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INTRODUCTION

Purpose of Study

5.1 This study presents available information on the soils and geology within and immediately beyond the site of the proposed inert waste recovery facility to be operated by Roadstone Wood Ltd. at Brownswood Quarry, Enniscorthy, Co. Wexford, together with an interpretation of the existing local geological environment in the vicinity of the site. It will identify how this environment will be impacted by the proposed waste recovery facility and, where possible, will identify how these impacts may be mitigated.

Difficulties Encountered in Compilation

5.2 This impact assessment is based on a visual inspection of the site, published geological maps and available ground investigation data obtained by site investigations undertaken in 2001 and 2008. No particular difficulties were encountered in preparing this report.

Personnel

5.3 This study of soils and geology was undertaken and prepared by:

- Peter Glanville, B.A., Ph.D., PGeo., Geomorphologist, SLR Consulting Ireland
- Derek Luby, B.Sc., M.Sc., M.I.E.I., Senior Geotechnical Engineer, SLR Consulting Ireland

Consultations

5.4 In undertaking this study, documentation and information was obtained from the following bodies:

- Teagasc;
- Quarternary Section, Geological Survey of Ireland, Haddington Road, Dublin 4;
- Bedrock Geology Section, Geological Survey of Ireland, Haddington Road, Dublin 4; and
- Groundwater Section, Geological Survey of Ireland, Haddington Road, Dublin 4.

RECEIVING ENVIRONMENT

Outline of the Baseline Study

5.5 For the purposes of this soil and geology chapter, the study area was taken to be the entire existing footprint of the Old Quarry site owned by Roadstone Wood Ltd. at Brownswood, Enniscorthy, Co. Wexford. The baseline study

was prepared using previously published regional geological and geomorphological data, together with ground investigation information obtained at the site from an environmental investigation in 2008 and a geophysical and borehole investigation on an adjoining landholding to the east of the Old Quarry in 2001 which will be developed as an extension to the Old Quarry in the future. Existing exposures of in-situ soil and/or subsoil deposits and rock faces at the quarry were also visually inspected to assist in the interpretation of ground conditions occurring across the application site.

Soil

5.6 Soil is the top layer of the earth's crust. It is formed by mineral particles, organic matter, water, air and living organisms. It is an extremely complex, variable and living medium and its characteristics are a function of parent subsoil or bedrock materials, climate, relief and the actions of living organisms over time.

5.7 Soil can take thousands of years to evolve and is essentially a non-renewable resource. Soil performs many vital functions. It supports food and other biomass production (forestry, biofuels etc.) by providing anchorage for vegetation and storing water and nutrients long enough for plants to absorb them. Soil also stores, filters and transforms others substances including carbon and nitrogen. It also has a role supporting habitats and serves as a platform for human activity, landscape and archaeology.

5.8 The soils in the area immediately beyond the application area and Old Quarry are classified as Rolling Lowland Soils (Gardiner and Radford, 1980). They consist mainly of well drained Acid Brown Earth soils with minor amounts of grey and brown podzolic soils, and are primarily derived from Ordovician Shale subsoils. Well drained Acid Brown Earth soils are suitable for a range of agricultural uses including cultivated crops, pasture and forestry.

5.9 Soils across the Old Quarry have been removed in the past to facilitate the development of the quarry at the site. A limited amount of stripped soil is likely to be stored in landscaping bunds across the site and will remain stockpiled until such time as it required for future restoration of the site.

Regional Quaternary Geology

5.10 Quaternary geology comprises the study of soils deposited or formed during the last 2 million years. Such soils are termed quaternary soils. The two main types of quaternary soil in Ireland are glacial till, deposited at the base or margins of ice sheets, and sand and gravel, whose deposition is generally associated with the melting of ice sheets, at the end of periods of glaciation. Other extensive quaternary soils in Ireland include basin and blanket peat, river alluvium and estuarine deposits.

5.11 During the maximum (peak) of the last (Midlandian) glaciation approximately 24,000 to 20,000 years ago, a large ice sheet covered most of central Ireland, while another ice sheet pushed down the Irish Sea basin from Scotland. The Irish Sea Basin ice sheet pushed up onto the Irish coastline

between Louth and Wexford, depositing geological material which previously occurred across the Irish Sea Basin, as it did so.

5.12 The site at Brownswood lay outside the limits of the maximum Midlandian ice sheet extent during the last glaciation, and the Ordovician glacial till subsoils in the area around the site were laid down during a previous glaciation. The Teagasc (2006) subsoil map of the area around the application site is reproduced in **Error! Reference source not found.**,

5.13 The subsoil at the Old Quarry has been removed to facilitate the quarrying operation at the site. The subsoil is stored in landscaping bunds across the site and will remain stockpiled until such time as it required for future restoration of the site.

Regional Solid Geology

5.14 The most recent geological map of the Enniscorthy area (Tietzsch-Tyler and Sleeman, 1994) shows that the area around the Old Quarry is underlain by the rocks of the Campile formation. The Campile formation consists of rhyolites and rhyolitic tuffs in grey and brown slaty mudstones with occasional andesites and andesitic tuffs, see Figure 5-2. This formation crops out in an NE-SW direction through the centre of County Wexford.

5.15 The GSI memoir that accompanies the 1:100,000 scale map of this area notes that *"Granites recorded in the Campile formation south of Enniscorthy and thermally metamorphosed rocks at Oilgate on the banks of the River Slaney may reflect the presence of a sub-surface pluton, perhaps 30kilometres long (which trends) in an NE-SW direction and is 12 kilometres wide"* (see Figure 5-2).

5.16 Bedrock along the floor of the River Slaney floodplain typically occurs within 5 metres of the ground surface. The Quaternary (subsoil) deposits consist primarily of glacial till material derived from the local bedrock.

5.17 The Campile formation is classified as a regionally important aquifer in the Wexford-South Kilkenny-East Waterford region (Tietzsch-Tyler and Sleeman, 1994), with numerous records of large well yields (up to 1,000m^3 / day), particularly from the rhyolites.

5.18 Bedrock is very close to the ground surface in the area round the Old Quarry, with only a thin soil and subsoil cover.

Local Site Geology

5.19 The rocks within the Old Quarry are described as a granodiorite and therefore are generally untypical of those of the Campile formation. In the quarry, the quality of the rock is variable, being quite fresh in places and heavily weathered elsewhere. The rocks are cleaved and dip to the northeast at 25 - 50 degrees. Within the quarry other rock types occur also, and these are generally identified as greywackes.

5.20 Drilling at a proposed extension area to the east of the existing quarry void, and the subsequent logging of the core determined that the geological deposit here comprises primarily of granodiorite. Granodiorite is a very hard and durable rock and produces aggregates with good strength characteristics. The granodiorite material to be quarried from the proposed extension area will be used mostly as aggregate for surface dressing, thus conserving its use as a premium stone.

5.21 There is also a proportion of other material types, principally sedimentary tuffs and cherts, that occur around the periphery of this deposit.

5.22 The site inspection and the available ground investigation information indicates that the soils and subsoil material which previously occurred across the application site have been striped, stockpiled for future use in restoration of the site.

5.23 The Granodiorite and Ordovician grewackes at the site have been worked out at the site to a depth of c. -22m OD at the lowest point. The former quarry has been inundated by groundwater to approximately 7mOD, which means that the existing pond is 29m deep at its deepest point.

Geohazards

5.24 The site at Brownswood is underlain by granodiorite and Ordovician rocks from the Campile Formation. There are no karst solution features at the site. Groundwater does seep into the quarry excavation, however the seepages are relatively small and most groundwater movement is along fractures or weathered zones in the rock (the granodiorite is considered to be an aquitard, a poor aquifer).

5.25 Given the gently undulating nature of the topography around the site and the fact that the underlying subsoil generally comprises glacial till, it is considered that the area around the application site is unlikely to be susceptible to any landslide hazard. No historical landslides are identified in the surrounding area by the Irish Landslides Working Group (GSI, July 2006).

5.26 The OPW flood database (www.floodmaps.ie) indicates there is no recorded flooding in the immediate vicinity of the site at Brownswood. Given the elevated nature of the site above the floodplain of the River Slaney the risk of flooding locally from the river is considered to be very low.

Geological Heritage

5.27 The rock exposures within the existing quarry are not considered of sufficient interest or importance to warrant designation or protection for earth science or geological heritage purposes.

5.28 The Geological Survey of Ireland has confirmed that there are no established or proposed geological National Heritage (pNHA) sites in the immediate vicinity of the application site, refer to Appendix 5-1.

5.29 County Wexford has several sites of geological and geomorphological interest which are considered worthy of protection (Wexford County Development Plan, 2005 – 2011). The geological and geomorphological sites to be protected are identified as Natural Heritage Areas (NHA's) in the development plan. There are no NHA designations at the quarry at Brownswood.

Economic Geology

5.30 Historical mapping indicates that there was some quarrying activity at the application site back in the late 1800's. In the early 1960's, Roadstone Wood Ltd.'s predecessor company acquired the site. Quarrying activity was subsequently intensified and a readymix concrete batching facility was established at the site.

5.31 The presence of construction materials processing and production facilities around the Old Quarry site, means there is no spare land available to extend the quarry and as a result, rock extraction at this site has ceased. The existing concrete and asphalt production facilities are currently supplied with aggregate from Murphy's Quarry, immediately to the south.

5.32 In 2002, Roadstone Wood Ltd. secured planning permission for an eastward extension to the Old Quarry which will ensure a long-term supply of aggregate to the established concrete and asphalt production facilities.

Contaminated Ground

Made Ground

5.33 No material has been imported to the application site for recovery purposes to date. There is some Made Ground beneath the existing work yard and concrete plant. This Made Ground largely comprises glacial till sourced at the site and/or also some crushed rock fines from aggregate processing activities.

Existing Ground Information

5.34 A ground investigation was undertaken at the site in 2008 by TOBIN Consulting Engineers (Tobin) to examine the extent of alleged fly tipping / dumping of waste and potential soil contamination arising from oil spillages at a number of locations around the quarry.

5.35 The ground investigation was conducted at the behest of staff from the Environmental Enforcement Section of Wexford County Council. The scope of the investigation was agreed with Council officials and comprised the following works at six locations around the site:

- 10 No. trial pits with a long reach excavator; and
- 6 No. shell and auger Boreholes.

5.36 The ground investigation was undertaken by Geotech Specialists and included logging of the trial pits and borehole and soil sampling. The factual ground investigation report was submitted to Wexford Co. Council on the 25th March 2008. A copy of the factual ground investigation report is included in a larger report prepared by Tobin, which is reproduced in Appendix 5-2.

5.37 The 2008 ground investigations at the site of the alleged fly tipping / dumping in the northern, upper level of the quarry floor (Site A) encountered possible Made Ground up to 23m depth, refer to Appendix 5-2 and Figure 5-3. This predominantly comprised subsoil and broken rock with occasional inert construction and demolition (C&D) material (<1%), which is concentrated within the uppermost 1-3 m. The occasional C&D material identified included concrete, macadam blacktop, metal and plastic. The material encountered is believed to have originated from the Murphy Quarry and largely comprises 'strippings' (soil, subsoil, weathered and broken rock). A summary of the investigation findings is provided in Table 5-1 below.

Table 5-1
Site Ground Investigation Summary Details

GI Site	Hole ID	Final Depth	Material	Summary Description
Site A	BH01	10m	Made Ground	sandy GRAVEL sandy gravelly CLAY
	BH02	10m	Made Ground	sandy GRAVEL sandy gravelly CLAY
	BH03	3.2m	Made Ground	sandy GRAVEL with some concrete
	BH03A	3m	Made Ground	sandy gravelly CLAY with some concrete
	BH04	1.9m	Made Ground	Asphalt and road sub-base
	BH04A	10m	Made Ground	Stone/clay/cobbles/road sub-base Slightly gravelly CLAY
	BH05	3.3m	Made Ground	gravelly CLAY
	BH06	23.3m	Made Ground	gravelly CLAY
	TP01	5m	Made Ground	clayey sandy GRAVEL gravelly CLAY
	TP02	4.5m	Made Ground	gravelly SAND clayey SAND & GRAVEL
Site B	TP03	1.8m	Made Ground	clayey sandy GRAVEL
Site E	TP04	0.9m	Made Ground	sandy clayey GRAVEL
Site D	TP05	0.6m	Made Ground	clayey GRAVEL and cobbles
	TP06	1.1m	Made Ground	gravelly CLAY/SILT
	TP07	1m	Made Ground	clayey GRAVEL and cobbles

GI Site	Hole ID	Final Depth	Material	Summary Description
Site F	TP08	2.5m	Made Ground	sandy SILT gravel and cobbles with some peaty subsoils
	TP09	4.5m	Made Ground	gravelly CLAY sandy clayey GRAVEL sandy SILT
	TP10	3m	Made Ground	sandy SILT Clayey GRAVEL

5.38 A number of shell and auger boreholes were drilled at Site A. Several attempts at drilling encountered obstructions, generally within the upper 3m. Two drill holes were successfully drilled to 10m and one was successful to 23m. No water was encountered / recorded in any of the boreholes (refer to Appendix 5-2).

5.39 Elsewhere, the ground investigation indicated Made Ground comprising hardcore material and subsoil overlying broken rock at Sites B and C. Broken rock was encountered at two other sites, identified as Sites D and E. Details of the investigation findings are provided in Table 5-1 above and also in Appendix 5-2).

5.40 A number of trial pits were excavated along the western edge of the site and photographs from the pits (see Appendix 5-2) appear to indicate Made Ground comprising hardcore material and possibly glacial till material with broken rock. At one location (Trial Pit No. 8) peaty subsoils were encountered.

5.41 Inspection of trial pit excavations identified no evidence of non-inert waste at Site A. Evidence of localised soil contamination by hydrocarbons was however identified locally around an oil bund at an existing garage (Site B) and at the former site of the primary crusher (Site C).

5.42 The factual ground investigation report recommends that three groundwater monitoring boreholes be installed at the site and that groundwater in the boreholes be monitored on a regular basis. In light of this recommendation, four groundwater monitoring boreholes were installed in the Old Quarry in 2010.

5.43 Roadstone Wood Ltd. considers that the findings of the ground investigation and subsequent groundwater monitoring has adequately resolved and closed out Wexford County Council's concerns about potential ground contamination at the quarry site. It is currently awaiting confirmation from the Council that it has no further requirement for investigation or remediation works in respect of the suspect ground.

IMPACT OF THE PROPOSED WASTE FACILITY

Evaluation of Impacts

5.44 The evaluation of impacts on the soil and geology at and in the vicinity of the existing quarry site and proposed waste recovery facility at Brownswood is based on a methodology similar to that outlined in the '*Guidelines for the Assessment of Geology, Hydrology and Hydrogeology for National Road Schemes*' published by the National Roads Authority (2009).

5.45 The importance of existing soil and geology attributes identified above is assessed in Table 5-2 below

Table 5-2
Importance of Geological Attributes in Vicinity of Application Site

Attribute	Status / Occurrence	Importance
Geohazards	Erosion of exposed soils on existing slopes and stockpiles.	Low
Geological Heritage	No heritage feature at or contiguous to site	None
Economic Geology	Economic extraction complete at quarry	Low
Agricultural Soils	Productive soil previously removed and stockpiled at the application site. Other soil in vicinity of site used for wide range of agricultural activities.	Low
Made Ground	Crushed aggregate and glacial till materials at site of low economic or environmental value. Largely free of contamination except locally around oil bund and primary crusher.	Low

5.46 The significance of the impacts on the soil and geology attributes is assessed in Table 5-3 below:

Table 5-3
Significance of Impacts on Soil and Geology

Attribute	Impact of Proposal on Attribute	Magnitude
Geohazards	Elimination of localised erosion at existing soil stockpiles. Elimination of risk of rockfalls and rock slope instability.	Small, positive
Geological Heritage	No impact	None
Economic Geology	No further extraction at the site or sterilisation of potential aggregate resource	Negligible
Agricultural Soils	Restoration of former landform and placement of topsoil / subsoil on completion of backfilling will restore lands to basic agricultural use.	Small, positive
Made Ground	Importation of soil, stones and possibly small volumes of inert construction and demolition waste introduces a risk of potential soil contamination	Small, negative

5.47 The proposed waste recovery activity, in backfilling and restoring the existing quarry void will create a new ground surface above the groundwater level, and will 'smooth' the site topography so as to better integrate it into the surrounding rural landscape.

5.48 The restoration of ground level above the groundwater table and the creation of a more uniform topography will facilitate the re-establishment of agricultural soil across the application site and its return to agricultural use. As this proposal constitutes a small improvement on an attribute of low importance, this impact is assessed as being minor and positive.

5.49 In the absence of any controls, the importation of soil, stones and small quantities of inert construction and demolition waste could introduce a risk of potential soil contamination at the application site. While the 2008 ground investigation at the site (refer to Appendix 5-1) indicated two small areas of shallow hydrocarbon contamination (where fuel and plant were stored / previously stored), it did not reveal any evidence of systemic soil contamination across the quarry site.

5.50 Assuming the proposed waste recovery facility is run in accordance with best waste management practice, this risk of potential contamination is likely to remain small. Given that the risk of introducing contamination into existing relatively degraded, low value subsoils and/or rock is small to moderate, the significance of this potential impact is assessed as minor and negative.

Interaction with Other Environmental Receptors

5.51 The potential risks associated with the introduction of contaminated soil when backfilling and restoring the application site could have implications for groundwater quality, were infiltrating rainfall to percolate down through the contaminated backfill materials. This aspect is discussed in more detail in Chapter 6 of this Environmental Impact Statement.

5.52 When successfully completed however, the proposed backfilling and restoration works will provide an increased thickness of soil and subsoil cover above the existing groundwater table, thereby reducing the potential risk of future groundwater contamination.

5.53 During the backfilling and restoration works, the presence of exposed, unvegetated soil surfaces could give rise to dust blows during dry windy weather. These issues are discussed in more detail in Chapter 7 of the Environmental Report (Air Quality).

Do-nothing Scenario

5.54 If the application site is not restored to a similar ground level as the surrounding quarry, and it remains essentially unchanged from its existing layout, the limited, or non-existent soil cover at the site will mean that there is limited, or no protection for groundwater quality. Left unmanaged over time, there is also a small risk that the void slope or face instability could arise around the existing quarry, most likely in the form of localised soil slope instability or rockfall.

MITIGATION MEASURES

5.55 In order to minimise the risk of importing and introducing contaminated soil to the application site, management systems will be introduced to establish the source of imported materials in advance and to confirm that they are inert. Once received at the site a multiple level soil testing regime will be established to test the material for compliance and will include:

- comprehensive on-site verification, comprising visual inspection and record of all imported soil unloading at the site
- basic characterisation testing covering a wide range of parameters to determine the leaching behaviour of the inert soils imported to site;
- frequent, compliance testing covering a limited range of key soil parameters.

An outline waste acceptance and handling plan for the proposed inert waste recovery facility, incorporating these and other controls, is provided in Appendix 2-1 of this EIS.

5.56 During backfilling of the quarry, all temporary surfaces will be graded to facilitate overground run-off of surface water, thereby minimising the volume of rainfall percolating through the backfilled material. This will further reduce any residual risks of any potential contaminants leaching into the soil and bedrock (or groundwater).

5.57 In order to confirm that there are no residual risks to in-situ soil or bedrock, monitoring of groundwater will continue for the duration of the quarry void backfilling works and for a short aftercare period.

5.58 In order to reduce the risk of localised erosion and potential dust emissions during the backfilling works, the area of bare or exposed subsoils, particularly those outside the quarry void (stockpiles), will be kept to a minimum, insofar as practicable. Consideration could be given to establishing temporary vegetation cover over exposed soil surfaces pending final backfilling and restoration to final ground level.

5.59 In order to maximise the future agricultural potential of the restored land, a minimum 150mm thick layer of topsoil and 300mm thick layer of subsoil should be placed over the backfilled materials. The final landform will also be graded so as to facilitate overground run-off of surface water to the pond area where the runoff will infiltrate to the groundwater.

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FIGURES

APPENDIX 5-1
Correspondence from Irish Geological Heritage Programme (IGHP)

APPENDIX 5-2
Ground Investigation Factual Report (Tobin Ref. No. 4644/02)