7.0 SOILS & GEOLOGY

7.1 Introduction

This chapter assesses and evaluates the potential impacts of the Proposed Development described in Chapter 3 (Description of the Proposed Development) on the geological and hydrogeological environment. The impact on hydrology and hydrogeology is addressed in Chapter 8.

7.2 Methodology

7.2.1 Guidelines

This assessment has been carried out generally in accordance with the following guidelines:

- EPA *EIA Report Guidelines 2022*;
- Environmental Impact Assessment of Projects - *Guidance on the preparation of the Environmental Impact Assessment Report, European Union 2017*;
- Institute of Geologists of Ireland (IGI) *Guidelines for the preparation of Soils Geology and Hydrogeology Chapters of Environmental Impact Statements* (2013); and
- National Roads Authority (NRA) *Guidelines on Procedures for the Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes* (2009).

In the EIA assessment, consideration is given to both the importance of an attribute and the magnitude of the potential environmental impacts of the proposed activities on that attribute. Appendix 7.2 presents the impact assessment criteria provided in the IGI publication.

The principal attributes (and impacts) to be assessed include the following:

- Geological heritage sites in the vicinity of the perimeter of the subject site;
- Landfills, industrial sites in the vicinity of the site and the potential risk of encountering contaminated ground;
- The quality, drainage characteristics and range of agricultural uses of soil around the site;
- Additional quarries or mines in the vicinity, the potential implications (if any) for existing activities and extractable reserves;
- The extent of topsoil and subsoil cover and the potential use of this material on site as well or requirement to remove it off-site as waste for disposal or recovery;
- Classification (regionally important, locally important etc) and extent of aquifers underlying the site perimeter area and increased risks presented to them by the proposed development e.g., removal of subsoil cover, removal of aquifer (in whole or part), drawdown in water levels, alteration in established flow regimes, change in groundwater quality.

7.2.2 Sources of Information

Desk-based geological information on the substrata (both quaternary deposits and bedrock geology) underlying the extent of the site was obtained through accessing national databases and site archives. The collection of baseline regional data was undertaken by reviewing the following sources:

- Geological Survey of Ireland (GSI) - on-line mapping, Geo-hazard Database, Geological Heritage Sites & Sites of Special Scientific Interest, Bedrock Memoirs and 1:100,000 mapping;
- Teagasc soil and subsoil database;
- Ordnance Survey Ireland - aerial photographs and historical mapping;
- Environmental Protection Agency (EPA) – website mapping and database information;
- National Parks and Wildlife Services (NPWS) – Protected Site Register; and
- Meath County Council - illegal landfill information.

Site specific data was derived from the following sources:

- Kilsaran Concrete (2016) Development at Bellewstown Co. Meath Environmental Impact Statement January 2016
- A May 2008 a geological investigation was carried out by John Barnett and Associates, which included the rotary coring of 3 boreholes to the north of the site (JBA BH1 to JBA BH3).
- July 2008 Tobin Consulting Engineers supervised the drilling of 5 air rotary water monitoring boreholes along the site boundaries, including the fitting of piezometers within these wells to facilitate long term groundwater monitoring
- October 2008 Tobin Consulting Engineers undertook a detailed geological investigation, which included the drilling of a further 14 air rotary exploratory boreholes to assess the nature, quality and fracturing within the bedrock beneath the quarry (BH1 to BH14.
- November 2008 Tobin Consulting Engineers again supervised the drilling of a single air rotary water supply borehole to be used in the pump test that followed (PW1). This was used to assess the nature, quality, and groundwater flow characteristics of the rock beneath the existing quarry.
- In October 2010 10 no investigation (core samples) boreholes were carried out by SLR Ltd. to the west and northwest of the application site (Series SLR 1 to SLR 10).

7.3 Receiving Environment

The receiving environment is discussed in terms of; soils & geology and site history including potential for contamination.

7.3.1 Site Setting & Topography

The Bellewstown Quarry is located approximately 1 km to the west of Bellewstown Village. The location of the quarry in relation to its surrounding environment is shown on Figure 7.1

The application area is 47.3 ha, which incorporates area for road 7.9 ha and quarry area of 39.4 ha (includes an overall extraction area of 17.3 ha (8.1 ha existing plus additional 9.2 ha permitted and continued to be proposed).

The current working floor varies from 116 m Above Ordnance Datum (mAOD) (lower bench) to 128 mAOD on the upper bench. Under this development scheme, Kilsaran Concrete is proposing to quarry to a maximum depth at 98 mAOD over the total extraction area of 17.3 hectares. The EIAR is prepared to assess the potential impact of this further development of the quarry on the locality.

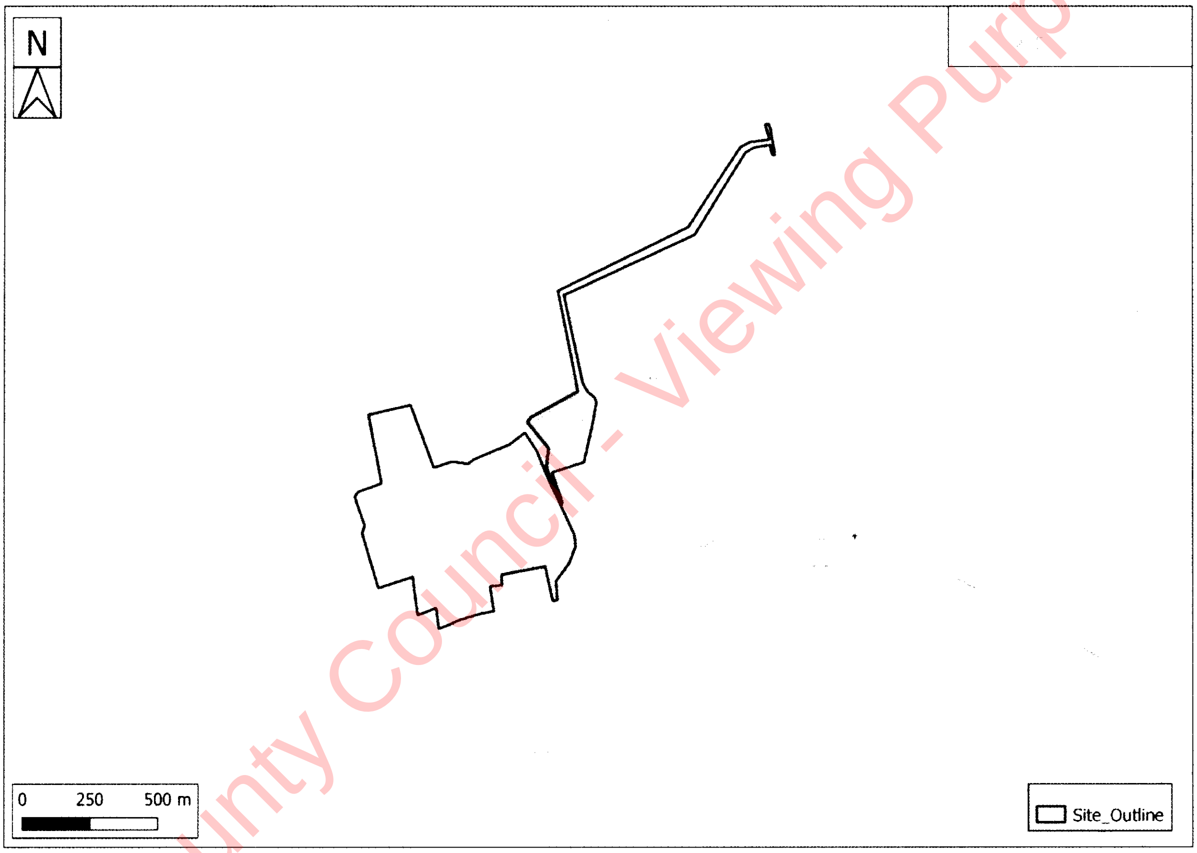

Figure 7.1: Location of Subject Site Outlined in Red.

7.3.2 Land Use

The Bellewstown Quarry is an active quarry, which allows an opportunity to visually assess rock profiles on the quarry faces. The quarry development site is located in the townlands of Hilltown Little Bellewstown and Hilltown Great 1.5 kilometres west of Bellewstown Cross and 8 kilometres south of Drogheda. The quarry has been in operation for a number of years and is currently operating under planning permission An Bord Pleanála Ref. No. PL17.QD0013

There are no active IPPC/IED or licenced waste facilities within 2 km of the quarry, the closest being Cookstown Limited t/a Euro Farm Foods. 2.8 km to the north (Licence Number P0822-01).

Historical Ordnance Survey (O.S) maps were examined to review previous uses of the site and the likelihood of any residual contamination to be present at the site. O.S maps from 1830 onwards indicate that that the subject site was in agricultural use.

Bellewstown Quarry commenced operation prior to 1st October 1964. The location of a quarry is marked on the Ordnance Survey map from 1909 and the revision of that map made between 1958 and 1982. Activities at the quarry have continued to this day. This is illustrated by Ordnance Survey aerial photographs flown in 1973, 1995, 2000 and 2004.

Meath County Council operated the quarry in the early 1960s. The quarry was subsequently operated by a number of parties up to the time a former owner, Mr John Gallagher purchased the quarry in 1982 and operated it from 1982 to 2007. It was purchased at auction from Mr Gallagher by Kilsaran. Kilsaran has operated the quarry from 2006 to date.

7.3.3 Soils

EPA soil mapping indicates that the soils at the site are comprised of 'AminSW' - Shallow well drained mineral soil derived from mainly acidic parent materials. An area of AminSRPT can be seen to the west for the site 'shallow, lithosolic-podzolic type soils potentially with peaty topsoil's - predominantly shallow soils derived from non-calcareous rock or gravels with/without peaty surface horizon'. As per the EPA online mapping tools (Corine 2018 maps), the local area has been classified as "Agricultural Areas - Pastures" (Code 231) with area of "Agricultural areas – Arable Land to the east, north and south (Code 211). The soil mapping for the site is presented below in Figure 7.2.

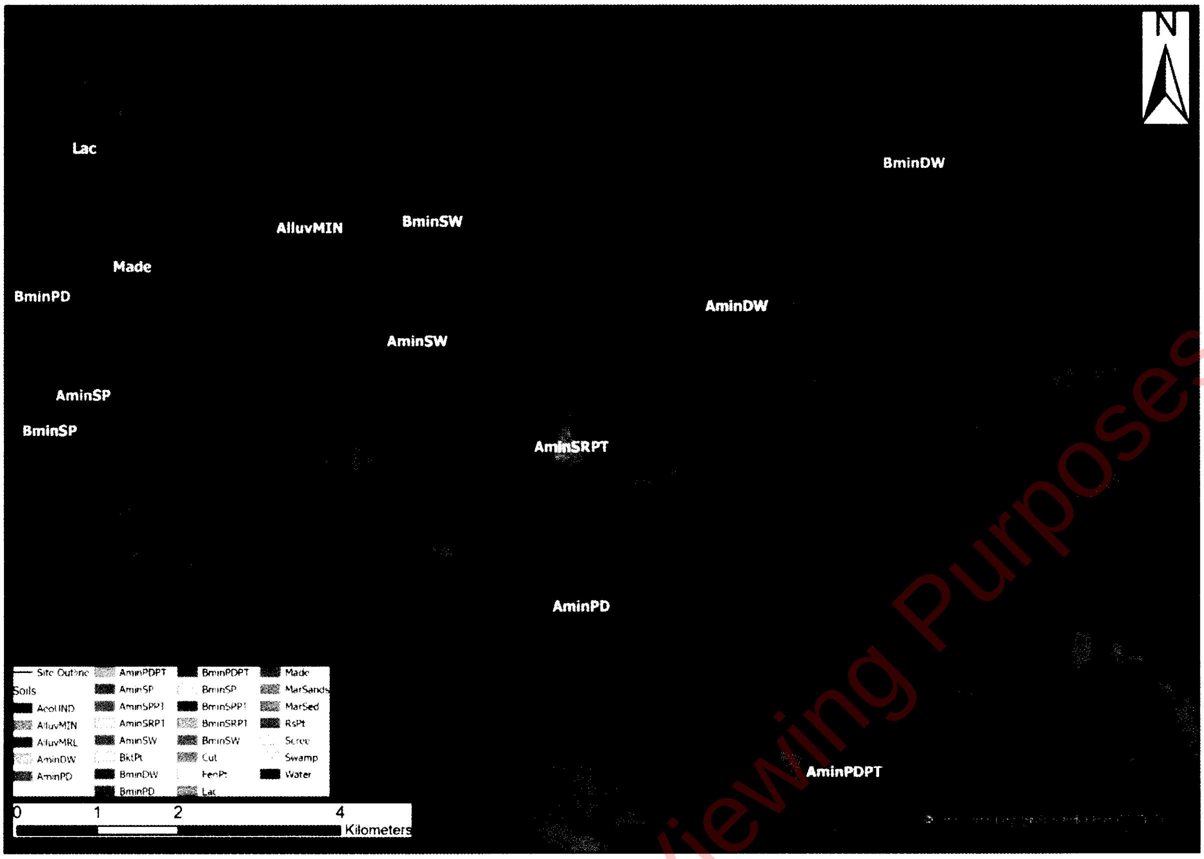

Figure 7.2: Soils Map. (GSI, 2021.)

7.3.4 Subsoils (Quaternary)

Figure 7.3 illustrates the subsoil types found surrounding the site. The subsoil type underlying the current quarry area is predominantly classified as Rck – Bedrock Outcrop or Subcrop denoting the quarry and the high bedrock in the area (further information is provided in section 7.3.5). There are also small areas of TLPSsS - Till derived from Lower Palaeozoic sandstones and shales.

Descriptions of site-specific data and aquifer vulnerability is provided in section 7.3.7.

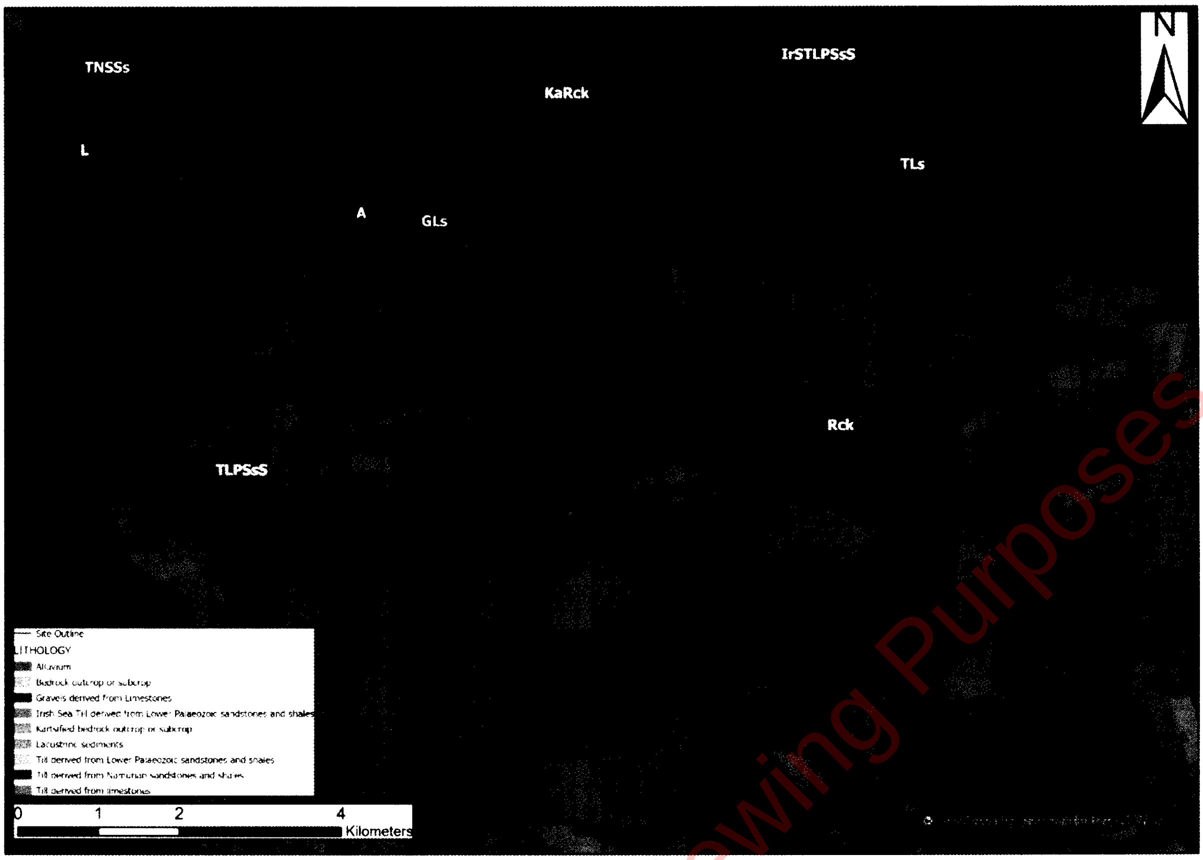

Figure 7.3: Subsoil (Quaternary) Map. (GSI, 2021.)

7.3.5 Geology

Reference to the GSI Bedrock Geology Map indicates that the site is underlain by Hilltown Formation, Carnes Formation, Bellewstown Member as well as Diorite intrusions. The Hilltown Formation is present predominantly within the proposed extraction area. The Hilltown Formation is overlain by the younger Bellewstown member and Carnes Formation along the southern boundary (outside the extraction area).

Reference to the relevant geological information, the 1:100,000 scale Sheet No.13 – Bedrock Geological Map of Meath (Geological Survey of Ireland (GSI), indicates that the site and surrounding area is underlain by Ordovician age felsic volcanic rocks. These Lower Palaeozoic rocks represent a complex geological history and comprise a large range of rock types including greywackes (turbidites), volcaniclastic sediments, lavas, shales, mudstones, and cherts. During the Ordovician the Iapetus Ocean began to close and volcanoes formed adjacent to the continental margins, giving rise to a complex suite of volcanic and deep-water sediments. As two continents collided, the accumulated sediments were squeezed up to form a chain of mountains (Caledonian Orogeny). These rocks were interbedded with the sedimentary rocks.

The GSI show no mapped faults, or any other geological structures identified on GSI Sheet No. 13 in the area of the proposed quarrying area. (see Figure 7.4). The proposed haul road overlies the Prioryland Formation made up of the same Ordovician age felsic rocks seen in the Hilltown and Carnes formations. It is not proposed to remove rock material from the Prioryland Formation. The new access road overlies this formation to the north and due to the relative shallow nature of the proposed road construction there will be a negligible impact to the underlying bedrock in this area.

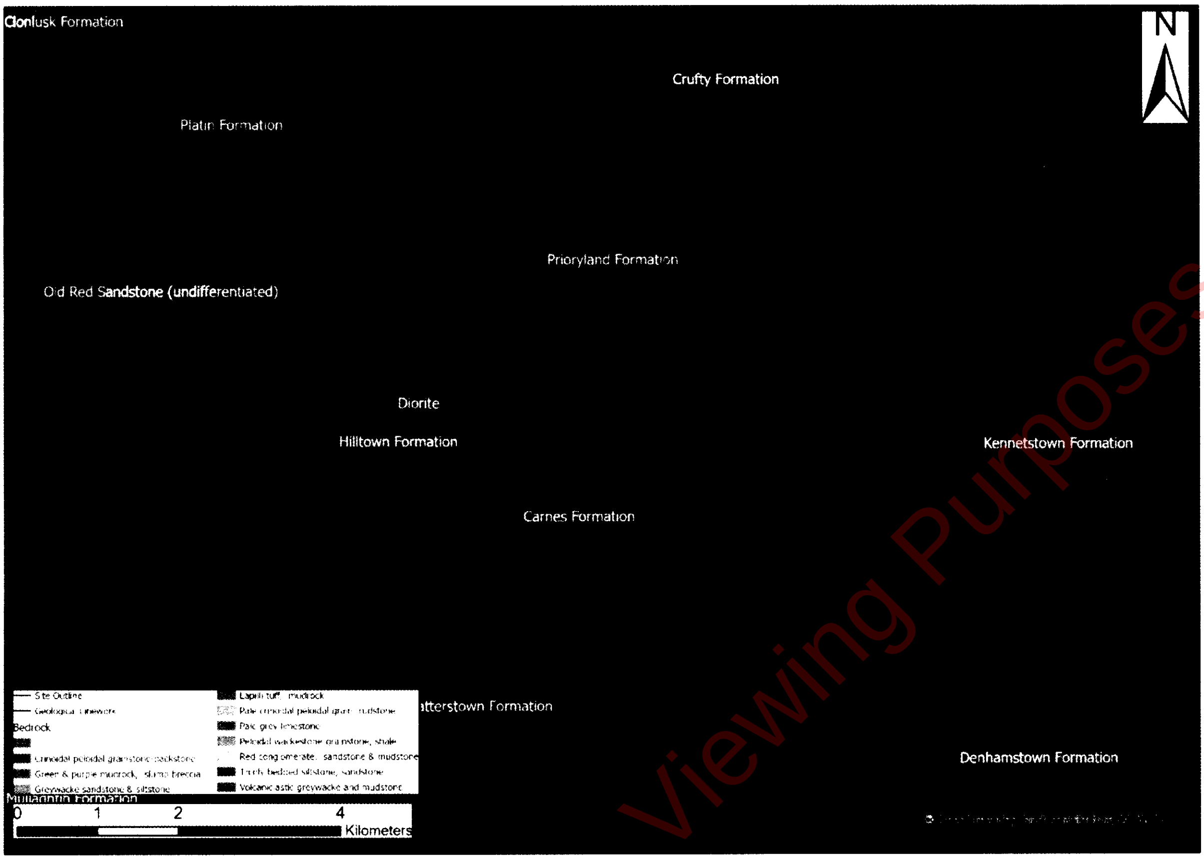

Figure 7.4: Bedrock Geology Map. (GSI, 2021.)

7.3.5.1 Hilltown Formation

The Hilltown Formation is comprised of volcanic rhyolite, ignimbrite and rhyolitic tuffs deposited during the Ordovician era. Rhyolite lavas are typically highly viscous and are explosively ejected from volcanoes. Rhyolite lava exhibits a typical banded structure produced by its flow pattern.

Rhyolite lavas occur in continental and submarine volcanoes, especially island arcs. The volcanics of the Hilltown formation are believed to have been deposited within an island arc system immediately south of the Iapetus suture. These rocks are a mixture of subaerial and shallow marine volcanic rocks. Evidence of aerial tuff deposits is also seen within the volcanic material. Reworking of the material is evident within the quarry. Ignimbrites, turbiditic chert beds and mudstones are present within the quarry.

The Hilltown Formation dips at approximately 45-60 to the South and striking east-west across the quarry. The Hilltown Formation was structurally altered during the closing of the Iapetus Ocean during the Caledonian Orogeny. It is thought that the Diorite intrusions occurred between the Ordovician and Devonian periods.

7.3.5.2 Carnes Formation

The Carnes Formation is comprised of volcaniclastic turbidites, mudstones and pebbly mudstones. The Bellewstown member (CCbe) is present between the Hilltown Formation and the Carnes Formation. The Bellewstown Member is comprised of Calcareous sandstone and bioclastic limestone approximately 5 m thick.

The Bellewstown member is located to the south of the quarry extraction area, but within the ownership boundary, at the contact between the Carnes Formation and the Hilltown Formation (see Figure 7.2). It is not proposed to quarry the Bellewstown Member.

With respect to site specific geological appraisal of the Bellewstown Quarry, the rock exposed on quarry faces is a sequence of mudstones, volcanics, greywacke and diorite. The rock units, or beds, are inclined (slope) to the south at moderate/steep angles. The mudstones are inclined at an angle ranging from 45 to 60 degrees, which is considered a moderate to steep dip.

The north and south faces represent a dip section, in which the succession is inclined. The succession is inclined to the south and the highest (or youngest) exposed beds occur to the south of the quarry, whereas the oldest rocks occur to the north. Photo Plate No. 7.1 shows a north south section of quarry face (dip section) which shows the layered volcanics and chert bands.

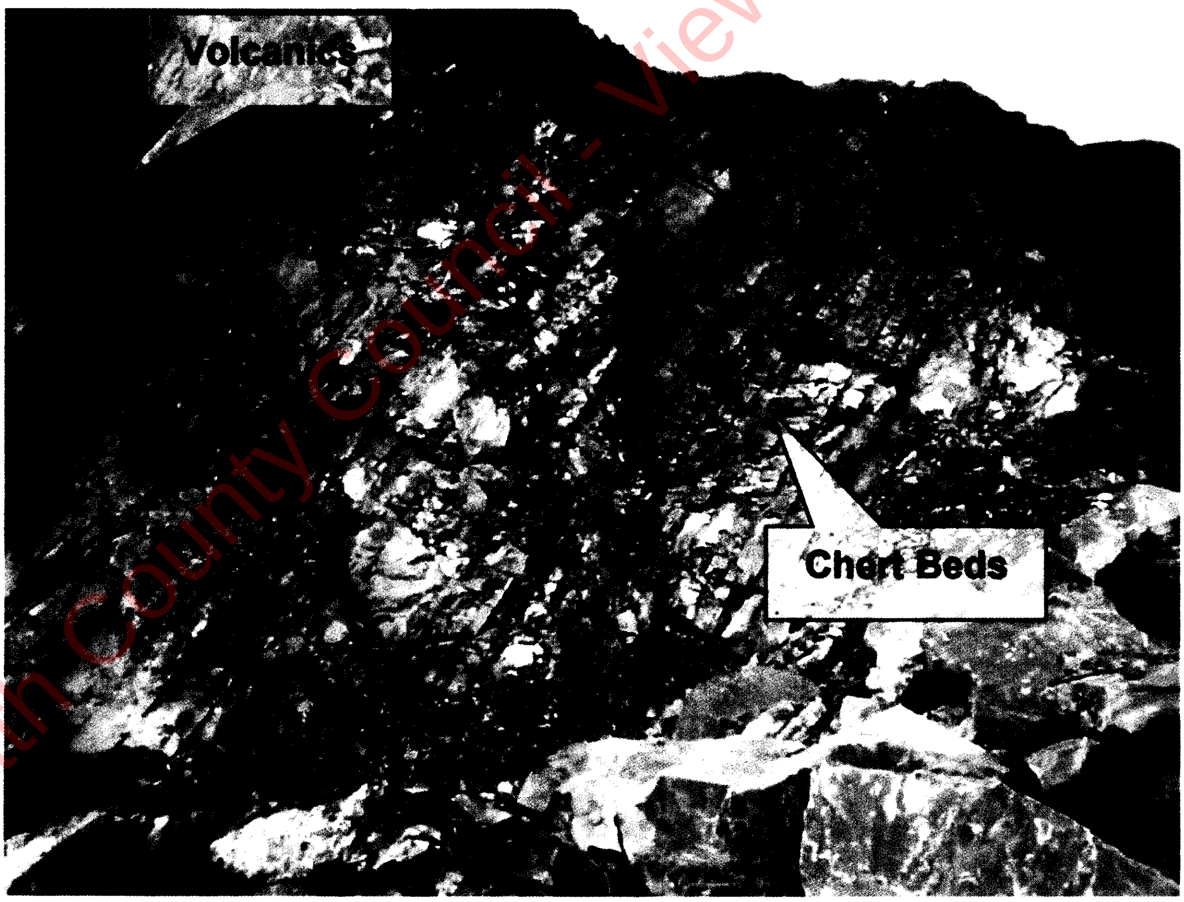

Plate 7.1: Quarry Exposure Facing to the West.

Photo Plate No. 7.2 depicts the western quarry face which shows the beds inclined at the dip angle (45-60 degrees on the photo shown). Rhyolites are shown on Photo Plate No. 7.3.

Plate 7.2: Western Quarry face showing mudstone and rhyolite exposures.

Plate 7.3: Rhyolite present in northern face showing distinctive columnar jointing.

Diorite intrusions exist within the quarry, an example is shown below in Photo 7.4. This would confirm the Diorite formation show in on GSI mapping as seen in Figure 7.4

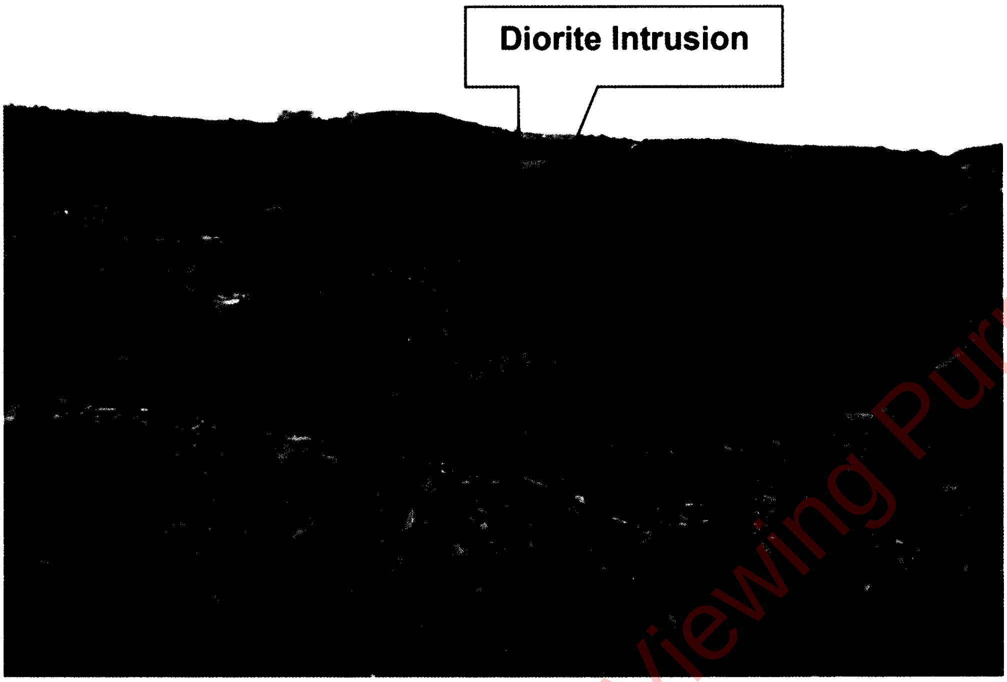

Plate 7.4: Diorite intrusion exposed within northern face, surrounded by rhyolites and mudstones, facing west.

Visual appraisal of the quarry faces in 2016 indicates that the rock succession exposed within the Bellewstown Quarry comprises predominantly volcanics deposits and diorite with mudstone, chert, and greywacke. As per the GSI mapping referred to above (Figure 7.4)

The rock is generally tight, however, jointing and fracturing is noted across the quarry. The volcanic rocks can be grouped into two hydrogeological units based on rock type: the ryholitic tuffs and diorite intrusions. Fracturing of the volcanics occurs by columnar jointing which has opened up the otherwise hard rocks (see photo plate 7.3 above).

The jointing of the rock is generally closed and very tight. The joints display evidence of being infilled with clasts and mineral sediments. Larger fracturing occurs at the contact between the intrusive rocks and the volcanic rocks. These joints within the quarry face are infilled by rock debris, mineralization, and clay material (see photo plate 7.5). Mineralisation within the joints is comprised of quartz veins, limonite, and sulphide minerals (pyrite and calcopyrite).

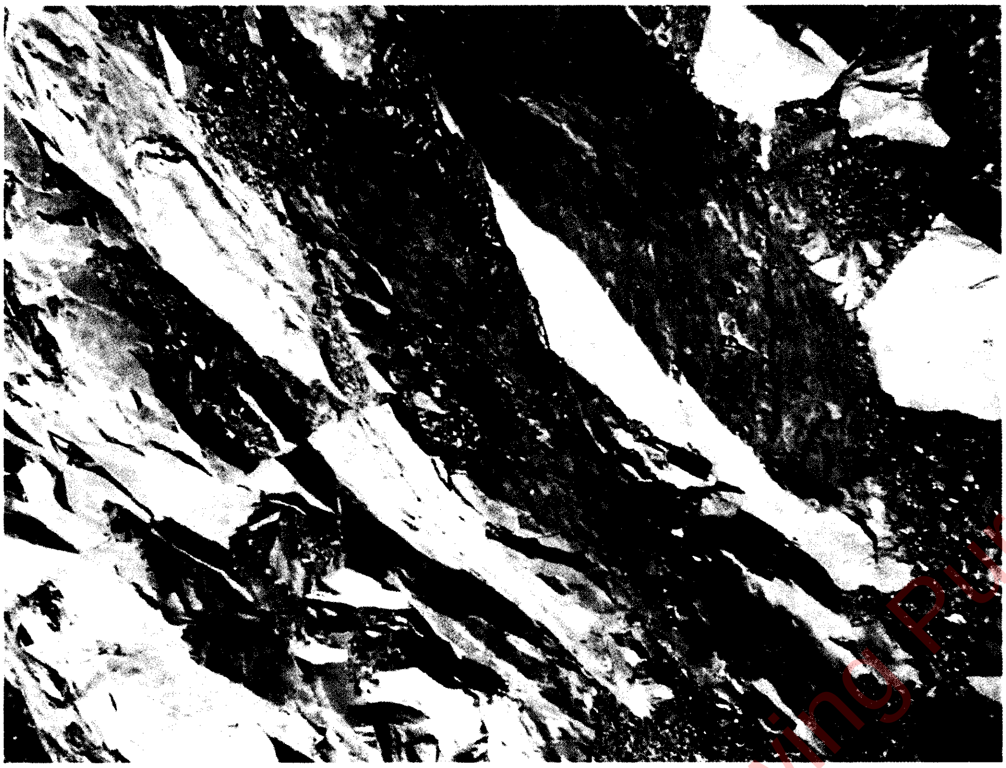

Plate 7.5: Shows a representative view of the infilled jointing system developed in the bedrock.

The infill of the jointing with sediment and mineralization indicates groundwater flow occurred within the formation in the distant geological past. However, the jointing is tight across the site. There is no visual evidence of washout of joints or bedding. Some areas show the presence of vesicles within the bedrock. This is likely to be a consequence of weathering of the sulphide minerals. While these vesicles increase the porosity, mineralisation is relatively confined.

During the previous visual assessment of the site, a number of closed/infilled fault areas were recorded. To the north of the site, a fault area was observed. The fault area was located to the north of the intrusive diorite. There was deformation and faulting of the rocks surrounding this area. During the course of investigations, extensive drilling of geological core boreholes, groundwater boreholes and exploratory boreholes have been drilled within the site. In total, 28 boreholes were drilled. Summary borehole logs for the site investigation points are provided in Appendix 7.3, with the location of boreholes shown in Appendix 7.4.

All boreholes recorded a succession of weak to strong, tuffaceous rhyolites and diorite. The results of the drilling are consistent with the rock exposed on the existing quarry walls and also the bedrock recorded by the GSI.

The drilling has demonstrated that the same succession of bedrock continues to at least 70 mAOD within the quarry. As it is proposed to excavate to 98 mAOD (as previously permitted), it can be inferred that the same will be encountered to finished depth.

7.3.6 Aquifer Classification

The GSI classifies the principal aquifer types as:

Bedrock Aquifer

- Lk - Locally Important Aquifer – Karstified
- Ll - Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones
- Lm - Locally Important Aquifer - Bedrock which is Generally Moderately Productive
- Pl - Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones
- Pu - Poor Aquifer - Bedrock which is Generally Unproductive
- Rkd - Regionally Important Aquifer (karstified diffuse)

Gravel Aquifer

- Lg - Locally Important Aquifer - Sand & Gravel
- Rg - Regionally Important Aquifer - Sand & Gravel

The GSI (2021) currently classifies this bedrock aquifer underlying the proposed site as a (Pl) a Poorly Productive Aquifer, which is generally unproductive except in localised zones. Part of the proposed access road overlies a Pu aquifer, also classed as poor with bedrock which is Generally Unproductive Figure 7.5 below presents the current bedrock aquifer map for the site and surrounding area.

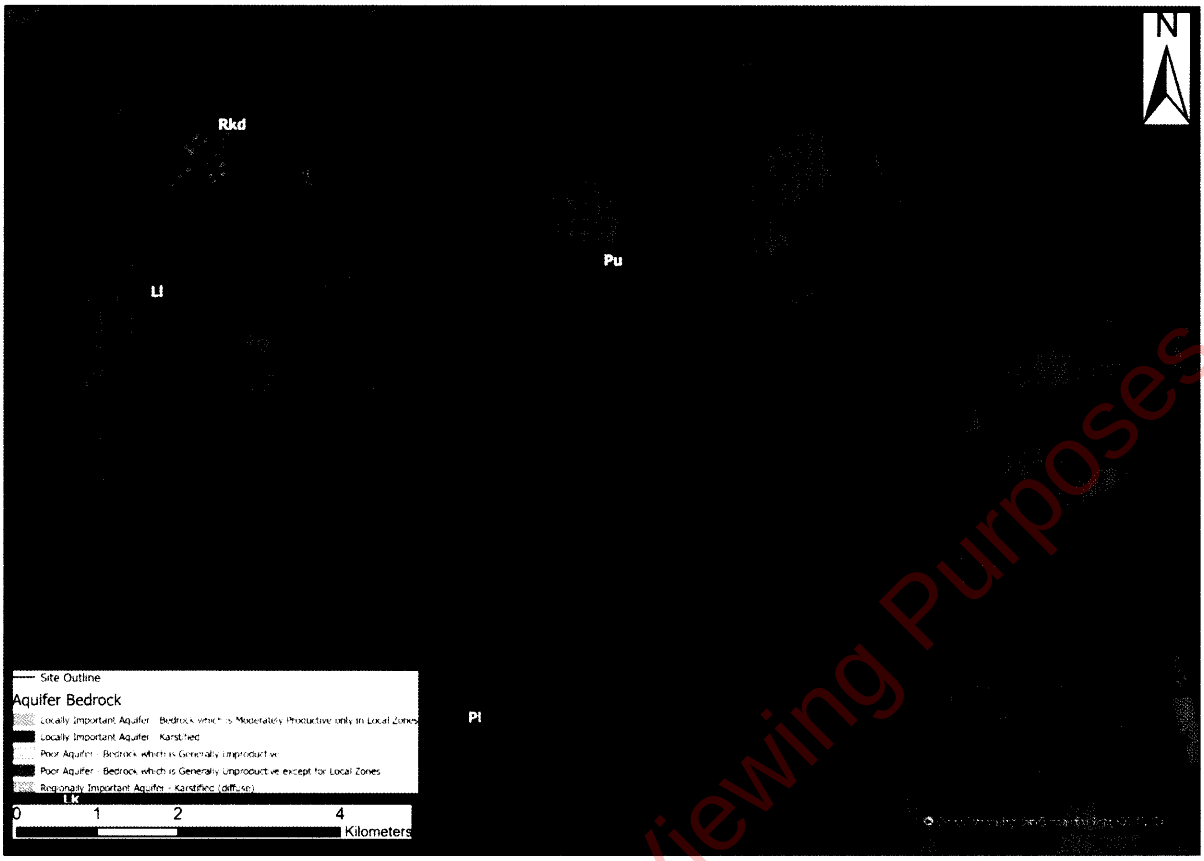

Figure 7.5: Aquifer Classification Map. (GSI, 2020.)

The volcanics can be grouped into two hydrogeological units based on rock type: the tuffs, and the lava flows and intrusives. Permeabilities are developed primarily by fracturing. The sulphides are more acidic, and weather more easily and create vesicles which increase the porosity. Permeabilities are increased in the volcanic flows by columnar jointing which has opened up the otherwise hard rocks. The joints within the quarry face are infilled by rock debris and clay.

During assessments within the site minor groundwater seeps were noted to the quarry from the quarry walls. During periods of very heavy rainfall, seepages from the surface adjacent to the quarry were noted along discrete joints within the quarry. The estimated yields from the boreholes are generally low. A sump for collection and removal of surface water and groundwater seepage is located at the south-eastern corner of the lower bench. The sump is pumped to a settlement pond, hydrocarbon interceptor and reed bed at the southern boundary of the site prior to being discharged (under discharge licence, Licence Ref: 10/02) via a local drainage ditch to a tributary stream of the River Nanny (i.e., to the Lunderstown Stream). The sump pump is switched on and off manually according to the level of water in the sump. Discharge from the quarry is measured continuously by means of a v-notch weir and water level data logger as per the discharge licence requirements..

The hydrogeological and surface water environment are covered in Chapter 8.

7.3.7 Aquifer Vulnerability

Aquifer vulnerability is a term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated generally by human activities. Due to the nature of the flow of groundwater through bedrock in Ireland, which is almost completely through fissures/ fractures, the main feature that protects groundwater from contamination, and therefore the most important feature in the protection of groundwater, is the subsoil (which can consist solely of/ or of mixtures of peat, sand, gravel, glacial till, clays or silts).

The GSI (2021) presently classifies the bedrock aquifer in the region of the subject site primarily as having an (E) – Extreme Vulnerability status or with rock at or near the ground (red areas shown in Figure 7.6) indicating little to no soil cover of the underlying bedrock which is to be expected in a quarry area such as this.

Figure 7.6: Aquifer Classification Map. (GSI, 2020.)

Vulnerability Rating	Hydrogeological Conditions				
	Subsoil Permeability (Type) and Thickness			Unsaturated Zone	Karst Features
	High permeability (sand/gravel)	Moderate permeability (e.g. Sandy subsoil)	Low permeability (e.g. Clayey subsoil, clay, peat)	(Sand/gravel aquifers only)	(<30 m radius)
Extreme (E)	0 - 3.0m	0 - 3.0m	0 - 3.0m	0 - 3.0m	-
High (H)	>3.0m	3.0 - 10.0m	3.0 - 5.0m	>3.0m	N/A
Moderate (M)	N/A	>10.0m	5.0 - 10.0m	N/A	N/A
Low (L)	N/A	N/A	>10.0m	N/A	N/A

Notes: (1) N/A – not applicable.
(2) Precise permeability values cannot be given at present.
(3) Release point of contaminants is assumed to be 1-2 m below ground surface.

Table 7.1: GSI Vulnerability Rating. (GSI, 1999.)

7.3.8 Geological Heritage

The Irish Geological Heritage (IGH) Programme is a partnership between the Geological Survey of Ireland (GSI) and the National Parks and Wildlife Service (NPWS) of the Department of Communications, Energy and Natural Resources.

The GSI provide scientific appraisal and interpretative advice on geological and geomorphological sites. They are responsible for the identification of important sites that are capable of being conserved as Natural Heritage Areas (NHA).

Kilsaran Concrete as members of the Irish Concrete Federation (ICF) will follow the Guidelines on Geological Heritage – 'Guidelines for the Extractive Industry' jointly issued in 2008 by the GSI and ICF (copy of Guidelines attached to Appendix 7.5)

The GSI has identified a large section of the application site as a County Geological Site (CGS) (See Appendix 7.6). The Irish Geological Heritage Site Report Form refers to the site's importance and states;

> *'The ongoing quarry extension provides a new opportunity for significant improvements in knowledge of the detailed geology and stratigraphy of the Bellewstown Inlier. This will be recommended as an NHA.'*

The rocks present represent a sequence of volcanic and sedimentary rocks that were isolated from contemporary rocks, probably as a volcanic island in the middle of the ancient Iapetus Ocean, 450 million years ago.

This development presents an opportunity for cooperation between the quarrying industry and the GSI to help further the understanding of the Nations geological past. The existence of the quarry will not detract from the identified site but will add vital knowledge enriching our understanding of geological heritage. On cessation of quarrying exposed sections of the strata will act as learning tools for future generations.

In 2008 Kilsaran and the GSI entered into an agreement to cover access and research at Bellewstown. Trial trenching has already been carried out to find and sample the Bellewstown member of the Carnes Formation, an account of this exercise was published in Earth Science

Ireland, Issue 9, copy attached as Appendix 7.7. The GSI undertook drilling to recover cores of the rock sequence in the quarry during 2015 as part of their ongoing investigations.

7.3.9 Economic Geology

The EPA/ GSI Extractive Industry Register and the GSI mineral database were consulted to determine whether there were/ are any additional mineral sites close to the subject site. There are 3 active quarries circa 5 km of the Bellewtown Site. These are:

- Mullaghcrone Quarry – 5.5 km to the north operated by Roadstone Ltd and processing Aggregates and fill materials (Quarry Number MH015)
- Duleek Quarry – 4.7 km to the northwest operated by Roadstone Ltd and processing Aggregates and fill materials (Quarry Number MH013)
- Annagor Quarry – 3.8 km to the northeast operated by Kilsaran Concrete and processing limestone and agricultural lime (Quarry Number MH001)

7.3.10 Radon

According to the EPA (now incorporating the Radiological Protection Institute of Ireland), the site is located in a High Radon Area where is it estimated that between 10 & 20% of dwellings will exceed the Reference Level of 200 Bq/m^3. This is the second highest of the five radon categories which are assessed by the EPA. There will be no impact on the development due to its non-domestic/ residential nature.

7.3.11 Geo Hazards

Much of the Earth's surface is covered by unconsolidated sediments which can be especially prone to instability. Water often plays a key role in lubricating the slope failure. Instability is often significantly increased by man's activities in building houses, roads, drainage, and agricultural changes. Landslides, mud flows, bog bursts (in Ireland) and debris flows are a result. In general, Ireland suffers few landslides. Landslides are more common in unconsolidated material than in bedrock, and where the sea constantly erodes the material at the base of a cliff landslides and falls lead to recession of the cliffs. Landslides have also occurred in Ireland in recent years in upland peat areas due to disturbance of peat associated with construction activities. The GSI landslide database was consulted and there are no recorded landslides in the vicinity of the proposed development. Due to the local topography and the underlying strata there is a negligible risk of a landslide event occurring at the site.

In Ireland, seismic activity is recorded by the Irish National Seismic Network. The Geophysics Section of the School of Cosmic Physics at the Dublin Institute for Advanced Studies (DIAS) has been recording seismic events in Ireland since 1978. The station configuration has varied over the years. However, currently there are five permanent broadband seismic recording stations in Ireland and operated by DIAS. The seismic data from the stations comes into DIAS in real-time and are studied for local and regional events. Records since 1980 show that the nearest seismic activity to the proposed location was in the Irish sea (1.0 – 2.0 Ml magnitude) and ~70 km to the south in the Wicklow Mountains. There is a very low risk of seismic activity to the proposed development site.

There are no active volcanoes in Ireland so there is no risk from volcanic activity.

7.3.12 Area of Conservation

The National Parks and Wildlife Service (NPWS) database shows no protected site (either European or national) in the vicinity of the proposed development site. Duleek Commons Natural Heritage Area (NHA) is 4.1 km to the northwest. The River Nanny Estuary and Shore Special Protected Area (SPA) is 7.2 km to the northeast beside the Laytown Nunes/ Nanny Estuary proposed Natural Heritage Area (pNHA).

7.3.13 Conceptual Site Model

Hydrogeological and surface water aspects of the proposed development are covered in Chapter 8. The current conceptual site model (CSM) for the proposed development based on a comprehensive data set at the site and descriptive summary is provided below:

- The site for the development is located on a current rock quarry It is not proposed to extend the quarry beyond what was granted by An Bord Pleanála on 24th October 2018 (referred to the 37L development in Chapter 3)
- The base of excavation will be around 98 m Above Ordnance Datum (mAOD) this is referred to as Bench 3, therefore with an 18 m face the next highest bench (Bench 2) will be quarried to an approximate level of 116 m AOD, and in turn the next highest (Bench 1) which is the existing quarry floor is at an elevation of 128.mAOD as permitted under the 37L permission in 2018.
- The dominant subsoil material in the surrounding area is a shallow well drained till deposit derived from lower palaeozoic rocks. This material is generally clay dominant with angular gravels/clast intermixed. In the vicinity of the quarry, the subsoil is thin, and rock occurs at or close to the surface. The site and surrounding land are underlain by Bedrock at surface (Rck). Within the existing quarry, much of the soil and subsoil have been stripped to expose the bedrock. The stripped overburden has been used around the boundary of the site to create earthen berms, to mitigate direct views from the surrounding environment onto the site.
- Reference to the relevant geological information indicates that the site and surrounding area is underlain by Ordovician age felsic volcanic rocks. These Lower Palaeozoic rocks represent a complex geological history and comprise a large range of rock types including greywackes (turbidites), volcaniclastic sediments, lavas, shales, mudstones, and cherts.
- As fracture connectivity within the bedrock aquifer is poor, there is no likely hydrogeological connectivity to potential environmental receptors.

7.3.14 Rating of Site Importance of Geological/Hydrogeological Features

Based on the NRA (2009) methodology (refer to Appendix 7.2), the importance of the geological features on this site are rated as High. Furthermore, the type of soil and geological environment across the development site is considered 'Type A - Passive geological/

hydrogeological environments' due to the site being underlain by a 'Poor aquifer and historically stable geological environment. This is based on the geological value at a local scale.

7.4 Characteristics of the Development

The proposed development seeks to extend the life of the current permitted quarry from 10 years to 25 years (as originally proposed 37L development) and proposes to develop a new dedicated quarry access road to facilitate an increase in the permitted number of HGV loads to and from the quarry from a maximum of 32 No. per day to an average of 81 No. per day (with +/-15% fluctuations in the number of loads to and from the quarry proposed to address certain demands on the quarry as and when required, equating to a maximum of 93 No. loads per day).

Access to the quarry is currently provided from the local road (Mullagh Road) that runs in a north-south direction and bounds the eastern portion of the site. In order to overcome the Board's concerns regarding impacts on the local community, the subject development proposes the provision of a new private road, as well as new entry/exit points onto this new road, to serve the quarry. In addition, to facilitate the development, it is proposed to relocate the weighbridge and wheel wash closer to the new entrance to the quarry, as well as providing a new shipping office beside the weighbridge. A new powerhouse is proposed to facilitate a mains electric supply for use by pumps, plant, and machinery in the future.

7.5 Potential Impacts of the Development

<u>Subsoil and Bedrock Removal</u>

Topsoil and shallow subsoil stripping will be required in order to facilitate additional quarrying and installation of the access road to the east. A significant part of the proposed extent of the development has already been stripped of overburden material

The removal of the localised subsoil and rock will result in a local loss of natural material. As noted there will be no additional extractions from the currently operation quarry than those permitted in the 37L permission of 2018 Proposed excavation depths are to 98 mAOD. The area to be extracted will expose rock faces and not have any impact on the importance of the site for geological heritage.

In constructing the proposed link road, to decrease and increase ground levels, land will need to be excavated (c. 789m^3 of materials) as well as infilled (c. 1,169 m^3 of materials), respectively, as and where needed. It is intended that the any materials excavated at the site will be used to fill in areas that require it. Where additional materials are required to infill land, these will comprise 380 m^3 and will be obtained from the quarry.

<u>Accidental Fuel Spillages and Leakages</u>

Potential impacts arising from quarrying activities could include accidental leakage of hydrocarbon fuels and/or oils from on-site diesel-fuelled equipment, vehicles and/or plant machinery which may be used within the application site during normal proposed operations, for example on and equipment or visiting vehicles and trucks. Onsite staff have not reported any incidents that have occurred in the area of the proposed development including at the existing quarry.

Slope Stability

If not constructed in accordance with appropriate design procedures, there is a potential impact with slope failure along the proposed eastern, northern, and western bench levels.

Agricultural Land

The proposed quarry development will result in a loss of agricultural land immediately to the northwest and southwest of the current quarry however this is insignificant based on the availability of similar land in the area.

Furthermore, the restoration plan will involve the flooding of the quarry with planting around the perimeter of the quarry to create a new habitat. The road will remain on-site and for agricultural use..

Based on the points stated above the potential impact on the land, soils and geology and is considered to have a long term-imperceptible impact with a neutral effect on quality i.e. An impact capable of measurement but without noticeable consequences.

7.5.1 Do Nothing Scenario

There is an operating quarry located at the site under permissions ABP Ref.PL17.QD0013. The proposed quarry extension will have all control measures highlighted in section 7.6 below. Should the proposed development not go ahead the do-nothing scenario would have a neutral imperceptible impact on the land soils and geological environment.

7.6 Mitigation Measures

The following is an outline of the mitigation measures proposed.

Soil and Subsoil Removal and Management of Stockpiles

Topsoil and shallow subsoils will be used during the restoration of the site and for current berms where possible.

Suitable areas will be allocated for both temporary and permanent stockpiling of excavated shallow overburden material pending removal for re-use on site. Such areas will be located away from the identified sensitive receptors and settlement ponds onsite. Any temporary stockpiles will also comply with setback conditions outlined in the requirements of Inland Fisheries Ireland (2016) 'Guidelines on protection of fisheries during construction works in and adjacent to waters.

- Bedrock crushing activities will only take place within the quarry extraction void.

- Where applicable, any contaminated soil or suspected contaminated soil will be isolated from clean soil pending testing to confirm its classification and disposed of to a licenced facility if required.. Contaminated material stockpiles, if required, will be bunded to ensure any liquid run-off is retained prior to licenced removal from site.
- The planned after-care plan for the site will be carried out in an organised manner and following a specific site restoration plan for the quarry.

Fuel and Chemical Handling

- To minimise any impact on the underlying subsurface strata from material spillages, all oils, solvents, and other liquids used during construction (i.e., quarry excavation activities) will be stored within bunded areas. These storage areas shall be rendered impervious. Appropriate signage will be in place. The amount of fuels/ chemicals stored will be kept to a minimum. All chemical containers will be labelled and copies of SDS sheets shall be maintained for ease of access and reference.
- In the event of a spillage, drainage from bunded areas shall be inspected and diverted for collection and safe disposal if required. The integrity and water tightness of all bunding structures shall be tested and demonstrated. All fuel oil areas will have an appropriate spill apron.
- Oil and fuel storage tanks shall be stored in designated areas, and these areas shall be bunded to a volume of 110% of the capacity of the largest tank/ container within the bunded area(s). Refuelling and maintenance will take place on designated hardstanding (impervious) areas. Potential run-off from these areas will be passed through an oil interceptor where required. Waste oils shall be contained within a bunded area and removed by an appropriately licenced contractor. The proposed new fuel tanks will be fully bunded and roofed (see Drawing KC10 for more information).

  With respect to portable equipment containing fuel oil, drip trays or approved equipment shall be used. An adequate supply of spill kits and hydrocarbon adsorbent packs will be stored in the works area and made available at all times. Guidelines such as 'Control of Water Pollution from Construction Sites, Guidance for Consultants and Contractors', (CIRIA 532, 2001) will be complied with.

Training programmes (in the safe handling of hazardous fuels) will be put in place for all relevant personnel which will also be trained in the implementation of site procedures.

Slope Stability

To minimise the potential impact of slope instability, the embankments i.e. benching profiles to proposed phased mAOD will be constructed in accordance with the British Standards 'BS6031, Code of Practice for Earthworks' which further includes information with regard to safety issues.

With regard to Health & Safety measures, as earthworks and excavations progress, the quarry management will provide adequate slope protection in a diligent and expeditious manner on completion of each stage of excavation, following the approved methodology.

Impacts and mitigation measures associated with groundwater and surface waters are discussed in Chapter 8.

7.7 Predicted Impacts of the Development

Overall, the potential impact during the proposed operational phase (following EPA assessment criteria) is considered to have a 'Neutral impact in terms of quality with a slight to moderate significance'. The proposed development will have a 'Negligible Impact in terms of the magnitude of impact on the Land, soils & geology attribute' i.e., the proposed development results in an impact on the attribute but of insufficient magnitude to affect either use or integrity.

7.8 Residual Impacts of the Development

There are no likely significant impacts on the land, geological or hydrogeological environment associated with the quarry operation with mitigation in place. As such the impact is considered to have a long-term, imperceptible significance with a neutral impact on quality i.e. no effects of effects that are imperceptible, within normal bounds of variation or within the margin of forecasting error.

Following the NRA criteria for rating the magnitude and significance of impacts on the geological and hydrogeological related attributes, the magnitude of impact is considered Negligible for the quarry operational phases.

7.9 Cumulative Impact

The anticipated cumulative effects of the Proposed Development, the development and other known developments as outlined in Chapter 3 are addressed below.

In relation to the potential cumulative impact on the land, soils and geological environment during the construction phases, those key engineering works which would have additional impacts above are:

- Construction works will require additional removal of topsoil and subsoil cover and will further increase the vulnerability of the underlying bedrock. Although there is little change in the environment at this location due to extreme vulnerability found in the area currently.
- Run-off containing large amounts of silt could cause damage to surface water systems and receiving watercourses. Run-off from the quarry will therefore need to be managed using the methods described for the Proposed Development; and
- Contamination of soils and groundwater underlying the site from accidental spillage and leakage from construction traffic and construction materials may occur unless project-specific Environmental Management Plan (EMP) is put in place and complied with. It is proposed that project specific EMP will be put in place for the proposed development.

In relation to the potential cumulative impacts from the operational stages, the following would apply:

- Accidental releases from fuel storage/unloading could contaminate groundwater or soil environments unless mitigated adequately i.e., bunded tanks and delivery areas. All developments are required to ensure they do not have an impact on the receiving water environment in accordance with the relevant legislation (primarily S.I. No. 366/2016 –

European Union Environmental Objectives (Groundwater) (Amendment) Regulations 2016 such that they would be required to manage runoff and fuel leakage discharge to ground.

- There will be a further loss of greenfield area locally however, the area of development is small in the context of the overall agricultural land available in the region and the site is already secured and unavailable for agricultural use, subject to a grant of permission for the Proposed Development. It should be noted that there will be no change to the quarry activities than those already granted permission in 2018 apart from the addition of the haulage road. Other development works are required to facilitate the proposed development, as well as improving road infrastructure generally for the area.
- The cumulative assessment has considered the public roadworks proposed to the L1615 and repair and improvement works to works at Beaumount Bridge which have been agreed in principle with Meath County Council and will be carried out by Kilsaran under licence from Meath County Council's and on the Local Authority's behalf in accordance with the *Roads Act*, *1993* (as amended) in the event of a grant of permission for the proposed development

The residual cumulative effect on land, soils, geology and hydrogeology for the construction and operation phases are anticipated to be ***long-term***, ***neutral*** in terms of quality and of ***imperceptible*** significance, once the appropriate mitigation measures are put in place for each development

7.10 References

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APPENDIX 7.1: IMPACT RATINGS AND ASSESSMENT CRITERIA (SOILS, GEOLOGY AND HYDROGEOLOGY) - GLOSSARY OF IMPACTS FOLLOWING EPA GUIDANCE DOCUMENTS (2022 GUIDELINES).

Quality of Effects It is important to inform the non-specialist reader whether an effect is positive, negative or neutral.	**Positive Effects** A change which improves the quality of the environment (for example, by increasing species diversity, or improving the reproductive capacity of an ecosystem, or by removing nuisances or improving amenities). **Neutral Effects** No effects or effects that are imperceptible, within normal bounds of variation or within the margin of forecasting error. **Negative/Adverse Effects** A change which reduces the quality of the environment (for example, lessening species diversity or diminishing the reproductive capacity of an ecosystem, or damaging health or property or by causing nuisance).
Describing the Significance of Effects 'Significance' is a concept that can have different meanings for different topics – in the absence of specific definitions for different topics the following definitions may be useful (also see *Determining Significance*).	**Imperceptible** An effect capable of measurement but without significant consequences.
	Not Significant An effect which causes noticeable changes in the character of the environment but without significant consequences.
	Slight Effects An effect which causes noticeable changes in the character of the environment without affecting its sensitivities.
	Moderate Effects An effect that alters the character of the environment in a manner that is consistent with existing and emerging baseline trends.
	Significant Effects An effect which, by its character, magnitude, duration or intensity, alters a sensitive aspect of the environment.
	Very Significant An effect which, by its character, magnitude, duration or intensity, significantly alters most of a sensitive aspect of the environment. **Profound Effects** An effect which obliterates sensitive characteristics.
Describing the Extent and Context of Effects Context can affect the perception of significance. It is important to establish if the effect is unique or, perhaps, commonly or increasingly experienced.	**Extent** Describe the size of the area, the number of sites and the proportion of a population affected by an effect.
	Context Describe whether the extent, duration or frequency will conform or contrast with established (baseline) conditions (is it the biggest, longest effect ever?)

Describing the Probability of Effects Descriptions of effects should establish how likely it is that the predicted effects will occur so that the CA can take a view of the balance of risk over advantage when making a decision.	**Likely Effects** The effects that can reasonably be expected to occur because of the planned project if all mitigation measures are properly implemented.
	Unlikely Effects The effects that can reasonably be expected not to occur because of the planned project if all mitigation measures are properly implemented.
Describing the Duration and Frequency of Effects 'Duration' is a concept that can have different meanings for different topics – in the absence of specific definitions for different topics the following definitions may be useful.	**Momentary Effects** Effects lasting from seconds to minutes.
	Brief Effects Effects lasting less than a day.
	Temporary Effects Effects lasting less than a year.
	Short-term Effects Effects lasting one to seven years.
	Medium-term Effects Effects lasting seven to fifteen years.
	Long-term Effects Effects lasting fifteen to sixty years.
	Permanent Effects Effects lasting over sixty years.
	Reversible Effects Effects that can be undone, for example through remediation or restoration.
	Frequency of Effects Describe how often the effect will occur (once, rarely, occasionally, frequently, constantly – or hourly, daily, weekly, monthly, annually).

APPENDIX 7.2: IMPACT ASSESSMENT CRITERIA PROVIDED IN THE IGI *GUIDELINES FOR THE PREPARATION OF SOILS GEOLOGY AND HYDROGEOLOGY CHAPTERS OF ENVIRONMENTAL IMPACT STATEMENTS* (2013).

Table 9.1 Criteria for rating site importance of Geological Features (NRA)

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 high 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
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 9.2 Criteria for rating impact magnitude at EIS stage – Estimation of magnitude of impact on soil / geology attribute (NRA)

Magnitude of Impact	Criteria	Typical Examples
Large Adverse	Results in loss of attribute	Loss of high proportion of future quarry or pit reserves
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
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of	Loss of small proportion of future quarry or pit reserves
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
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

The NRA criteria for estimation of the importance of hydrogeological attributes at the site during the EIA stage are summarised in Table 4 below.

Table 9.3 Criteria for rating Site Attributes - Estimation of Importance of Hydrogeology Attributes (NRA)

Magnitude of Impact	Criteria	Typical Examples
Extremely High	Attribute has a high quality or value on an international	Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation e.g. SAC or SPA status
Very High	Attribute has a high quality or value on a regional or national scale	Regionally Important Aquifer with multiple well fields Groundwater supports river, wetland or surface water body ecosystem protected by national legislation – NHA status Regionally important potable water source supplying >2500 homes
High	Attribute has a high quality or value on a local scale	Regionally Important Aquifer Groundwater provides large proportion of baseflow to local rivers Locally important potable water source supplying >1000 homes Outer source protection area for regionally important water source
Medium	Attribute has a medium quality or value on a local scale	Locally Important Aquifer Potable water source supplying >50 homes Outer source protection area for locally important water source
Low	Attribute has a low quality or value on a local scale	Poor Bedrock Aquifer Potable water source supplying <50 homes

Table 9.4 Criteria for Rating Impact Significance at EIS Stage – Estimation of Magnitude of Impact on Hydrogeology Attribute (NRA)

Magnitude of Impact	Criteria	Typical Examples
Large Adverse	Results in loss of attribute and /or quality and integrity of attribute	Removal of large proportion of aquifer. Changes to aquifer or unsaturated zone resulting in extensive change to existing water supply springs and wells, river baseflow or ecosystems. Potential high risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >2% annually.
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	Removal of moderate proportion of aquifer. Changes to aquifer or unsaturated zone resulting in moderate change to existing water supply springs and wells, river baseflow or ecosystems. Potential medium risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >1% annually.
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Removal of small proportion of aquifer. Changes to aquifer or unsaturated zone resulting in minor change to water supply springs and wells, river baseflow or ecosystems. Potential low risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >0.5% annually.
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Calculated risk of serious pollution incident <0.5% annually.

Table 9.5: Rating of Significant Environmental Impacts at EIS Stage (NRA)

Importance of Attribute	Magnitude of Importance			
	Neglible	**Small Adverse**	**Moderate Adverse**	**Large Adverse**
Extremely High	Imperceptible	Significant	Profound	Profound
Very High	Imperceptible	Significant/moderate	Profound/Significant	Profound
High	Imperceptible	Moderate/Slight	Significant/moderate	Profound/Significant
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight/Moderate

APPENDIX 7.3: SUMMARY BOREHOLE LOGS FOR THE SITE INVESTIGATION POINTS.

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Project Name:	Bellewstown	Project No. 501.00036.00011	Co-ords:	307284E - 267159N	Hole Type: Rotary
Location:	Bellewstown Quarry		Level:	136.50 m AOD	Scale 1:50
Client:	Kilsaran Concrete Products		Dates:	21/10/2010-26/10/2010	Logged By JGK

Piezo	Drill Tag	TCR	SCR	RQD	FI	Depth (m)	Level (m OD)	Litho	Stratum Description
	10.30								FINE-GRAINED DARK GREY-GREEN MUDTONE
		100	65	20	17				
	11.00					11			
		100	85	9	16	12			
	12.60					13			
		100	75	10	21				
	14.00					14			
		100	35	0	30	15			
	15.60					16			
		100	55	14	17				
	17.00					17			
						17.50	119.00		FINE-GRAINED GREY-GREEN SILTSTONE Fresh, dark grey-green fine-grained tuff lithology, siltstone and mudstone. Broken in places with some Fe oxide staining.
		100	90	23	14	18			
	18.60					19			
		100	70	21	13				

Continued next sheet

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Location:	Bellewstown Quarry		Level:	136.50 m AOD	Scale: 1:50
Client:	Kilsaran Concrete Products		Dates:	21/10/2010-26/10/2010	Logged By: JGK

Piezo	Drill Tag	TCR	SCR	RQD	FI	Depth (m)	Level (m OD)	Litho	Stratum Description
	20.00	100	0	0	30				FINE-GRAINED GREY-GREEN SILTSTONE
	21.00	100	25	0	18	21, 22			
	22.60	100	50	8	9	23, 24			
	24.50	100	85	60	8	25			
	26.00	100	90	80	7	26, 27			
	27.60	100	90	65	13	28			
	28.70	100	95	80	9	29			

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Borehole No **10-BH05**

Project Name:	Bellewstown	Project No. 501.00036.00011	Co-ords:	307284E - 267159N	Hole Type Rotary
Location:	Bellewstown Quarry		Level:	136.50 m AOD	Scale 1:50
Client:	Kilsaran Concrete Products		Dates:	21/10/2010-26/10/2010	Logged By JGK

Piezo	Drill Tag	TCR	SCR	RQD	FI	Depth (m)	Level (m OD)	Litho	Stratum Description
									FINE-GRAINED GREY-GREEN SILTSTONE
	30.30								
		100	35	27	22	31			
	31.60					32			
		100	94	53	8	33			
	33.20								
		100	94	69	8	34			
	34.80					35			
		100	75	38	11	36			
	36.40					37			
		100	50	18	18				
	38.00					38			
						38.80	97.70		FINE-MEDIUM-GRAINED GREY-GREEN SILTSTONE Fresh, dark grey-green medium-grained, occasionally fine-grained banded grained tuff lithology, siltstone and mudstone. Broken in places with some Fe oxide staining.
		100	79	31	14	39			
	39.90								

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Borehole No
10-BH05

Project Name: Bellewstown	Project No. 501.00036.00011	Co-ords: 307284E - 267159N	Hole Type: Rotary
Location: Bellewstown Quarry		Level: 136.50 m AOD	Scale: 1:50
Client: Kilsaran Concrete Products		Dates: 21/10/2010-26/10/2010	Logged By: JGK

Piezo	Drill Tag	TCR	SCR	RQD	FI	Depth (m)	Level (m OD)	Stratum Description
		100	40	12	14			FINE-MEDIUM-GRAINED GREY-GREEN SILTSTONE
	40.90							
		100	39	9	17			
	42.50							
		100	57	50	13			
	44.00							
		100	10	0	20			
	45.50							
						46.00	90.50	MASSIVE MID-GREY IGNIMBRITE BRECCIA Fresh, pale to mid-grey very coarse ignimbrite or lithic tuff.
		100	46	36	12			
	46.90							
		100	75	66	7			
	48.50							
		100	57	33	15			

End of Borehole at 50.00 m

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Borehole No
10-BH06
Sheet 1 of 3

Project Name:	Bellewstown	Project No. 501.00036.00011	Co-ords: 307189E - 267298N	Hole Type Rotary
Location:	Bellewstown Quarry		Level: 119.60 m AOD	Scale 1:50
Client:	Kilsaran Concrete Products		Dates: 27/10/2010	Logged By JGK

Drill Tag	TCR	SCR	RQD	FI	Depth (m)	Level (m OD)	Stratum Description
							OVERBURDEN Poor recovery of agricultural soils
					22.00	117.60	MODERATE-STRONGLY-WEATHERED MEDIUM-COARSE PALE TUFF Strongly weathered buff-brown medium to coarse-grained rhyolitic tuff.
2.60	90	25	0	44			
3.40	100	10	0	15	3.40	116.20	MODERATELY-WEATHERED MEDIUM-COARSE PALE TUFF Moderately weathered buff-brown medium to coarse-grained rhyolitic tuff. Common silica/calcite veining with Fe and Mn oxides.
4.40	100	91	78	6			
6.00	95	50	50	14			
7.10	100	89	78	7			
8.00	100	50	46	6			
9.20	100	57	39	9			

Continued next sheet

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Project Name: Bellewstown	Project No. 501.00036.00011	Co-ords: 307189E - 267298N	Hole Type Rotary
Location: Bellewstown Quarry		Level: 119.60 m AOD	Scale 1:50
Client: Kilsaran Concrete Products		Dates: 27/10/2010	Logged By JGK

Piezo | Core Geotechnical Data

Drill Tag	TCR	SCR	RQD	FI
10.60				
	100	20	20	24
11.60				
	100	62	14	10
12.40				
	100	28	0	18
14.00				
	100	17	0	15
15.90				
	100	0	0	17
16.80				
	100	46	33	11
18.00				
	100	43	9	12
19.50				

Depth (m)	Level (m OD)	Litho	Stratum Description
			MODERATELY-WEATHERED MEDIUM-COARSE PALE TUFF
11.30	108.30		SLIGHTLY WEATHERED MUDSTONE Slightly weathered green-brown banded mudstone/siltstone grade tuffs.
13.50	106.10		At 13.5m contact dips at 61Â° MODERATELY-WEATHERED MEDIUM-COARSE PALE TUFF Moderately weathered buff-brown medium to coarse-grained rhyolitic tuff. Abundant silica/calcite veining with Fe and Mn oxides.
18.00	101.60		GREEN-GREY MUDSTONE, LOCALLY WEATHERED Very slightly weathered, greenish-grey, fine-grained (locally medium-grained) banded mudstone/siltstone tuff

Continued next sheet

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Borehole No **10-BH06**
Sheet 3 of 3

P ct Name: Bellewstown	Project No. 501.00036.00011	Co-ords: 307189E - 267298N		Hole Type Rotary
Location: Bellewstown Quarry		Level: 119.60 m AOD		Scale 1:50
Client: Kilsaran Concrete Products		Dates: 27/10/2010		Logged By JGK

Piezo	Drill Tag	TCR	SCR	RQD	FI	Depth (m)	Level (m OD)	Litho	Stratum Description
		100	49	12	10				GREEN-GREY MUDSTONE, LOCALLY WEATHERED
	21.00					21			
		100	38	0	16	21.70	97.90		GREY-GREEN FINE - MEDIUM-GRAINED BANDED TUFF Fresh, pale-grey green banded fine and medium-grained tuffs
						22			
	22.20								
		100	41	12	12	23			
	23.90					24			
		100	47	35	15	25			
	25.40								
		100	46	29	16	26			
	26.60					27			
		100	19	0	30	27.40	92.20		DARK-GREEM MEDIUM-GRAINED BANDED TUFF Fresh, dark-green banded medium-grained tuffs.
						28			
						28.40	91.20		End of Borehole at 28.40 m
						29			

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Borehole No
10-BH07

Project Name: Bellewstown	Project No. 501.00036.00011	Co-ords: 307362E - 267411N		Hole Type Rotary
Location: Bellewstown Quarry		Level: 108.50 m AOD		Scale 1:50
Client: Kilsaran Concrete Products		Dates: 28/10/2010		Logged By JGK

Piezo	Drill Tag	TCR	SCR	RQD	FI	Depth (m)	Level (m OD)	Litho	Stratum Description
									OVERBURDEN Poor recovery of agricultural soils and glacial tills
	5.00								
		55	0	0	30	5.60	102.90		PALE GREENISH-GREY MEDIUM TO COARSE-GRAINED TUFF Fresh (locally moderately or strongly weathered to 10.8m) pale green-grey medium to coarse-grained rhyolitic tuffs.
	6.10								
		100	59	59	13				
	7.70								
		100	50	50	15				8.1m to 8.5m rock broken and Fe stained
	8.50								
		100	63	63	13				
	9.10								
		100	58	45	8				

Continued next sheet

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Project Name: Bellewstown	Project No. 501.00036.00011	Co-ords: 307362E - 267411N	Borehole No **10-BH07** Sheet 2 of 3
			Hole Type Rotary
Location: Bellewstown Quarry		Level: 108.50 m AOD	Scale 1:50
Client: Kilsaran Concrete Products		Dates: 28/10/2010	Logged By JGK

Drill Tag	TCR	SCR	RQD	FI
10.40				
	100	54	39	10
11.80				
	100	81	59	4
13.40				
	100	67	67	5
14.00				
	100	66	59	7
15.60				
	100	50	40	11
16.60				
	100	29	25	9
18.00				
	100	56	47	4
19.60				

Depth (m) scale: 11, 12, 13, 14, 15, 16, 17, 18, 19

Depth (m)	Level (m OD)	Stratum Description
		PALE GREENISH-GREY MEDIUM TO COARSE-GRAINED TUFF
		11.1m to 11.5m rock broken and Fe stained
		18.0m, 10cm rock broken and Fe stained
19.50	89.00	QUARTZ VEIN
		19.5m to 20.3m quartz veins, rock broken and Fe stained
		Quartz veining, rock broken and Fe oxide stained

Continued next sheet

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Borehole No **10-BH07**

Project Name: Bellewstown	Project No. 501.00036.00011	Co-ords: 307362E - 267411N	Hole Type: Rotary
Location: Bellewstown Quarry		Level: 108.50 m AOD	Scale: 1:50
Client: Kilsaran Concrete Products		Dates: 28/10/2010	Logged By: JGK

Piezo	Drill Tag	TCR	SCR	RQD	FI	Depth (m)	Level (m OD)	Litho	Stratum Description
		100	15	0	13				QUARTZ VEIN
	20.60					20.30	88.20		PALE GREENISH-GREY MEDIUM TO COARSE-GRAINED TUFF Fresh pale green-grey medium to coarse-grained rhyolitic tuffs.
		100	81	69	6				
	22.20								
	23.00	100	44	44	30	22.60	85.90		PALE GREENISH-GREY MEDIUM TO COARSE-GRAINED TUFF - CRUSHED Fresh pale green-grey medium to coarse-grained rhyolitic tuffs. Rock crushed to residual sand, possible due to minor faulting?
	24.00	100	10	0	30				
						23.90	84.60		PALE GREENISH-GREY MEDIUM TO COARSE-GRAINED TUFF Fresh pale green-grey medium to coarse-grained rhyolitic tuffs.
		100	19	10	12				
						25.20	83.30		End of Borehole at 25.20 m

Core Geotechnical Data (TCR, SCR, RQD, FI). Depth scale: 21, 22, 23, 24, 25, 26, 27, 28, 29

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Borehole No **10-BH08**

P ct Name: Bellewstown	Project No. 501.00036.00011	Co-ords: 307119E - 267225N	Hole Type: Rotary
Location: Bellewstown Quarry		Level: 123.90 m AOD	Scale: 1:50
Client: Kilsaran Concrete Products		Dates: 29/10/2010-01/11/2010	Logged By: JGK

Piezo	Core Geotechnical Data: Drill Tag	Type	Results	Depth (m)	Level (m OD)	Litho	Stratum Description
							OVERBURDEN Minor recovery of glacial tills to 2.0m, no recovery from 2.0m to 9.0m.
	9.00			9.00	114.90		WEATHERED GREEN-GREY MUDSTONE. VERY BROKEN Moderate to strongly weathered green to brown-green fine grained mudstone lithology. Rock very broken with abundant Fe oxide staining on feactures and discontyinuities.

Continued next sheet

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Borehole No
10-BH08

Project Name: Bellewstown	Project No. 501.00036.00011	Co-ords: 307119E - 267225N	Hole Type: Rotary
Location: Bellewstown Quarry		Level: 123.90 m AOD	Scale: 1:50
Client: Kilsaran Concrete Products		Dates: 29/10/2010-01/11/2010	Logged By: JGK

Piezo	Drill Tag	TCR	SCR	RQD	FI	Depth (m)	Level (m OD)	Litho	Stratum Description
		40	0	0	30				WEATHERED GREEN-GREY MUDSTONE. VERY BROKEN
	11.00								
		65	3	0	30				
	12.60					12.60	111.30		WEATHERED GREEN-GREY MUDSTONE. BROKEN Moderately weathered green to brown-green fine grained mudstone lithology. Rock broken with abundant Fe oxide staining on feactures and discontyinuities.
		90	13	0	30				
	14.10								
		100	30	15	30	15.50	108.40		PALE GREY MEDIUM TO COARSE-GRAINED TUFF Fresh, massive uniform pale to mid-grey medium to coarse-grained rhyolitic tuff.
	16.50								
		100	94	87	3				
	18.10								
		100	89	88	3				
	19.70								

Depth scale: 11, 12, 13, 14, 15, 16, 17, 18, 19

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Borehole No
10-BH08

P ct Name: Bellewstown	Project No. 501.00036.00011	Co-ords: 307119E - 267225N	Hole Type Rotary
Location: Bellewstown Quarry		Level: 123.90 m AOD	Scale 1:50
Client: Kilsaran Concrete Products		Dates: 29/10/2010-01/11/2010	Logged By JGK

Piezo	Drill Tag	TCR	SCR	RQD	FI	Depth (m)	Level (m OD)	Litho	Stratum Description
		100	75	72	5				PALE GREY MEDIUM TO COARSE-GRAINED TUFF
						21			
	21.30								
						22			
		100	88	83	5	23			
						24			
	24.50								
						25			
		100	100	95	5				
						25.80	98.10		GREEN-GREY MASSIVE FINE-GRAINED TRACHYTE Fresh, dark grey-green fine-grained igneous lithology. Probably trachyte lavas. Common hydrothermal veining with pyroxene? Infills.
	26.00					26			
		100	94	94	3	27			
	27.60								
						28			
		100	96	96	3				
	29.00					29			
		100	100	100	2				

End of Borehole at 30.00 m

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Borehole No **10-BH09**

Project Name: Bellewstown	Project No. 501.00036.00011	Co-ords: 307202E - 266907N	Hole Type: Rotary
Location: Bellewstown Quarry		Level: 141.90 m AOD	Scale: 1:50
Client: Kilsaran Concrete Products		Dates: 01/11/2010-03/11/2010	Logged By: JGK

Piezo	Drill Tag	TCR	SCR	RQD	FI	Depth (m)	Level (m OD)	Litho	Stratum Description
									OVERBURDEN Poor recovery of agricultural soils and glacial tills
	1.50					1.50	140.40		FINE-MEDIUM-GRAINED GREY-GREEN BANDED TUFF Fresh to slightly weathered, but very broken pale to dark grey banded fine and medium-grained mudstone/siltstone tuffs
		90	30	0	30				
	3.80								
		75	12	0	30				
	5.00								
		100	11	0	30				
	7.20								
		100	14	0	30	8.30	133.60		WEATHERED PALE GREY MEDIUM TO COARSE-GRAINED TUFF Moderate to strongly weathered pale buff-brown mediumto coarse-grained rhyolitic tuff.
	9.50								

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P ct Name:	Bellewstown	Project No. 501.00036.00011	Co-ords:	307202E - 266907N	Hole Type: Rotary
Location:	Bellewstown Quarry		Level:	141.90 m AOD	Scale: 1:50
Client:	Kilsaran Concrete Products		Dates:	01/11/2010-03/11/2010	Logged By: JGK

Piezo	Drill Tag	TCR	SCR	RQD	FI	Depth (m)	Level (m OD)	Litho	Stratum Description
		100	13	0	30				WEATHERED PALE GREY MEDIUM TO COARSE-GRAINED TUFF
	10.60								
						11			
		50	4	0	30				
						12			
	12.80								
						13			
		100	11	0	30				
						14			
	14.80								
						15			
		100	2	0	30				
						16			
	16.70								
						17			
		100	39	21	16				
	17.90								
						18			
		100	33	25	17				
						19			
	19.20								
		100	14	0	16				

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Borehole No
10-BH09

Project Name: Bellewstown	Project No. 501.00036.00011	Co-ords: 307202E - 266907N		Hole Type: Rotary
Location: Bellewstown Quarry		Level: 141.90 m AOD		Scale: 1:50
Client: Kilsaran Concrete Products		Dates: 01/11/2010-03/11/2010		Logged By: JGK

Drill Tag	TCR	SCR	RQD	FI	Depth (m)	Level (m OD)	Stratum Description
20.00							WEATHERED PALE GREY MEDIUM TO COARSE-GRAINED TUFF
	100	27	11	17			
21.50							
	100	27	0	21			
23.00							
	100	48	19	23			
24.20							
	100	21	7	30			
					25.60	116.30	SHALE Dark green brown shale.
25.70							
					26.20	115.70	FINE-MEDIUM-GRAINED GREY-GREEN BANDED TUFF Fresh pale to dark grey banded fine and medium-grained mudstone/siltstone tuffs. Fine-grained lithologies dominate.
	100	26	7	16			
28.20							
	100	52	35	13			
29.00							
	100	47	44	9			

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Borehole No
10-BH09

P ct Name:	Bellewstown	Project No. 501.00036.00011	Co-ords:	307202E - 266907N	Hole Type Rotary
Location:	Bellewstown Quarry		Level:	141.90 m AOD	Scale 1:50
Client:	Kilsaran Concrete Products		Dates:	01/11/2010-03/11/2010	Logged By JGK

Piezo	Drill Tag	TCR	SCR	RQD	FI	Depth (m)	Level (m OD)	Litho	Stratum Description
									FINE-MEDIUM-GRAINED GREY-GREEN BANDED TUFF
	30.60								
						31			At 31.0m sequence dips at 35Â°
		100	34	26	18				
	32.00					32			
		100	35	31	17				
						33			
	33.50								
						34			
		100	29	17	19				
									34.8m to 37.1m rock broken and Fe stained
						35			
	35.30								
		100	12	9	21	36			
	36.70								
						37			
		100	36	0	21				
	37.90					38			
		100	43	10	12				
						39			
	39.40								
						39.90	102.00		

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Borehole No **10-BH09**

Project Name:	Bellewstown	Project No. 501.00036.00011	Co-ords:	307202E - 266907N	Hole Type: Rotary
Location:	Bellewstown Quarry		Level:	141.90 m AOD	Scale: 1:50
Client:	Kilsaran Concrete Products		Dates:	01/11/2010-03/11/2010	Logged By: JGK

Piezo	Drill Tag	TCR	SCR	RQD	FI	Depth (m)	Level (m OD)	Litho	Stratum Description
		100	37	20	16				PALE GREY MEDIUM TO COARSE-GRAINED IGNIMBRITE TUFF Detail 39.90m - 43.10m : Fresh mixed unit consisting of pale-grey, coarse-grained rhyolitic tuffs with thin units of dark to mid grey-green fine to medium-grained tuffs. Interpreted as an ignimbritic sequence.
	40.80					41			
		100	30	25	16	42			
									42.5m to 42.6m tuff weathered to a residual sand
						43			
						43.10	98.80		BANDED DARK-GREEN FINE-GRAINED MUDSTONE AND PALE COARSE-GRAINED TUFF Pale-grey, coarse-grained rhyolitic tuffs with thin units of dark to mid grey-green fine to medium-grained tuffs. Frequent ripup clasts of finer darker material are present within the pale coarse tuffs. Interpreted as an ignimbritic sequence.
	43.20	100	85	69	23				
	44.00					44.00	97.90		FINE-MEDIUM-GRAINED GREY-GREEN BANDED TUFF Fresh pale to dark grey banded fine and medium-grained mudstone/siltstone tuffs. Fine-grained lithologies dominate.
		100	35	25	12				
						44.60	97.30		PALE GREY MEDIUM TO COARSE-GRAINED TUFF Fresh, massive uniform pale to mid-grey medium to coarse-grained rhyolitic tuff.
	45.00					45			
						45.20	96.70		FINE-MEDIUM-GRAINED GREY-GREEN BANDED TUFF Fresh pale to dark grey banded fine and medium-grained mudstone/siltstone tuffs. Fine-grained lithologies dominate.
						46			
		100	46	38	10				At 46.7m sequence dips at 13Â°
						47			
						48			
	48.40								
						49			
		100	48	31	17				
						49.40	92.50		PALE GREY MEDIUM TO COARSE-GRAINED TUFF Fresh, massive uniform pale to mid-grey medium to coarse-grained rhyolitic tuff.

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Borehole No **10-BH09**

P ct Name:	Bellewstown	Project No. 501.00036.00011	Co-ords:	307202E - 266907N	Hole Type Rotary
Location:	Bellewstown Quarry		Level:	141.90 m AOD	Scale 1:50
Client:	Kilsaran Concrete Products		Dates:	01/11/2010-03/11/2010	Logged By JGK

Piezo	Drill Tag	Core Geotechnical Data TCR	SCR	RQD	FI	Depth (m)	Level (m OD)	Litho	Stratum Description
	50.00	100	42	36	10				PALE GREY MEDIUM TO COARSE-GRAINED TUFF
	51.60	100	48	34	14	51.50	90.40		FINE-MEDIUM-GRAINED GREY-GREEN BANDED TUFF Fresh pale to dark grey banded fine and medium-grained mudstone/siltstone tuffs. Fine-grained lithologies dominate.
	53.00	100	55	52	13				
						55.40	86.50		End of Borehole at 55.40 m

Depth scale: 51, 52, 53, 54, 55, 56, 57, 58, 59

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Borehole No: **10-BH10**
Sheet 1 of 5

Project Name:	Bellewstown	Project No. 501.00036.00011	Co-ords: 307407E - 267024N
Location:	Bellewstown Quarry	Level:	146.10 m AOD
Client:	Kilsaran Concrete Products	Dates:	04/11/2010-06/11/2010

Hole Type: Rotary
Scale: 1:50
Logged By: JGK

Core Geotechnical Data

Drill Tag (m)	TCR	SCR	RQD	FI
2.00 – 3.10	80	20	0	30
3.10 – 3.90	65	0	0	30
3.90 – 4.70	100	5	0	30
4.70 – 6.30	100	19	13	21
6.30 – 8.00	100	47	15	18
8.00 – 9.60	100	56	28	14

Depth (m)	Level (m OD)	Stratum Description
0.00 – 2.80	143.30	OVERBURDEN Minor recovery of gravel and clays
2.80 – 3.90	142.20	VERY WEATHERED AND BROKEN MUDSTONE Heavily weathered and broken pale green-grey mudstones
3.90 – 4.70	141.40	BROKEN AND WEATHERED BANDED DARK-GREEN FINE-GRAINED AND MID-GREEN MEDIUM-GRAINED TUFF Fresh pale to dark grey banded fine and medium-grained mudstone/siltstone tuffs.
4.70 –		BANDED DARK-GREEN FINE-GRAINED AND MID-GREEN MEDIUM-GRAINED TUFF Fresh pale to dark grey banded fine and medium-grained mudstone/siltstone tuffs. Common pyrite on bedding planes and discontinuities.

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Borehole No **10-BH10**

Project Name: Bellewstown	Project No. 501.00036.00011	Co-ords: 307407E - 267024N	Hole Type Rotary
Location: Bellewstown Quarry		Level: 146.10 m AOD	Scale 1:50
Client: Kilsaran Concrete Products		Dates: 04/11/2010-06/11/2010	Logged By JGK

Piezo	Drill Tag	TCR	SCR	RQD	FI	Depth (m)	Level (m OD)	Litho	Stratum Description
		100	79	58	8				BANDED DARK-GREEN FINE-GRAINED AND MID-GREEN MEDIUM-GRAINED TUFF
	11.00					11			
		100	84	69	7	12			
	12.60								
		100	86	36	10	13			
	14.00					14			
		100	79	61	10	15			
	15.50								
		100	55	55	15	16			
	16.80					17			
		100	56	36	9	18			
	18.40								
		100	27	14	15	19			

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Borehole No
10-BH10

Project Name:	Bellewstown	Project No. 501.00036.00011	Co-ords:	307407E - 267024N	Hole Type: Rotary
Location:	Bellewstown Quarry		Level:	146.10 m AOD	Scale: 1:50
Client:	Kilsaran Concrete Products		Dates:	04/11/2010-06/11/2010	Logged By: JGK

Piezo	Drill Tag	TCR	SCR	RQD	FI	Depth (m)	Level (m OD)	Litho	Stratum Description
	20.00	100	43	43	13				BANDED DARK-GREEN FINE-GRAINED AND MID-GREEN MEDIUM-GRAINED TUFF
						21.10	125.00		BROKEN AND WEATHERED PALE GREY MEDIUM TO COARSE-GRAINED TUFF Moderate to strongly weathered pale-buff coloured medium to coarse grained rhyolitic tuff.
	21.50	100	8	0	30				
	22.70	100	16	0	30				
	24.10	100	35	27	19				
						24.50	121.60		BANDED DARK-GREEN FINE-GRAINED AND MID-GREEN MEDIUM-GRAINED TUFF Fresh pale to dark grey banded fine and medium-grained mudstone/siltstone tuffs. Common pyrite on bedding planes and discontinuities.
	25.90	100	59	29	10				
	27.50	100	63	29	15				
	28.70	100	34	29	22				

Continued next sheet

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