is in accordance with the definition given in the Environmental Protection Act 1990<sup>2</sup>.

The assessment has identified those sites that present the greatest potential risk of an adverse environmental impact. The potential impact is based on the criteria presented in Table 11.3. Where sites have been categorised as 'major' risk sites, recommendations have been presented for ground investigations or for remedial and/or mitigation measures as part of the scheme development.

**Table 11.3 Criteria for Assessing Impact of Potentially Contaminated Land**

| Impact Assessment | Definition   |
|-------------------|--|
| Major             | An area within the scheme limits that is (or is considered to be likely to be) heavily contaminated (based on historic or current land-use and/or available site investigation data), and where impacts that result from migration of contaminants on or off-site as a result of construction and/or operation of the scheme would impact significantly on sensitive receptors within the built and natural environment. Extensive remedial and mitigation measures would need to be taken to avoid adverse environmental or health and safety implications. |
| Moderate          | An area within the scheme limits that is, or is considered to be likely to be, contaminated (based on historic or current land-use and/or available site investigation data), and where impacts that result from migration of contaminants on or off-site as a result of construction and/or operation of the scheme could impact on sensitive receptors within the built and natural environment. Moderate remedial and mitigation measures would need to be taken to avoid adverse environmental or health and safety issues.                              |
| Minor             | A site within the scheme limits for which a contaminating potential is a possibility, but where it is considered very unlikely that any contamination would affect the development or the environment surrounding the scheme during construction or operation. No mitigation measures would be proposed at this stage, but careful observation would be required during construction and operation.  |
| Negligible        | A site within the scheme limits that may be contaminated but where there is very little likelihood of impact on receptors either within or outwith the limits. No mitigation measure would be required.  |

### 11.2.3.4 Waste Management

There are two classes of waste management issues associated with GARL. These include:

<sup>1</sup> DoE (1995) Prioritisation and Categorisation Procedure for Sites which may be Contaminated (CLR6)

<sup>2</sup> Section 78A(2) of the Environmental Protection Act 1990 (as amended): '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) pollution of controlled waters is being, or is likely to be, caused.'

- The presence of an active or former licensed waste management sites within or in the vicinity of the limits; and
- Issues associated with disposal of waste material as part of the construction and operation of the scheme.

Issues associated with licensed waste management sites include the impact that the scheme would have on such operational sites and also the implications that these sites may have for the scheme.

In addition, during construction, waste materials such as soils, demolition rubble, contaminated material and general site waste would be generated. Disposal options would depend on volumes generated and treatment options available. The management of wastes would be in accordance with the National Waste Strategy (Scotland) and the Glasgow and Clyde Valley Area Waste Plan 2002 that sets out a hierarchy for handling wastes as follows:

- Prevention;
- Reuse/Refurbish;
- Recycle;
- Other recovery; and
- Compost.

The aims of the waste hierarchy would be taken into account during the assessment of impacts. The criteria for assessing impacts of the scheme associated with waste management issues are set out in the table below.

**Table 11.4 Criteria for Assessing Impact from Waste Management Issues**

| <b>Impact Assessment</b> | <b>Definition</b>   |
|--------------------------|---|
| Major                    | Where a site licensed under the Waste Management Licensing Regulations 1994 (as amended) is present within or close to the scheme limits. Also where disposal of Hazardous Waste, or large quantities of Non-Hazardous Waste, would be required as a consequence of construction and/or operation of the development.       |
| Moderate                 | Where a closed waste management site, that may or may not have surrendered its Waste Management Licence, is present within or close to the limits and/or where disposal of Non-Hazardous Waste, or large quantities of Inert Waste, would be required as a consequence of construction and/or operation of the development. |
| Minor                    | Where there are closed and unlicensed waste management sites and/or unlicensed sites within or adjacent to the limits. This could include areas of fly-tipping within the limits. Also, where there would be a requirement to dispose of Inert Waste as a consequence of construction and/or operation of the development.  |
| Negligible               | Where there are no waste management sites within or close to the limits and/or where minimal waste disposal would be required as a consequence of construction and/or operation of development.   |

### 11.3. Existing Conditions

#### 11.3.1. General

In describing baseline conditions for convenience the GARL scheme has been divided into the following sections:

- Glasgow Airport Rail Link branch line to the existing main line.
- The proposed St Andrew's Crescent Fuel Farm at Glasgow Airport
- The existing main line from Paisley Gilmour Street to Central Station
- Elderslie Loop

#### 11.3.2. Intrusive Site Investigation

An intrusive investigation, mainly for geotechnical reasons, was undertaken in April 2005 and comprised 4 cable tool percussion boreholes and 3 trial pits sunk along the proposed Glasgow Airport Rail Link branch line alignment.

Made Ground was encountered within all of the exploratory holes extending to depths of between 0.80 and 1.40 metres below ground level. The Made Ground was generally associated with hardstanding construction and was recorded to comprise bituminous surfacing, Type 1 sub base, sand and gravel and ash. This was underlain by peat then Clyde Alluvium and beneath this the superficial stratum comprised glacial till. Bedrock was found to lie at depth from 24.8 metres to more than 40 metres.

Within the boreholes a single groundwater strike was recorded within borehole BH103 at 3.20 metres depth. Groundwater seepages were more notable within the trial pits and groundwater seepages were noted at depths of between 1.50 and 3.00 metres depth. Groundwater monitoring standpipes were installed within each of the boreholes to depths of between 11.00 and 20.00 metres within the alluvial deposits in order to monitor groundwater levels. This indicated that the groundwater table generally lies at shallow depth within the made ground between 1.30 and 2.12 metres below existing ground level (note that this level would be subject to variation due to seasonal and other factors).

Soil gas monitoring was undertaken at the same time as the groundwater monitoring. Methane was detected at low concentrations of 0.9 and 2.1% by volume in air within boreholes BH101 and BH102 respectively. It is noted that gas level in BH102 exceeds the 1% by volume level quoted in Waste Management Paper 27 indicating that gas protection measures for some structure may be required. No methane was detected in the remaining groundwater monitoring standpipes.

Contamination testing, for a range of contaminants was undertaken on seven soil samples from three trial pits located on the edge of area currently occupied by the existing fuel farm. The chemical analysis of the soil samples revealed elevated concentrations of lead, extractable petroleum hydrocarbons (EPH), polyaromatic hydrocarbons (PAH) and xylenes above guideline screening values.

It should be noted that extensive intrusive site investigations have been undertaken in the vicinity of Glasgow Airport and St James' Park in recent years. These are summarised in Table 11.5.

**Table 11.5 Summary of Previous Intrusive Ground Investigations Reviewed**

| Location                            | Date          | Contractor                    | Comments  |
|-------------------------------------|---------------|-------------------------------|---|
| Glasgow Airport, Site of MSCP No. 2 | November 2000 | Wimtec Environmental Limited. | 8 No. cable tool percussion boreholes, three of which were undertaken by rotary coring and 14 No. window sampler boreholes. |
| St James Interchange (M8 Jct 29)    | 1989 - 1990   | Scott Wilson Scotland Limited | 12 No. boreholes undertaken prior to construction of St James' Interchange  |
| St James' Park                      | Various       | Various (from BGS Records)    | 9 No. boreholes   |
| South of St James' Park             | Various       | Various (from BGS Records)    | 5 No. boreholes   |
| Site of Relocated Fuel Farm         | Various       | Various (from BGS Records)    | 6 No. boreholes to a depth of 50m approx  |

These boreholes broadly confirmed published geological maps and the findings of the site investigation undertaken by Faber Maunsell

### 11.3.3. Geology

The geology of scheme has been determined from published BGS 1:50,000 scale Sheet 30E (Glasgow) Drift (1994) and Solid (1993) as well as sheets from the BGS 1:10,000 series: NS46NE (1993) and NS46SE (1996), Drift and Solid. In addition, borehole and trial pit records from site investigations from the vicinity of the route have been consulted where available.

#### 11.3.3.1 Glasgow Airport Rail Link Branch Line

##### *Drift*

Superficial deposits within the airport terminal area are recorded to comprise Raised Marine Intertidal and Subtidal deposits, which mainly comprise clays and silts. These deposits are locally overlain by alluvial sands and gravels associated with the Abbot's Burn and the March Burn, both now culverted. To the west of St Andrew's Crescent, extending from airport aprons to the main rail line a large deposit of Peat is recorded overlying the Raised Marine deposits. Made ground is also recorded in this area underlying the playing fields and also the route of the M8 and associated slip roads. These deposits of made ground also underlie the southern edge of the new fuel farm site (see below).

Made Ground, described as having been deposited by man associated with road and rail embankments, is recorded to underlie the preferred route of the branch line extending from north of the St James' Interchange, bisecting the St James' Park and terminating along the length of the slip road embankment which links the St James' Interchange to Greenock Road. The thickness of the Made Ground is not recorded although it is likely to be underlain by Peat and Raised Marine deposits.

To the south of the slip road and within St James' Park the superficial deposits are again recorded to comprise Intertidal and Subtidal Raised Marine deposits which extend towards the main railway line. However, the western half of St James' Park playing fields is shown as made ground, with an area of spoil in the western corner. On reaching the main line, Made Ground is recorded associated with the railway embankment.

##### *Solid*

At Glasgow Airport the underlying bedrock is recorded to comprise strata belonging to the Limestone Coal Formation or the Clackmannan Group. This formation generally comprises mudstones in its lower part and sandstones in its upper part with subordinate coals and ironstones. The rock strata are recorded to dip towards the north-west at around 30 degrees.

Within this vicinity a number of large faults are recorded including the Paisley Ruck, a south west – north east trending, broad fault zone consisting of highly shattered rocks, which lies to the south of the airport, approximately 600 metres to the east of the St James' Interchange and crossing the south eastern corner of the St James' Park.

The Blackstone Fault and the Candrens Fault both extend from the Paisley Ruck, trending westwards, downthrowing the strata to the north. The Blackstone Fault downthrows the strata by around 110 metres beneath the southern apron of the airport and the Candrens Fault, which lies beneath the St James' Interchange, downthrows the strata by around 40 metres. Two small fault lines run perpendicular between these names faults, approximately 300 metres and 200 metres to the west and east of the St James' Interchange respectively forming a basin feature.

The Lower Garscadden Ironstone outcrops within the north western corner of the St James' Park and the underlying Johnstone Clayband Ironstone outcrops across the centre of the park, both of which have a north east – south west orientation.

The Top Hosie Limestone, which demarks the upper boundary of the Lower Limestone Formation, and which lies parallel to the Johnstone Clayband Ironstone, outcrops to the north west corner of the St James' Park Pavilion with the outcrop of Lillie's Shale and Coal lying approximately 20 metres to the south east. The Lower Limestone Formation comprises mainly mudstones with siltstones, sandstones and thin limestones, ironstones and coals.

To the east of the Paisley Ruck the Lawmuir Formation of the Strathclyde Group is recorded, mainly Sandstones with subordinate clayrocks, limestones and coals. The rock strata within the vicinity of the fault zone are known to be highly fractured. In general the rock strata are expected to dip to the west at approximately 30 degrees.

#### *Mining*

Historical evidence indicates mineral workings in the area within the fireclay and ironstone deposits. The 1:10,000 geological sheet (NS46NE) records a number of mineshafts to the west of the site of the proposed branch line, the closest being at National Grid Reference 246450, 665450, approximately 300 metres west of the St James' Interchange (likely to be the former Boghead Ironstone Mine).

Correspondence received from The Coal Authority has indicated workings in one coal seam within the area of the proposed alignment. These workings, for which the last date of working is recorded as 1886, lie at some 150 to 170 metres below ground surface. The coal seam is not recorded although it is expected to be the Lillie's Shale or Coal.

Mining activity in fireclay and ironstone was also recorded within the area of the proposed branch line with six seams of fireclay being exploited at depths recorded as shallow to 110 metres. The last date of working in the fireclay was noted as 1914. One Ironstone seam, thought to be the Johnstone Clayband Ironstone, is recorded to have been worked within the area of the proposed rail line varying in depth between 40 and 110 metres, the last date of working being 1878. The Coal Mining Report issued by The Coal Authority is included in Appendix 11.

#### 11.3.3.2 St Andrew's Crescent Fuel Farm

##### *Drift*

The BGS Sheet NS46NE (Drift) indicates that for the majority of the site the bedrock strata are overlain by deposits of peat overlying Raised Marine Intertidal and Subtidal deposits. However, the southern edge of the site is underlain by made ground that forms part of a larger area of made ground that extends to the east, underlying the playing fields to the west of St Andrew's Crescent, and also to the west to include the M8, the St James' Interchanges and the western half of St James' Park playing fields. In addition, Raised Marine Intertidal and Subtidal deposits, in this area comprising mainly clay, underlie the northern edge of the site. These deposits extend to the north, east and west and are the main extent of drift deposits beneath Glasgow Airport.

##### *Solid*

The BGS Sheet NS46NE (Solid) edition indicates that the underlying bedrock comprises strata of the Limestone Coal Formation, which in this area consists mainly of mudstones with some coals and ironstones, none of which outcrop beneath the proposed fuel farm site. The geological plan indicates that there is a fault approximately 100 metres to the southeast of the site, which downthrows 10 metres towards the northwest.

##### *BGS Borehole Records*

As mentioned previously, records for six boreholes excavated previously at the site of the proposed fuel farm were reviewed. The borehole logs showed that the site is underlain by:

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- Made Ground (2.10 to 2.85m thick)
- Peat (0.5 – 2.30m thick)
- Clyde Alluvium – Silts and Clays (31.50-43.10m thick)
- Clyde Alluvium – Sands (2.0 – 3.00m thick)
- Glacial Till (encountered at depths of between 45.80 and 50.50m bgl)

The boreholes terminated before reaching bedrock.

#### 11.3.3.3 Paisley to Central Station

##### *Drift*

Geological maps indicate that the natural superficial deposits along the length of the main line railway comprise Quaternary drift deposits of various origins, ranging from Glacial (deformation and lodgement tills) to Glaciomarine (intertidal and subtidal clays and silts) to Alluvium (sands and gravels). Information collected during the construction of the Clyde Tunnel highlighted the rapid horizontal and vertical changes that can occur between these deposits.

From the point where the St James' Link joins the main line, as far to the east as the footbridge at Arkleston Junction, the route is underlain by Made Ground, which forms the embankment upon which the main line sits. Between the footbridge and Arkleston (road) Bridge the route is underlain by mainly Late Devensian Raised Marine Intertidal and Subtidal deposits, which in this area are mainly clay. However, a drumlin, comprising glacial till, straddles the route at this point.

From Arkleston Bridge eastwards bedrock is present at or near surface although no other outcrops on the route are recorded. Thereafter, Raised Marine Intertidal and Subtidal deposits underlie the route as far as the Hillington Industrial Estate, where the route then encounters older Glaciomarine deposits and some sections of made ground.

Between Hillington Industrial Estate and Pollockshields the main rail line runs along the geological boundary between the Alluvial and Glaciomarine deposits, the alluvial deposits generally located to the north of the rail line, the Glaciomarine deposits to the south. An intermittent band of Glacial Till may underlie both these deposits at depth.

Along this section of the rail line the geological sheet records pockets of Made Ground, the most notable being a two kilometre strip that underlies the rail line along the central area of this section of the route. This stretch of made ground coincides with the presence of a retained embankment along this section.

Continuing eastwards, at the approaches to Central Station the underlying drift comprises Clays and Silts of the Glaciomarine deposits (including the Paisley Formation), which extend up to the Pollockshields area of Glasgow. Glacial Till is expected to be encountered at depth. At Glasgow Central Station itself the main line railway is underlain by Sands and Gravels, comprising alluvial deposits associated with the River Clyde.

The geological sheet indicates that drift thickness is generally around 20 to 25 metres along the length of the main rail line, although to the south and south west of the River Clyde, the drift appears to thin, and at Gallowhill bedrock outcrops in one of the cuttings (Arkleston Cutting). The tendency for the drift to thin towards the south west appears to be supported by the increasing frequency and surface area of outcrops in this direction.

##### *Solid*

The area between Glasgow Airport and Central Station is heavily faulted and the solid geology varies dramatically along the length of the main line section scheme.

Between Paisley St James Station and Paisley Gilmour Street underlying strata comprise rocks of the Lawmuir Formation, within the Strathclyde Group, comprising mainly sandstones, with siltstones, mudstones, marine and non-marine limestone, coals and seatearths. Between Paisley Gilmour Street Station and Wallneuk Junction the Lower Limestone Formation is present, comprising mainly mudstones with sandstones, siltstones, marine limestones, coals and seatearth. In this area the formation is folded slightly with outcrops of the Hurler Limestone and Coal defining the eastern and western limits of this formation.

From Wallneuk to Arkleston Bridge, the route is underlain by the Lawmuir Formation, with the Blackbyre Limestone outcropping just west of the bridge. At Arkleston itself a large north south trending Dolerite intrusion is recorded. Thereafter the underlying strata belong to the Lower Limestone Formation

Just to the east of Penilee Bridge the Top Hosie Limestone outcrops marking the transition to the Limestone Coal Formation. This formation comprises a cyclic sequence of sandstones, siltstones, mudstones, coals, blackband and clayband ironstones and seatrocks, which underlies superficial deposits between Hillington Industrial Estate and Bellahouston.

Within the Limestone Coal Formation sequence a number of economic coal seams are present and the main line rail line crosses the subcrops of the Glasgow Shale Coal, the Knightswood Gas Coal, the Lower Garscadden Ironstone (or Coal) and the Kilsyth Coking Coal.

From Bellahouston to Shields Junction, the bedrock strata is recorded as the Passage Formation, an interbedded sequence of sandstone with fireclays and thin mudstones, limestone, coal and seatrock. This formation is dissected by the Lower Coal Measures around the Pollockshields area. The Lower Coal Measures typically comprise a cyclic sequence of sandstone, siltstone, mudstone, coal and seatrock.

From Tradeston to Glasgow Central Station the underlying bedrock is recorded to comprise the Upper Limestone Formation. This Upper Limestone Formation generally comprises a cyclic sequence of sandstone, siltstone, mudstone and marine limestone with subordinate seams of coal and seatrock. A number of major Limestone beds are recorded to subcrop within the area of the railway station including the Calmy Limestone and the Orchard Limestone. Depth to bedrock in this area is expected to be around 15.00 to 20.00 metres below existing ground surface.

#### *Mining*

The 1:50,000 BGS Geological Map does not record any evidence of mineral workings along this section of the proposed scheme.

#### 11.3.3.4 Elderslie Loop

##### *Drift*

The majority of this section is underlain by Quaternary deposits comprising Late Devensian glacial till, consisting of boulders and stones in a hard to stiff sandy silty clay matrix. However, at the eastern end of this section the route is underlain by made ground.

##### *Solid*

Strata of the Lawmuir Formation underlie the majority of the Elderslie Loop section. Within this formation the Dykebar Limestone outcrops beneath the eastern end of the section. In addition, part of the Paisley Ruck underlies the western end of Elderslie Loop.

#### *Mining*

Details of historical mining beneath the Elderslie Loop section are not known; however, no coal seams outcrop beneath this section of the scheme.

#### 11.3.4. Hydrogeology

The 1:625,000 Groundwater Vulnerability Map of Scotland (BGS 1995) indicates that the Glasgow and Paisley area is underlain by a minor aquifer and that the underlying bedrock generally comprises rocks of moderately permeability. These rocks are fractured or potentially fractured and do not have a high permeability, or other formations of variable permeability. Although these formations seldom produce large quantities of water for abstraction, they are important for local supplies and in supplying base flow to rivers.

The superficial drift deposits vary in thickness and can be substantial in parts. They are often variable in composition changing from highly permeable sands and gravels to low permeable clays and silts over short distances both laterally and vertically.

It should be noted that shallow groundwater may be encountered within the superficial deposits, particularly in the St James' Park area where localised flooding and poor drainage are reported.

#### 11.3.4.1 Groundwater Abstractions

Superficial aquifers in this area are not well developed. In addition, there are no official records regarding groundwater (or surface water) abstractions in Scotland, although this will become a requirement in Scotland under the Water Environment and Water Services (Scotland) Act 2003, which transposes the Water Framework Directive (WFD) into Scottish legislation. SEPA will be responsible for the management of River Basin Districts (i.e. river catchment areas) and this will include preparing an inventory of groundwater and surface water abstractions for the first time in Scotland.

#### 11.3.4.2 Groundwater Flow

Groundwater flow in the vicinity of the GARL is not known. However, generally flow relates to the position and orientation of surface water-bodies, particularly watercourses, even though these may now be culverted or covered over. Therefore, in the vicinity of the St James' Park flow may be generally northwards towards the Black Cart River and the Clyde and also possibly towards the White Cart.

The nature of the base water supply to the Paisley Moss LNR is not known and it could be either be due to general surface water accumulation above some sort of aquiclude or aquitard, e.g. the water in the LNR is not hydraulic connected with deeper groundwater due to an interposing layer of clay, or it could be that the base water supply is from underlying groundwater, with which it is connected. In addition, as discussed in

Chapter 10 of the ES, Surface Water, the Abbot's Burn formerly flowed across or near the Paisley Moss in a west to east direction (towards the White Cart) and therefore it is possible that surface water and shallow groundwater flow in the immediate vicinity of the LNR moves in a similar direction. It is also likely that groundwater in the area is tidal to some extent, as the Clyde is tidal as far inland as Glasgow Green.

#### 11.3.4.3 Groundwater Quality

Groundwater quality in the area is not known. Groundwater quality is likely to vary depending on potential point and diffuse sources of pollution in the area, including industrial estates, former undermining, petrol stations, areas of made ground, etc. Groundwater Source Protections Zones do not yet exist in Scotland and although there are two Nitrate Vulnerable Zones in Scotland, none is located in the vicinity of the site.

No groundwater monitoring has been undertaken as part of this study. However, it is likely that groundwater quality will be low in the Murray Business Area, due to historical and current industrial activities, and also possibly in the vicinity of Glasgow Airport due to previous undermining, waste management activities, airport operations (e.g. de-icing) and other industrial sources including the use and storage of aviation fuel.

#### 11.3.5. Contaminated Land

Historical plans have been consulted to determine past uses of the GARL route and therefore the potential for ground contamination. In addition a site walkover of selected areas was carried out.

Specific attention was paid to land underlying the limits of the proposed scheme that define where the new infrastructure will be sited as well as construction areas and associated access routes. Copies of historical maps consulted are included in Appendix to Chapter 11 Volume 4 of the ES.

Note that detailed descriptions of historical development along the proposed route are set out in the Desk Top Geotechnical Study. However, baseline information on potentially contaminated land within and close to the limits is discussed below.

Areas of potentially contaminated land within the scheme limits in this area are presented in Table 11.6 below. Significant areas of potentially contaminated land outwith scheme limits are identified in Table 11.7. Such areas of land are important because contamination can be mobile and therefore may be able to move into areas that may not have had previous contaminating uses. In addition, identified locations of potentially contaminated land are shown on Figure 12.1.

**Table 11.6 Potentially Contaminated Land Within or Close to Scheme Limits**

| Activity/ Source                                     | Location  | Ref. | Potential Contamination  |
|--|---|------|--|
| Former railway sidings (1898-1973)                   | Sidings at Paisley St James                       | 1    | Heavy metals, creosote, diesel and oil spills, chlorinated and other hydrocarbon solvents, pesticides, asbestos, coal and ash.   |
| Abercorn Rope Works (1898-1938)                      | North of Clark Street                             | 2    | Heavy metals, coal and ash.  |
| McGarvie's (present)                                 | North of Clark Street                             | 2    | Diesel and oil spills, degreasers (hydrocarbon solvents), etc.   |
| Falcon (Rope) Works (1914-1957?)                     | South of McFarlane Street                         | 3    | Heavy metals, coal and ash.  |
| RentoKill (present)                                  | South side of McFarlane Street                    | 3    | Demolition wastes, asbestos, hydrocarbons, etc.  |
| Made Ground  | Western corner of St James' Park                  | 4    | Domestic waste, commercial and industrial waste & rubble.  |
| Glasgow Airport Fuel Farm                            | Immediately west of St Andrew's Drive West        | 5    | Hydrocarbons including aviation fuel and diesel.   |
| Former railway land and station (1898-1969)          | Land between Broomloan Road and Transco gasholder | N/A  | Heavy metals, creosote, diesel and oil spills, chlorinated and other hydrocarbon solvents, pesticides, asbestos, coal and ash.   |
| Existing and former railway lines (1850s to present) | Mainline route                                    | NA   | Heavy metals, creosote, diesel and oil spills, chlorinated and other hydrocarbon solvents, pesticides, asbestos, coal and ash.   |
| Made Ground  | Various sections of the mainline                  | N/A  | Made ground has been used on identified sections of the route. Although its composition is unknown it is likely to comprise reworked natural deposits. However, there may be traces of contaminants such as heavy metals, ash, coal, organic compound or landfill gas. |

**Table 11.7 Potentially Contaminated Land Close to Scheme Limits**

| Activity/ Source                  | Location   | Ref. | Potential Contamination   |
|-----------------------------------|--|------|---|
| Abercorn Oil Works (1898-1957?)   | 50 metres south of St James' Park                | 6    | Presumably a shale oil works and therefore likely to be heavily contaminated with hydrocarbons, ash, heavy metals, etc. Possible that groundwater beneath the site is contaminated with hydrocarbons. |
| Chemical Works (1898-1957?)       | Chemical Works                                   | 7    | Possibly strong acids or alkalis, heavy metals, ash, coal, hydrocarbons, solvents and other toxic materials.  |
| Starch Works (1898-1924)          | Immediately north of Murray St Bridge            | 8    | Oils, ash and possibly organic material.  |
| Tobacco Factory (1930s-1960s)     | Corner of Greenhill Road and Clark Street        | 9    | Oils, ash and possibly organic material.  |
| Carlton Castings (1980s-present)  | Corner of Greenhill Road and Clark Street        | 9    | Heavy metals, oils and degreasers (chlorinated hydrocarbons). Possible ash etc., from previous uses.  |
| Boghead Pit (Ironstone) (1864)    | 400 metres west of St James' Park                | 10   | Heavy metals, ash, coal, hydrocarbons.  |
| Walkinshaw Brickworks (1898)      | 400 metres west of St James' Park                | 11   | Includes a clay pit and mineral railways. Ash, coal, heavy metals and hydrocarbons.   |
| Hermand Oil Works (1898)          | 200 metres west of St James' Park                | 12   | Presumably a shale oil works - likely heavy contamination with hydrocarbons, ash, heavy metals, etc. Groundwater beneath the site may be contaminated with hydrocarbons.                              |
| Walkinshaw Pit (Ironstone) (1864) | 600 metres northwest of proposed fuel farm site. | 13   | Heavy metals, ash, coal, hydrocarbons.  |

### 11.3.6. Waste Management

#### 11.3.6.1 Licensed Waste Management Sites

The locations of sites with Waste Management Licences within or in the vicinity of the limits are shown on Figures 12.1 and detailed in the tables below. This information comes from the Envirocheck database and is based on data supplied by Renfrewshire Council. Note that a number are located within the GARL limits.

**Table 11.8 Licensed Waste Management Sites Within Scheme Limits**

| Type  | Location   | Fig. Ref. | Date Licence Surrendered               | Waste Accepted  |
|---|--|-----------|--|---|
| Renfrewshire Council Recorded Landfill Site | Western corner of St James' Park<br><br>Grid Ref:<br>246930, 665330                  | A         | Unknown – probably closed in the 1970s | Rubble, sub-soil, Parks Waste.  |
| Registered Landfill Site                    | Western corner of St James' Park<br>Grid Ref:<br>246900, 665400                      | A         | 1/12/1981                              | Cohesive inorganic material, frictional inorganic material, domestic, commercial and industrial waste & rubble.                             |
| Registered Waste Transfer Site              | Ailsa Industrial Services Ltd, 33/35 McFarlane Street<br>Grid Ref:<br>247220, 665090 | B         | 24/08/1990                             | Builders' rubble, demolition wastes, interceptor sludges, road gully contents, etc., tank washings and waste oil.                           |
| Registered Waste Transfer Site              | Ailsa Industrial Services Ltd, 33/35 McFarlane Street<br>Grid Ref:<br>247220, 665090 | B         | 01/01/1995                             | Scrap metal waste, inert waste, non-putrescible waste, non-hazardous liquids comprising waste oils from interceptor cleaning & tank washing |

| Type  | Location   | Fig. Ref. | Date Licence Surrendered | Waste Accepted   |
|---|--|-----------|--------------------------|--|
| Registered Waste Treatment or Disposal Site | Rentokil Ailsa Environmental Services Ltd, 33/35 McFarlane Street<br>Grid Ref:<br>247220, 665090 | B         | Operational              | Bonded asbestos sheeting, household, commercial & industrial waste |
| Registered Waste Transfer Site              | Melville McFadzean   | C         | 01/10/1994               | Controlled Wastes  |

**Table 11.9 Licensed Waste Management Sites Outwith Scheme Limits**

| Type  | Location  | Fig. Ref. | Date Licence Surrendered | Waste Accepted   |
|---|---|-----------|--------------------------|--|
| Registered Landfill Site                    | St Andrews Crescent/St James' Interchange<br>Grid Ref:<br>247000, 665800            | U         | 1/04/1981                | Cohesive inorganic material, frictional inorganic material, garden waste & rubble.   |
| Renfrewshire Council Recorded Landfill Site | McFarlane Street<br>50 metres west of St James' Park<br>Grid Ref:<br>246860, 665270 | V         | 31/12/1978               | Domestic and Demolition  |
| Renfrewshire Council Recorded Landfill Site | Candrens<br>200 metres west of St James' Park<br>Grid Ref:<br>246610, 665360        | W         | Unknown (closed)         | Unknown  |
| Registered Waste Treatment or Disposal Site | Hitech Equipment Ltd 37 Clark Street<br>Grid Ref:<br>247400, 664920                 | X         | Operational              | Ferrous & Non-Ferrous Metals, Mineral Oil/Water Mixtures, Mineral Oils, Sewage Sludge, Waste From Tank & Interceptor Cleaning, Waste-water/Residues From Street Clean. |
| Registered Waste Treatment or Disposal Site | Paisley Car Breakers, 3 McKean Street<br>Grid Ref:<br>247480, 664830                | Y         | Operational              | Motor vehicles and dismantled vehicle parts  |
| Registered Waste Treatment or Disposal Site | AG Thomson, 1 McKean Street<br>Grid Ref:<br>247590, 664830                          | Z         | Operational              | Motor vehicles and dismantled vehicle parts  |

### 11.3.6.2 Waste Disposal Issues

Waste management issues would be associated with areas of potentially contaminated land that fall within the limits and from which material may need to be disposed during construction of the GARL route and associated infrastructure. In addition, fly-tipped waste deposited with certain areas of the limits would have to be disposed of during construction of the scheme. Under the current licensing regime, waste falls into three categories comprising:

- Hazardous Waste;
- Non-Hazardous Waste; and
- Inert Waste

Material categorised as waste must be disposed of to a licensed waste management facility. However, the Waste Management Regulations do not allow for co-disposal of waste, i.e. Hazardous Waste cannot be disposed of together with a different waste, e.g. Inert Waste, etc. In addition, different costs and taxes are associated with the different categories of waste. Therefore it is important to accurately identify the type of waste produced by the proposed works to enable correct disposal.

Areas of potentially contaminated land are discussed above. The likely category of waste that may be generated from each of these areas during construction is assessed in the sections below.

## 11.4. Construction Impacts

### 11.4.1. Potential Impacts

The potential impacts on ground conditions associated with the construction phase of the GARL scheme are discussed in the following sections. Following sections set out proposed mitigation measures and then assess the level of likely residual impacts remaining after mitigation has been undertaken.

#### 11.4.1.1 Geology and Soils

No SSSI, RIGS or other sites designated for geological reasons are located within the scheme's limits and therefore there are no potential impacts on this type of receptor.

There are currently no mineral extraction activities being undertaken within or close to the scheme's limits and development of new extraction activities are unlikely in the vicinity of the GARL scheme. Therefore construction works are not likely to impact any such extraction operations. In addition, no areas of significant mineral resource have been identified that would be affected by construction works.

For most of the area within the limits there are no soils that would be affected by the development. However, some areas of currently undeveloped land will fall within the scheme's limits at St James' Park and in the vicinity of the proposed fuel farm and damage to soils may occur, particularly where construction compounds would be sited on St James' Park.

#### 11.4.2. Hydrogeology

There is a general risk to groundwater from construction activities. This includes run-off or accidental spillage from construction sites. Such run-off may contain hydrocarbons, hydraulic fluids, solvents, or other substances that could enter a local aquifer, particularly where the overlying drift comprises more permeable components such as peat, sands and gravels. In addition, drilling and piling operations during construction could open up preferential pathways into deeper strata that may contain aquifers.

A more specific risk to groundwater is posed from the decommissioning of the existing fuel farm if hydrocarbon contaminants are mobilised during these works. Furthermore, there is a risk to groundwater from the construction of the proposed fuel farm adjacent to Paisley Moss LNR, where the potential contamination of surface water and/or soils may in turn impact on groundwater.

#### 11.4.2.1 Contaminated Land

During construction activities, disturbance of potentially contaminated land within the limits could pose a risk to construction workers and local residents through direct contact with contaminants or generation of dust/aerosols that may be inhaled or may be deposited on playing fields or in gardens or houses. Contaminated run-off and dust from construction areas may also pose a risk to environmental receptors, such as surface waters or other sensitive habitats such as the Paisley Moss LNR. Potentially contaminated land may also pose a risk to construction materials, through direct contact with aggressive soil conditions or other types of physico-chemical degradation. Site investigation results indicate that low levels of methane may be present in ground either associated with made ground or peat deposits. This may pose a risk to some types of future structures.

#### 11.4.2.2 Waste Management

Formerly licensed waste management sites within the limits are regarded as other former industrial sites in that there is a risk of contamination from these areas, albeit the nature of the potential contamination is likely to be well documented by the licensing authority. Mitigation for these sites will be as for potentially contaminated land.

For the single active waste management site within the limits, at Rentokil Ailsa Environmental Services Ltd, there may be risks to the scheme from contaminated material handled at this site. However, good practice at this site should prevent significant contamination issues.

During construction there would be the requirement to dispose of material from within the limits, as required by the detailed design. It is possible that some of this material would come from areas that are potentially contaminated. Particular issues would include known sources of made ground, such as railway embankments, former railway or industrial areas and areas of former landfill, in addition to fly-tipped waste within the limits.

In general, waste material is likely to comprise Inert and Non-Hazardous waste, although there is the possibility of encountering material that could be classed as Hazardous Waste, for example drums of chemicals or paint, etc. Appropriate handling and disposal of this waste would be required.

In addition, construction activities themselves would generate waste. Most of this would be Inert Waste, however, Hazardous Waste including waste oils, solvents, etc., may also be generated, particularly

associated with decommissioning and clearance of the existing fuel farm at Glasgow Airport. These wastes would have to be disposed of appropriately following the necessary regulations in order to avoid impacts on the environment. In addition, disposal of waste to sites that do not have a current and appropriate Waste Management Licence would be prohibited.

#### 11.4.2.3 Ordnance

As Glasgow Airport was a military airfield prior to becoming a commercial airport, there is a risk of buried ordnance still being present in the vicinity.

#### 11.4.3. Mitigation

##### 11.4.3.1 General

Mitigation of construction impacts will depend on development and adherence to a defined Code of Construction Practice that contains an effective Environmental Management System, thus ensuring good practice and emphasising environmental protection. The Environmental Management System will be developed prior to commencement of site works and will be mandatory. It will ensure that construction activities took place in accordance with all relevant legislation for the protection of surface and groundwater, codes of good practice as well as best practice guidance for works on or near water, such as PPGs prepared by SEPA.

##### 11.4.3.2 Geology and Soils

Mitigation measures will be required to ensure that damage to soils during construction will be minimised, particularly with regard to construction compounds situated within formerly open land. Mitigation will include ensuring that soils are adequately protected and/or temporarily removed during construction works, then restored/replaced after such works have been completed. Measures to improve drainage and alleviate compaction of soils in the construction area in St James' Park, in addition to reseeded and reinstatement of pitches, will be required.

##### 11.4.3.3 Hydrogeology

Mitigation of hydrogeological risk during construction will comprise ensuring effective environmental management of construction activities. For example, this will ensure that run-off from construction areas will be contained/controlled and that adequate bunding and storage arrangements be put in place to prevent spills of fuel or other liquids escaping and potentially entering groundwater. PPG5 Works In, Near or Liable to Affect Watercourses, will be adhered to.

If de-watering activities are required, these will be managed in such way as to prevent impacts on local shallow aquifers, such as ensuring that discharged water is treated before release and/or construction of groundwater barriers to prevent draw-down of groundwater in adjacent areas. Measures such as this may be important at the proposed St Andrew's Crescent fuel farm site close to the Paisley Moss LNR, although as discussed in the Appendix to Chapter 2, construction methodologies avoiding significant de-watering will be preferred. Pollution Prevention Guidelines prepared by SEPA, such as PPG2 Above Ground Oil Storage Tanks, PPG20 Dewatering of Underground Ducts and Chambers and also PPG27 Installation, Decommissioning and Removal of Underground Storage Tanks will be referred to.

Piling/drilling operations will be required in most areas and there is a risk that such activities could pose a risk to deeper aquifers in these areas from the generation of preferential flow paths between potentially contaminated superficial groundwater and deeper aquifers. However, the piling methods employed will therefore ensure that the potential for contaminating groundwater will be minimised and that the creation of pathways between different aquifers will be avoided.

##### 11.4.3.4 Contaminated Land

Areas of potentially contaminated land within the limits have been identified from historical plans and site walkovers. The potential risks associated with these sites have been identified and assessed.

Although the likely potential contamination within the route is known based on review and assessment of historical information, etc., we generally do not have detailed contamination investigation information for certain sections of the GARL route, e.g. through the Murray Business Area and the site of the current fuel farm at Glasgow Airport, where construction works are planned. However, at the detailed design stage and where required, mitigation will include an intrusive ground investigation that will be carried out in advance of decommissioning and construction to confirm the ground conditions and hence facilitate appropriate site controls and waste management. In the event that contaminated ground is identified, a detailed risk assessment will be carried out and an appropriate remediation scheme agreed with Renfrewshire Council and, if required, with SEPA.

During construction, any materials encountered that may be contaminated will be tested for potential chemical contaminants associated with known past uses of the site. In addition, all standard health and

safely measures will be followed to ensure the minimum contact between site workers and members of the public and potential contaminants.

Measures will be put in place to ensure that run-off from sites is prevented and that dust and aerosol generation is minimised and appropriate PPGs will be followed. Areas of significant contamination that may impact on construction materials will be removed or isolated to avoid contact with any sensitive structures.

#### 11.4.3.5 Waste Management

Material to be disposed of will be assessed, and where required, tested to confirm its chemical characteristics so that it can be categorised as Inert, Non-Hazardous or Hazardous Waste as appropriate.

Measures will be put in place to ensure that as much of the excavated material as possible generated through construction will be re-used on other areas of the development, such as fill within the retained embankment between Clark Street and Murray Street. Where possible, alternative uses for extracted material will be sought, e.g. as fill for other construction projects within the west of Scotland. Where material has to be disposed of this will be carried out in accordance with the appropriate Waste Regulations and Duty of Care.

As part of the Code of Construction Practice for the construction of the scheme, waste minimisation measures will be put in place. Where waste material will be generated this will be handled and disposed of according to current Waste Management legislation.

#### 11.4.3.6 Ordnance

Where ground is broken in the vicinity of Glasgow Airport, construction methodologies will take into account the potential for buried ordnance to be present.

#### 11.4.4. Residual impacts

Residual impacts associated with the construction phase, comprising those impacts that are likely to remain after mitigation measures have been put in place, are discussed and assessed below.

##### 11.4.4.1 Geology and Soils

There are no sites designated for geological reasons within or close to the limits of the scheme either at the branch or mainline elements of the scheme. It is therefore anticipated that residual construction impacts will be Negligible.

Damage to soils during construction, particularly where construction compounds are situated, is probably unavoidable. In verge areas within the Glasgow Airport and also within the compound at the St Andrew's Crescent playing fields, some areas of amenity grassland would be damaged. However, as these areas of soil can be easily replaced the significance of impacts on soils would be of Negligible significance. Note that no significant areas of soil will be impacted on within the mainline portion of the scheme.

However, in St James' Park, although soils will be damaged during construction due to building of the viaduct and M8 Bridge and the placing of the main construction compound in this area, significant improvement works to the playing fields will be implemented as part of the scheme. This will include relining of pitches on the western side of the park with the possible inclusion of localised drainage works.

On the eastern side, which will be used as the main site compound, once construction works are completed soils will be reinstated and treated to reduce compaction effects. This is likely to involve installation of drainage on this side of the park. Once soils have been reinstated seeding and reinstatement of the pitches will take place. Overall a Minor positive impact for St James' Park is predicted.

There are no significant mineral resources in the St James' Park area that would be affected by the construction works. Impacts are therefore assessed as Negligible.

##### 11.4.4.2 Hydrogeology

Shallow aquifers within superficial deposits are likely to be the most at risk from impacts associated with construction of GARL.

In the Glasgow Airport and St James' Park portion of the scheme, superficial deposits include raised marine deposits comprising mainly clays. This is overlain by peat in the vicinity of the proposed fuel farm and by made ground at the M8 and in the western half of St James' Park. Groundwater is known to be present at shallow depth in these deposits. However, it is not known whether this groundwater mainly represents 'perched' water or whether it is in hydraulic continuity with groundwater in deeper deposits including the underlying solid geology.

Groundwater is at risk from contamination from a number of construction activities. These include:

- Construction of the proposed St Andrew's Crescent Fuel Farm;
- The construction compound at the St Andrew's Crescent playing fields;
- Decommissioning of the existing fuel farm at Glasgow Airport;
- The construction compound at St James' Park;
- Drainage works as part of the reinstatement of St James' Park;
- Piling operations for the viaduct, bridge, Airport Station and other structures;
- Main line works; and
- General impacts on deeper aquifers.

#### *St Andrew's Crescent Fuel Farm and Construction Compound*

Groundwater is very likely to be present at shallow depth in this area, particularly as the site is in close proximity to extensive areas of 'swamp' and open water at the Paisley Moss LNR. In addition, previous site investigation showed that groundwater was present at depths between 2.00m and 3.00 below bgl. In addition, these areas of 'swamp' extend into the proposed fuel farm site itself. Construction of the fuel farm is therefore may pose a risk to shallow groundwater from a number of activities. These may include:

- Dewatering operations;
- Ground improvement works; and
- Contamination from site works.

Although it is intended to avoid working below the level of the water-table, dewatering operations may be required to construct foundations and underground service and pipe runs, etc. However, where such activity is required it will be done in such a way as to avoid impacting on surrounding groundwater levels, thus reducing impacts on the LNR.

Disposal of extracted water would be undertaken so that sediments were not allowed to enter the groundwater to Paisley Moss LNR. Therefore the potential impact on groundwater from construction of the fuel farm is assessed as being of Minor negative significance.

The fuel farm will be supported on piles. Such works will be undertaken in such a manner so that impacts on groundwater will be minimised. The impact of these works on groundwater is assessed as being of Minor negative significance.

In addition, potential impacts from contaminants from general construction works at the fuel farm (and the proposed construction compound adjacent to St Andrew's Crescent) are possible. This may include contamination of groundwater with site run-off that may contain hydrocarbons, other chemicals associated with construction or silts or mud slurries. However, appropriate environmental controls will be implemented and PPGs will be adhered to, as discussed in the mitigation section above. Therefore the significance of any impact to groundwater is assessed as of being of Minor negative significance.

#### *Decommissioning of Existing Fuel Farm*

There is the potential for contamination of groundwater to occur due to release of hydrocarbons from tanks and pipework during decommissioning of the fuel farm. However, appropriate investigation of the likely presence of hydrocarbon contamination in the area, adoption of appropriate controls such as adherence to PPG27 Installation, Decommissioning and Removal of Underground Storage Tanks, and appropriate remediation and/or removal of any contaminated soils during construction should mean that overall decommissioning works will constitute a Minor negative impact.

#### *St James' Park Construction Compound*

As with other construction compounds there is a risk to shallow groundwater from contaminated run-off that may include hydrocarbons, silts and other chemicals. However, if appropriate environmental management practices are observed and the appropriate PPGs referred to then the overall impact is likely to be of Minor negative significance.

#### *Drainage Works at St James' Park*

Some drainage works are proposed for certain areas of St James' Park, including part of the western half of the park and also the eastern side where the main construction compound will be located. However, it is considered that these drainage works will be relatively minor and will not have a significant impact on groundwater in the area, assign that the appropriate PPGs and other guidance from SEPA are adhered to. The impact is therefore judge as being of Minor negative significance.

#### *Piling Works*

Due to the depth and compressibility of soils and superficial deposits in the area, extensive use of piling for the scheme is proposed. There are two main risks to groundwater from piling:

- Use of pile drilling fluids during piling to increase cohesiveness of surrounding soils; and
- Creation of preferential pathways between superficial groundwater and deeper aquifers.

Pile drilling fluids could potentially contaminate superficial groundwater deposits. However, such compounds that would be used would be selected to ensure that they were inert and would not impact on groundwater. The potential impact is therefore assessed as Minor negative.

Creation of the deep piles that will be required for the scheme may create preferential pathways for groundwater and therefore allow contaminants to migrate from superficial aquifer(s) to deeper groundwater. However, if appropriate PPGs are adhered to then the level of any contaminants in superficial groundwater within St James' Park should remain low. In addition, piling techniques will be employed that prevent the opening of pathways between the surface and shallow and deeper aquifers. Therefore the potential impact of piling operations for the scheme on groundwater is assessed being of Minor negative significance.

#### *Main Line/Elderslie Loop Works*

It is anticipated that works on the main line are unlikely to have an impact on groundwater resources and that therefore the significance of impacts is assessed as being Negligible.

#### *Deep Aquifers*

The Groundwater Vulnerability Map of Scotland (BGS 1995) indicates that the Glasgow and Paisley area is underlain by a minor aquifer and that the underlying bedrock generally comprises rocks of moderately permeability. These rocks are fractured or potentially fractured and do not have a high permeability, or other formations of variable permeability. We have no information on abstractions from aquifers in the vicinity of the scheme; however, it is known that the underlying aquifers are not designated as GSPZs or located within a Nitrate Protection Zone. In addition, mining in various areas, combined with historical industrial activity and the presence of unlined landfill and areas of made ground is likely to have degraded groundwater quality generally in the area.

As discussed in the mitigation section, environmental management during construction would prevent run-off and accidental spills entering and contaminating groundwater. The potential impact on groundwater within bedrock is assessed as Negligible whilst the potential impact on shallow groundwater is assessed as Minor negative.

#### 11.4.4.3 Contaminated Land

Areas of potentially contaminated land have been identified from historical plans. Using the source-pathway-receptor model a number of potential issues have been identified. There is a variety of potentially contaminated land within or close to the limits. The main types of potentially contaminated land that would be disturbed by the construction of GARL are listed below:

- Murray Business Area sites including:
  - Former sidings adjacent to Paisley St James Station;
  - Former ropeworks, now McGarvie's site, immediately north of Clark Street;
  - Former ropeworks, now operational Rentokil Ailsa Ltd, a Waste Transfer Site immediately south of McFarlane Street;
- Areas of made ground within St James' Park and the M8 corridor, including areas of former landfill;
- The existing fuel farm at Glasgow Airport; and
- Existing railway land on and adjacent to the main line and at Elderslie Loop

A number of other potentially contaminated sites lie outwith the limits of the scheme. Sites present in the St James' Park area are shown on Figure 12.1. The principle receptors for potentially contaminated land during construction works are as follows:

- Site workers;
- Members of the public;
- Groundwater (discussed above);
- Surface waters (discussed in Chapter 10 of the ES); and
- Construction materials.

Potential pathways may include:

- Direct contact;
- Ingestion and inhalation;
- Surface run-off; and
- Migration via Groundwater.

The risk to each of the receptors listed above will depend on the proposed works that will take place in that area of contamination, the type and quantity of chemical contamination present, the sensitivity of the receptor and the potential for there to be a pathway between the two. The main sites that may pose a risk are discussed below.

#### *Murray Business Area Sites*

A number of historical and current uses in the Murray Business Area may present a risk of contamination within the scheme limits. These sites are listed in Table 11.6 above and shown on Figure 12.1. The main risks in these areas are to site workers and to construction materials, mainly via direct contact during construction works. However, significant ground breaking is not anticipated in these areas, although it is likely that piling will be required.

Nevertheless, appropriate risk assessment of potential risks from contamination would be necessary to inform the site Environmental Management System and permit development of appropriate mitigation measures. With these mitigation measures in place contact between potential contaminants and any of these receptors would be minimised and the risk reduced to acceptable levels. Therefore the potential impact of potentially contaminated ground in this area is assessed as being Minor negative.

#### *Made Ground*

Made ground is present within the scheme limits within St James' Park, at the proposed compound at St Andrew's Crescent and also at the southern edge of the proposed St Andrew's Crescent Fuel Farm. This made ground may be disturbed during various works including site preparation works, piling, drainage and pitch reinstatement works, as well as construction of access roads and the new fuel farm within Glasgow Airport. Although the made ground represents, in some cases, former landfills (see Figure 12.1), fill material is likely to have consisted mainly of reworked soils from the construction of the M8, with the presence of some other more general wastes. Generally it is thought that this material will not be significantly contaminated, although some organic material may be present in the fill. However, during construction there will be some risks from this material to site workers and construction materials. Nevertheless, for the reasons discussed above the potential impact on these receptors is assessed Minor negative.

#### *Existing Fuel Farm*

Decommissioning of the existing fuel farm is likely to bring site workers into contact with hydrocarbon contamination. In addition, there is a risk to shallow groundwater from the mobilisation of such material if it is disturbed during construction works (as discussed above). However, it is assumed that PPG27 Installation, Decommissioning and Removal of Underground Storage Tanks and other PPGs will be followed to enable safe decommissioning and decontamination of the site. Therefore the impact is likely to be Minor negative.

#### *Existing Railway Land*

Existing railway land will potentially be contaminated with ash, coal, hydrocarbons, PAHs, herbicides and other substances. However, the proposed works will not involve excavation of railway land or significant disturbance of strata where such contaminants are likely to be present. Although there are risks to site workers and potentially construction materials from this contamination, the level of impact is assessed as being Negligible.

#### 11.4.4.4 Waste Management

Wherever chemically practicable, excavated materials would be reused on site in the formation of embankments, screening and landscaping bunds. It is likely that ground investigation together with soils testing would be necessary in both the fill source and fill placement areas to ensure satisfactory management of the excavated materials. However, there would be the requirement to dispose of excess or contaminated material, which cannot be used on the construction of the scheme.

In addition, the construction process would generate other waste, although the majority of this would be classed as Inert Waste. This will include spent ballast from main line workings that will be replaced with fresh ballast as part of the proposed works. Assuming that the proposed mitigation measures are put in place and that waste is identified and handled appropriately, according to Waste Management Regulations, it is likely that the potential impact in terms of waste management during construction would be Minor.

However, decommissioning of the existing fuel farm may generate significant quantities of hydrocarbon-contaminated material that would need to be disposed of. This impact in would therefore be assessed as of Moderate significance.

#### 11.4.4.5 Ordnance

It is a considerable time since Glasgow Airport was an operational military airfield. However, there is the possibility of buried ordnance being present in the construction area. However, it is thought unlikely that ordnance will be encountered during construction activities although appropriate precautions will be taken during ground breaking works. The potential impact is therefore assessed as being of Minor significance.

## 11.5. Permanent And Operational Effects

This section assesses the potential permanent and operation impacts of the proposed scheme.

### 11.5.1. Potential Impacts

#### 11.5.1.1 Geology and Soils

There are no designated sites in the vicinity of the scheme. In addition, there are currently no mineral extraction activities being undertaken within or close to the scheme's limits. Geological maps indicate that although mineral resources have been worked in various areas of Glasgow and Paisley, there are no significant economic deposits within or close to the scheme's limits that would be sterilised by development of the scheme. In addition, the Glasgow City Council and Renfrewshire Council Local Plans do not identify any proposed mineral extraction activities in areas that would be affected by the scheme.

Permanent loss of soils would occur in some areas, particularly within St James' Park, beneath the viaduct and also where additional permanent hardstanding may be provided for parking, etc. However, this is unavoidable as part of the GARL alignment crosses amenity grassland. In addition soils would be permanently lost from the new fuel farm site.

#### 11.5.1.2 Hydrogeology

During operation of the scheme there may be a risk to groundwater. This includes run-off or accidental spillage from the route, comprising hydrocarbons, herbicides and other substances that could enter a local aquifer. In addition, the design of drainage for the scheme would determine risks to groundwater, for example, if there were extensive use of soakaways or other similar measures.

Potentially, the greatest risk to groundwater would be the proposed St Andrew's Crescent Fuel Farm. This is because of the nature of its operations and the type and quantity of fuel that would be stored there as well as its proximity to the Paisley Moss LNR, which is a water dependent feature.

#### 11.5.1.3 Contaminated Land

During the lifetime of the development, there may be a risk from potentially contaminated land to the permanent infrastructure of the scheme. Aggressive ground conditions that remain in contact once the system has been built could degrade buried structures. Such conditions might include soils containing high sulphate, or acidic ground conditions that could attack buried concrete structures.

In addition, in certain areas, such as close to former landfills, other areas of made ground and natural peat deposits, there may be a risk of landfill gas, comprising methane, carbon dioxide, etc. This could enter buildings, manholes and service ducts posing a risk of asphyxiation and/or explosion to employees if permitted to accumulate.

There is also the risk that landfill gas originating from sites within the scheme limits could migrate off site, via service runs, etc., to infiltrate adjacent properties or structures, with attendant risks to members of the public and to property.

If not properly managed, operation of GARL could create contamination of land that was not previously contaminated, through long-term accumulation of small releases of hydrocarbons (e.g. lubricants, etc.) or other chemicals. If land eventually becomes severely contaminated, there may be a requirement under section 78 of the Environmental Protection Act (1990) as amended for this contamination to be remediated.

#### 11.5.1.4 Waste Management

During operation of GARL there would be waste management issues associated with waste oils and other materials. There would also be the requirement to dispose of litter from trains and stations and also from trackside litter collections, fly tipping, etc. Waste material is likely to comprise Inert and Non-Hazardous waste, although there is the possibility of encountering material that could be classed as Hazardous Waste, such as paint or chemicals. Appropriate handling and disposal of this waste would be required.

### 11.5.2. Mitigation

#### 11.5.2.1 Geology and Soils

As stated above permanent loss of soils will occur in some areas but damage to soils is unlikely during on-going operation of GARL, therefore no mitigation measures are required.

#### 11.5.2.2 Hydrogeology

The design of drainage for the scheme will channel any potentially contaminated run-off to interceptors and sewers rather than allowing contaminated water to simply soak straight into the ground.

Robust operation practice as well as secure and well bunded design of the new fuel farm (described in Chapter 2 of the ES) will be put in place to ensure that leakage from the facility is avoided, either from normal operations or during accidents or incidents. PPG 7 Refuelling Facilities and PPG 2 Above Ground Oil Storage Tanks will be adhered to.

#### 11.5.2.3 Contaminated Land

Mitigation in terms of potentially contaminated land will be similar to that required for hydrogeology, i.e. prevention and/or containment of hydrocarbon spills through good environmental management and maintenance so that land within the scheme is not contaminated by operational activities. Design of infrastructure will take into account potentially contaminated land so that structures will be protected from aggressive ground conditions and/or gas protection measures put in place to prevent ingress/migration of landfill gas if present. Monitoring and or venting of gas may be required for some structures, such as in the new fuel farm, where it is constructed close to made ground and peat deposits.

#### 11.5.2.4 Waste Management

Mitigation measure for waste management during operation will include development of management systems with the objective of minimising waste and developing waste procedures in accordance with the waste management regulations.

#### 11.5.3. Residual impacts

##### 11.5.3.1 Geology and Soils

Impacts on designated sites and mineral reserves are considered to be Negligible during operation of the scheme. Impacts on uncontaminated soils would be permanent and negative; however, the area of soils that would be permanently lost is relatively small and therefore the impact is assessed as Minor negative. This impact would be counter balanced by soil improvements at St James' Park where improved drainage would be constructed.

##### 11.5.3.2 Hydrogeology

Assuming that adequate and well designed drainage is put in place that will collect and/or treat any contaminated run off and/or spills from the scheme, and that an effective management system and training is implemented to prevent inappropriate disposal or spills, potential impacts to groundwater from the proposed scheme would be Minor.

For the new fuel farm there are operational risks to groundwater either due to routine and small-scale spills that are not contained accumulating over time due to poor management and/or inadequate design of containment facilities, or from some catastrophic event that meant large quantities of oil were realised that could not be contained within the facility. However, the details of the design, described in Chapter 2 of ES indicate that the site will be well bunded with more than adequate capacity to contain partial or total failure of the proposed fuel tanks, in addition to containing large spills that may originate from tankers. Therefore, assuming that this good design and operational practice is observed and that all PPGs and other regulations are adhered to then the impact on groundwater of the fuel farm is likely to be Minor.

##### 11.5.3.3 Contaminated Land

Prior to and during construction of the scheme, potentially contaminated land would be identified and appropriate mitigation measures taken to prevent impacts on infrastructure, personnel and the public during operation of the scheme. However, some residual impacts are likely to remain after mitigation that may have permanent impacts. As the route does pass through or close to potentially contaminated land and it may not be possible to remediate all of this land during development, the potential impact of contamination will still be present and therefore the impact is assessed as Minor.

One element of contamination that may persist is the potential for landfill gas being produced from made ground or peat deposits and slightly elevated levels of gas were encountered in one of the boreholes excavated by Faber Maunsell as part of this study. There is therefore the risk that gas could accumulate in underground structures, manholes or buildings in such areas. However, assuming that such risks were fully investigated, and that structures are properly designed and vented to prevent accumulation of gas, the impact of this is assessed as being of Minor significance.

In addition, an important risk is gradual contamination of previously uncontaminated land due to operation of the GARL. However, good design of infrastructure and effective environmental management of

operations should prevent contamination occurring. However, there is still a risk of this happening and therefore the residual impact has been assessed as Minor.

A residual risk to the GARL is that development of the route would mean that potentially contaminated land, such as areas of made ground and former industrial areas, would be taken into ownership. Such ownership may entail potential future liabilities, remediation costs, etc. However, assuming that investigation, assessment and appropriate remediation of such land (for example the existing fuel farm) is undertaken, then the overall impact of this issue is assessed as being of Minor significance.

#### 11.5.3.4 Waste Management

The operation of the scheme would generate waste from litter collection activities; however, effective environmental management and waste minimisation can achieve mitigation of this impact. The impact has been assessed as Minor as generation of large quantities of waste are not anticipated during operation of the scheme.

### 11.6. Summary of Residual Impacts

Based on currently available information on ground conditions along the route, the following residual impacts from construction and operational phases are predicted.

**Table 11.10: Summary of Impacts**

| Issue                                | Details                            | Construction Impact | Operational Impact |
|--------------------------------------|------------------------------------|---------------------|--------------------|
| <i>Geology</i>                       | Designated sites                   | Negligible          | Negligible         |
|                                      | Mineral Reserves                   | Negligible          | Negligible         |
|                                      | Undermining                        | Negligible          | Negligible         |
|                                      | Soils                              | Negligible          | Negligible         |
|                                      | St James' Park Soils               | Minor               | Minor Positive     |
| <i>Hydrogeology</i>                  | New Fuel Farm                      | Minor               | Minor              |
|                                      | Airport Compounds                  | Minor               | N/A                |
|                                      | Decommissioning existing fuel farm | Minor               | N/A                |
|                                      | St James' Park compound            | Minor               | N/A                |
|                                      | St James' Drainage works           | Minor               | Minor              |
|                                      | Piling                             | Minor               | N/A                |
|                                      | Main Line                          | Negligible          | Minor              |
|                                      | Deep Aquifers                      | Minor               | Minor              |
| <i>Potentially Contaminated land</i> | Murray Business Area               | Minor               | Minor              |
|                                      | Made Ground (including gas)        | Minor               | Minor              |
|                                      | Existing Fuel Farm                 | Minor               | Minor              |
|                                      | Existing Railway Land              | Negligible          | Negligible         |
|                                      | New Fuel Farm                      | Minor               | Minor              |
|                                      | Ownership Liabilities              | Minor               | Minor              |
| <i>Waste Management</i>              | Waste Materials                    | Minor               | Minor              |
|                                      | Decommissioning existing fuel farm | Moderate            | N/A                |
| <i>Ordnance</i>                      | Historical buried ordnance         | Minor               | N/A                |