Chapter 10 Soils and Geology

10.1 Introduction

This chapter outlines the soils and geology of the proposed M7 Naas to Newbridge Bypass Upgrade Scheme, depicting the existing ground conditions of the study area and identifying the potential impacts of the development, with appropriate mitigation measures recommended where necessary.

The study has been carried out in accordance with the NRA's guidelines (National Roads Authority (2009) Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes). A study area, in accordance with NRA guidelines, of 250m beyond the landtake boundary of the proposed scheme (and taking account of any potentially significant impacts which could arise at a greater distance away) was applied.

10.2 Methodology

Legislation and Guidelines

This chapter is prepared having regard to the requirements of Section 50 Sub-section (2 and 3) of the Roads Act 1993 as amended, and with the following guidance:

Table 10.1 Guidelines Considered

Guidelines
Environmental Protection Agency (2002) Guidelines on Information to be Contained in an Environmental Impact Statement
Environmental Protection Agency (2003) Advice Notes on Current Practice (in preparation of Environmental Impact Statements
National Roads Authority (2008) Environmental Impact Assessment of National Road Schemes – A Practical Guide
National Roads Authority (2009) Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes
Institute of Geologists of Ireland (2013) Guidelines for the Preparation of Soils, Geology, and Hydrogeology Chapters of Environmental Impact Statements

Consultation

Consultation was carried out with the Geological Survey of Ireland and the Department of Environment, Heritage and Local Government. No specific responses relating to soils and geology alone were received.

Sources of Information

The assessment and interpretation of existing ground conditions has been based on a desk study of available published information, a site reconnaissance and a review of the field logs and reports from both preliminary and historical site investigations.

The following available published information was reviewed:

- Geological Survey of Ireland, Bedrock Solid Geology Maps, 2012 – 2013;
- Geological Survey of Ireland, Draft Aquifer Maps, 2012 – 2013;
- Geological Survey of Ireland, Karst Features Database, 2012 – 2013;
- Geological Survey of Ireland, Draft Quaternary Maps, 2012 – 2013;

- Geological Survey of Ireland, Aggregate Potential Mapping, 2012 – 2013;
- Geological Survey of Ireland, Groundwater Wells Database, 2012 – 2013;
- Geological Survey of Ireland, Geotechnical Reports Database, 2012 – 2013;
- EPA, Local Authority landfill sites in Ireland 1995-1997;
- Geological Survey of Ireland, Directory of active quarries, pits and mines in Ireland, 2001;
- National Soil Survey of Ireland, An Foras Talúntais, 1977;
- Aerial photographs of the study area;
- Site investigation contract, Site Investigations Limited, *M7 Naas to Newbridge Bypass Upgrade Scheme Site Investigation Report,* Ref 5088, Final Report, September 2012.

Additional historical information on ground conditions at Newhall have been considered for the assessment of widening works to the existing embankments. A detailed review of historical site investigation records for the existing highway structure was undertaken. It is considered that this information is sufficient to characterise the receiving environment and the impacts of the proposed upgrade scheme.

Site Walkover

A walkover study was carried out by Roughan & O'Donovan-AECOM Alliance staff in January 2012 to inspect the motorway and identify any significant features of the road construction including its environs, utilities connections and drainage infrastructure. For the majority, the most notable features are identifiable close to the many overbridge structures which carry regional and local roads over the motorway.

Site investigation

As the information and proposed construction relate to mainly pavement reconstruction and improvement works and widening within the confines of the existing landtake, minor further earthworks were proposed outside of the current road footprint.

The objectives of the site investigation carried out were to identify pavement thicknesses and structural makeup of the existing carriage way to assess the performance of both the pavement and its foundations and to determine the subgrade materials of the existing road embankments and cuttings. Works included Ground Penetrating Radar, Falling Weight Deflectometer, pavement coring, slit trenching, trial pitting, and dynamic probing/window sampling.

Limitations

The identification of the underlying soils and geology was based on available mapping for the area and site investigation works carried out as part of the design of the road construction. This information was used to extrapolate across the study area. It should be noted that actual ground conditions can only been determine when excavated.

10.3 Impact Assessment Methodology

The potential impact of the proposed road development on the soils and geology environment has been assessed by classifying the importance of the relevant attributes and quantifying the likely magnitude of any impact on these attributes. The

rating criteria for assessing the importance of geological features within the study area are outlined in **Table 10.2** whilst the rating criteria for quantifying the magnitude of impacts are outlined in **Table 10.3**.

The rating of potential environmental impacts on the soils and geology environment are based on the matrix presented in Table 10.4 which take account of both the importance of an attribute and magnitude of the potential environmental impacts of the proposed road development on it. These impact ratings are in accordance with impact assessment criteria provided in the EPA publication *Guidelines on the Information to be contained in Environmental Impact Statements* (EPA, 2002).

The impact assessment methodology is also in accordance with the guidance outlined in Section 5.4 of the NRA's Guidelines on Procedures for Assessment & Treatment of Geology, Hydrology & Hydrogeology for National Roads NRA (2009). Impact categories, impact duration and type/nature of impacts have been taken into account in this assessment as per those guidelines.

Table 10.2 Criteria for Rating Site Importance (NRA 2009)

Importance	Criteria	Typical Example
Very High	Attribute has a high quality, significance or value on a regional or national scale. Degree or extent of soil contamination is significant on a national or regional scale. Volume of peat and/or soft organic soil underlying route is significant on a national or regional scale.*	Geological feature rare on a regional or national scale (NHA). Large existing quarry or pit. Proven economically extractable mineral resource
High	Attribute has a high quality, significance or value on a local scale. Degree or extent of soil contamination is significant on a local scale. Volume of peat and/or soft organic soil underlying route is significant on a local scale.*	Contaminated soil on site with previous heavy industrial usage. Large recent landfill site for mixed wastes. Geological feature of high value on a local scale (County Geological Site). Well drained and/or highly fertility soils. Moderately sized existing quarry or pit. Marginally economic extractable mineral resource.
Medium	Attribute has a medium quality, significance or value on a local scale. Degree or extent of soil contamination is moderate on a local scale. Volume of peat and/or soft organic soil underlying route is moderate on a local scale.	Contaminated soil on site with previous light industrial usage. Small recent landfill site for mixed wastes. Moderately drained and/or moderate fertility soils. Small existing quarry or pit. Sub-economic extractable mineral resource.

Importance	Criteria	Typical Example
Low	Attribute has a low quality, significance or value on a local scale. Degree or extent of soil contamination is minor on a local scale. Volume of peat and/or soft organic soil underlying route is small on a local scale.	Large historical and/or recent site for construction and demolition wastes. Small historical and/or recent landfill site for construction and demolition wastes. Poorly drained and/or low fertility soils. Uneconomically extractable mineral resource.

Table 10.3 Criteria for rating the impact magnitude at EIS stage – Estimation of magnitude of impact on soil/geology attribute (NRA 2009)

Magnitude of Impact	Criteria	Typical Examples
Large Adverse	Results in loss of attribute.	Loss of high proportion of future quarry or pit reserves. Irreversible loss of high proportion of local high fertility soils. Removal of entirety of geological heritage feature. Requirement to excavate / remediate entire waste site. Requirement to excavate and replace high proportion of peat, organic soils and/or soft mineral soils beneath alignment.
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute.	Loss of moderate proportion of future quarry or pit reserves. Removal of part of geological heritage feature. Irreversible loss of moderate proportion of local high fertility soils. Requirement to excavate / remediate significant proportion of waste site. Requirement to excavate and replace moderate proportion of peat, organic soils and/or soft mineral soils beneath alignment.
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute.	Loss of small proportion of future quarry or pit reserves. Removal of small part of geological heritage feature. Irreversible loss of small proportion of local high fertility soils and/or high proportion of local low fertility soils. Requirement to excavate / remediate small proportion of waste site. Requirement to excavate and replace small proportion of peat, organic soils and/or soft mineral soils beneath alignment.
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity.	No measurable changes in attributes.
Minor Beneficial	Results in minor improvement of attribute quality.	Minor enhancement of geological heritage feature.

Magnitude of Impact	Criteria	Typical Examples
Moderate Beneficial	Results in moderate improvement of attribute quality.	Moderate enhancement of geological heritage feature.
Major Beneficial	Results in major improvement of attribute quality.	Major enhancement of geological heritage feature.

Table 10.4 Rating of Significant Environmental Impacts at EIS Stage (NRA 2009)

Importance of Attribute	Magnitude of Impact			
	Negligible	**Small**	**Moderate**	**Large**
Extremely High	Imperceptible	Significant	Profound	Profound
Very High	Imperceptible	Significant/ Moderate	Profound/Significant	Profound
High	Imperceptible	Moderate/Slight	Significant//Moderate	Severe / Significant
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight / Moderate

10.4 Existing Environment

Bedrock geology

The bedrock geology underlying the study area is identified by the Geological Survey of Ireland (1:100,000 GSI series No. 16 Geology of Kildare-Wicklow) as given in Table 10.5 below and shown in refer to **Figure 10.1, EIS Volume 3.**

Table 10.5 Bedrock Geology along M7 Motorway

General Bedrock Geology Units				
Formation	**Description**	**Ch from**	**Ch to**	**ID**
Ballysteen Limestone	dark muddy limestone and shale	0,000	7,500	BA
Rickardstown Limestone	cherty and often dolomotised limestone	7,500	12,700	RK
Waulsortian Limestone	massive unbedded limestone-mudstone	12,700	13,400	WA
Ballysteen Limestone	dark muddy limestone and shale	13,400	15,725	BA

There are no geological features of importance such as karst features and/or geological heritage areas, identified within the study area.

Soils and Subsoils

The soil map for County Kildare (An Foras Taluntais 1970) indicates that the study area is underlain by Grey-Brown Podzolics soils of the Elton group and complex soils

of the Straffan Complex. The Podzolics are described as well drained with a loam structure and have a wide range of uses. The complex soils have poor drainage characteristics (improved by drainage) and have moderate to wide range of uses.

Geological Survey of Ireland Quaternary geology mapping (refer to **Figure 10.2, EIS Volume 2**) indicates that the majority of the road is underlain by Glacial Limestone Till (TLs). Glaciofluvial sands and gravel deposits (GLs) are present at either end of the route near Maudlins to the east and Clownings to the west. Made ground deposits are also predominant alongside the M7, with construction and development of commercial and industrial sites along the southern section of the M7 from Maudlins to Newhall. Continuous linear embankments, access roads and ancillary features such as drainage channels, attenuation ponds, environmental bunding and landscaping/plantations are present.

The excavation of 14 no. trial pits were carried out by Site Investigations Ltd along the hard shoulder and the central median of the roadway as part of the road upgrade development. These trial pits were excavated to a maximum depth of 1.5 m below ground level (bgl). The general lithology encountered is described as clayey/sandy gravel or gravelly clay/silt. Bedrock was not encountered in any of the trial pits excavated.

In addition, the GSI have records of the site investigation works carried out as part of the original Naas by-pass and the Newbridge by-pass. A series of trial pits (27 no.) and boreholes (100 no.) were excavated along the proposed section of the road upgrade. Depths of these investigative boreholes reached up to 18 m bgl. The lithology is described as glacial till and glacial-fluvial sands and gravels. Bedrock was reached in a number of the boreholes and these were recorded at depths ranging from 2.8 m to >18m bgl. The average depth to bedrock is recorded at between 5 – 10 m bgl.

At the proposed Newhall Interchange, the made ground fill associated with the existing mainline alignment is assumed to be within of the order of 1m to 2m. This is underlain by stiff glacial till/boulder clay with dense sand/gravel deposits present. Bedrock was encountered between 3m and 6m bgl. A transitional stratum of gravels, cobbles and/or boulders were typically identified with a thickness of between 0.3m and 1.2m at the subsoil/bedrock interface.

Subgrade Material/Road Embankments

Several of the side road embankments are observed to have side slopes up to 1.5H:1V on the approaches to structures. No settlement of mainline or side road embankments has been identifiable based on deformation to the road pavements. The trial pits and dynamic probing typically identify medium dense granular and firm cohesive materials consistent with general engineering fill and glacial deposits under a cover of topsoil. Topsoil thickness varies from 0.2m to 0.4m at trial pit locations, with an average thickness of approximately 0.3m.

Granular materials including Class 1 fill, Class 6F capping materials, Clause 804 subbase materials and potentially also glacial gravels were encountered at depths ranging from 0.25m to 1.1m depth, more frequently directly underneath the topsoil layer. The thickness observed ranges from a minimum of 0.2m up to a maximum of 1.15m. Cohesive materials including Class 2 fill and potentially also glacial boulder clays and tills were encountered at depths ranging from 0.2m to 0.9m, where present. They comprise firm to hard slightly sandy to sandy, slightly gravelly to gravelly CLAY/SILT, with frequent medium cobble contents.

Slopes cut into glacial soils have since been topsoiled and vegetated and generally appear to be stable at existing side slopes. Continued long term performance of the embankments and cuttings is expected.

Economic Geology & Mining Heritage

Bedrock deposits under the majority of the site are identified as being of very low and low potential by GSI Aggregate Potential Mapping. The Waulsortian Limestone Formation crosses the alignment at Maudlins and is of moderate potential.

The majority of aggregates and minerals near the project relate to fluvioglacial sand and gravel deposits albeit many refer to disused gravel pits as recorded on GSI Quaternary mapping. Granular deposits are present at each end of the route, at Kerdiffstown/Johnstown and at Hillsborough and just north of junction 10.

Quarries and pits active in the region include Walshestown, Newtowngrace and Brownstown. There are no quarries or pits located within the study area.

Karst Features

No karst features were identified within 250m of the road corridor during the site survey or in GSI databases.

Geological Heritage Areas

There are no geological heritage areas within 250 m of the road corridor.

10.5 Impacts of Development on Existing Environment

The following sections detail the potential Impacts of the proposed road realignment on the soils and geology aspects of the environment. These potential impacts are the impacts of the proposed development before mitigation measures are fully established.

Do Nothing scenario

In the event that the M7 Naas to Newbridge By-Pass Upgrade Scheme was not completed there would be no resulting impacts on the Soils or Geology within the study area.

Impacts on Soils/Subsoils

The likely impacts of the proposed road realignment on underlying soils/subsoil are as follows.

Construction Phase

During the construction phase of the development, the underlying soils/subsoils will be worked in order to facilitate the upgrade of the roadway. This will entail fill and regrading of existing soils/subsoils. There are no proposed major earthworks for the widening of the road with limited works outside of the existing roadway boundary, with the exception of an area for attenuation ponds at Ladytown and the area around the new J10 junction of Newtown. The importance of the soil is considered medium, and the impact significance is considered negligible. Consequently the rating of the significant environmental impact on the value of the soil in terms of agricultural value and fertility is considered imperceptible.

The construction phase entails the excavation of c. 0.5 m of soil from within the central median and the removal of the upper layers of the hardshoulder. Site

investigation works identified existing suitable subgrade materials along the central median and hardshoulder to facilitate the road upgrade. The existing road construction comprises large quantities of valuable material resources and hence the requirements for any significant earthworks are substantially reduced. In the event that any localised points of softer material are encountered, this material will be removed and replaced by a more suitable material in accordance with the NRA specifications. Any material removed as part of the construction works will be disposed off, in accordance with Waste Management Regulations, to a suitability licensed waste facility (as per the waste management plan (refer to chapter 4 and chapter 17). The site importance with regard to the proposed earthworks is considered low (volume of peat and/or soft organic soil underlying route is small on a local scale and minor soil contamination) and the impact significance is considered small adverse. Consequently the rating of the significant environmental impact on the value of the in terms of earthworks/unsuitable sub-material is considered imperceptible.

The construction of the new J10 interchange at Newhall (Ch 6 +700) will entail excavation works to the embankment along the margins of the roadway, and the importation of c. 90,000m^3 of fill material. This infill material may impact on the underlying soil and geology from compressing of the underlying surface. Ground conditions at the proposed Newhall Interchange includes stiff to hard glacial boulder clays and dense fluvioglacial sands and gravels. Site investigation measurements on the underlying subsurface indicated that the soils/subsoils are of low compressibility. The combination of the relatively thin overburden cover over bedrock and their low compressibility provide conditions whereby consolidation of the stiff and/or dense glacial soils is expected to progress quickly. It is presumed that additional embankment loading should not result in significant compression or consolidation of the underlying soils and bedrock materials as a result. The importance of the underlying geological features is considered low, and the impact significance from compression of the underlying geology is considered negligible. The rating of the significant environmental impact is therefore considered imperceptible.

Quantities of earthwork quantities are detailed in **Table 10.6**. This does not include for the importation of the road layers and blacktop etc. The estimated total of materials disposal is ca. 300,583 m^3 and 90,000 m^3 for the infill associated with the J10 interchange. The importance of the underlying geological features is considered low and the significance of the importation and exportation of materials as part of the road upgrade is considered slight. The rating of the significant environmental impact is therefore considered imperceptible.

Table 10.6 Material Quantities and Construction Traffic

	Section 1+ 2	**Section 3 + 4**	**Section 5 + 6**
Export Material (m^3)			
Median excavation and disposal	37,498	58,219	39,110
Attenuation pond excavation and disposal	11,250	5,625	5,625
Drains	36,456	49000	38024
Hard shoulder blacktop	4,944		
Hard shoulder subbase	14,832		
Disposal Totals	**104,980**	**112,844**	**82,759**
Import Material (m^3)			

	Section 1+ 2	Section 3 + 4	Section 5 + 6
Interchange Earthworks		90,000	
Import Totals		**90,000**	

Operational Phase

Once construction works are completed along the proposed upgrade section of the roadway, there will be no long-term impact on the underlying soil and geology.

Impacts on Bedrock

Bedrock was not encountered in any of the trial pits excavated along the proposed road upgrade section during the site investigations. Information obtained through the GSI indicate that bedrock lies at ca. 5-10 m bgl along the roadway and at shallow depths at the Newtown interchange (3m and 6m bgl). It is not envisaged that there will be any excavation of bedrock as part of these construction works.

As detailed previously there are no karst features or Geological Heritage areas identified.

Impacts on Mining Heritage Areas

There are no Mining Heritage Areas identified along the route of the upgrade works.

10.6 Mitigation Measures Recommended to Protect Environment

Earthworks

Excavation of Materials

The excavation of materials on site may encounter contaminated soils and/or unsuitable soft ground. If encountered, this material will be excavated and disposed of off-site in accordance with Waste Management Regulations and the waste management plan at appropriately licensed waste facilities (refer to **Chapter 17 Resource and Waste Management**).

Importation of Materials

In order to minimise the importation of material on-site, any suitable material excavated from site will be utilised in the construction of the upgrade. This may not always be suitable as volumes of materials required are greater than available, in particular for the construction of the new interchange at J10 Newhall and as such materials will need to be imported on-site. Only clean, uncontaminated material will be used as fill material.

Bedrock

There is no excavation of bedrock envisaged as part of the upgrade construction works.

Operational Phase

There are no specific operational mitigation measures deemed necessary.

10.7 Residual Impacts

It is inevitable that a significant volume of construction materials will be required to be mobilised. For a project of this size, the expected earthworks movements are

comparatively low, with overall rating of significant environmental impacts considered Imperceptible.

10.8 References

No.	Description
1.	Environmental Protection Agency (2002) Guidelines on Information to be Contained in an Environmental Impact Statement
2.	Environmental Protection Agency (2003) Advice Notes on Current Practice (in preparation of Environmental Impact Statements
3.	Institute of Geologists of Ireland (2013) Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements
4.	National Roads Authority (2009) Environmental Impact Assessment of National Road Schemes – A Practical Guide – Rev 1,
5.	B. McConnell, M.E. Philcox, C. V. MacDermott & A.G. Sleeman (1995) Geology of Kildare – Wicklow, booklet to accompany 1:100,000 Sheet 16. Geological Survey of Ireland
6.	Geological Survey of Ireland - online geological mapping service – www.gsi.ie
7.	Environmental Protection Agency - online mapping service – www.epa.ie
8.	Geological Survey of Ireland Geotechnical Report 2136 Newbridge By-Pass M7
9.	Geological Survey of Ireland Geotechnical Report 3009 Naas Road Interchanges Scheme
10.	Geological Survey of Ireland Geotechnical Report 2123 Newbridge By-Pass M7
11.	An Foras Taluntais, National Soil Survey of Ireland (1970) Soils of Co. Kildare