SECTION 6: HYDROLOGY & HYDROGEOLOGY

6.1 INTRODUCTION

SLR Consulting Limited (SLR) has been appointed by Roadstone Ltd. to undertake a hydrogeological and hydrological impact assessment for the backfilling and restoration of a limestone quarry at Milverton, County Dublin, using imported inert soil.

This section details the local hydrology and hydrogeology of the application site and surrounding area (up to 4km radius around the site boundary) and identifies potential hydrogeological and hydrological impacts associated with the proposed development.

Unmitigated potential impacts, assuming that no mitigation is in place for the initial assessment, are considered before discussing appropriate mitigation measures and then reassessing the potential impacts. The assessment is based on a detailed baseline description of the local geological, hydrological and hydrogeological regimes.

6.1.1 Background

Extraction of limestone rock and associated production of construction materials was suspended at Milverton in late summer 2008. The proposal to restore the quarry by importing inert soils to substantially backfill the existing quarry void to its original ground level is technically classified as recovery of waste through deposition on land. The large volume of imported inert soil and stone required to complete this task requires a Waste Licence Application to be submitted to the Environmental Protection Agency, together with a supporting Environmental Impact Statement.

This chapter presents an assessment of the environmental impact of the restoration of the site using inert soil and stones on the hydrogeological and hydrological environment. Further information on the waste types and proposed waste recovery facility is provided in Chapter 2 of this EIS.

Much of the information presented in this chapter was submitted in support of the Waste Licence Application to the EPA back in 2009. The chapter includes additional information in respect of the water environment which was provided in submissions to the EPA on foot of an Article 12 Compliance Notice in February 2011. It also references the discharge licence granted by Fingal County Council in May 2011 (Licence Permit Ref. No. WPW/F/074) and presents details of more recent groundwater and surface water quality monitoring undertaken in May 2014.

6.1.2 Scope of Work

This chapter identifies the local hydrogeological and hydrological environment based on available information in the vicinity of the site. A qualitative assessment has been undertaken of the potential impacts on this environment arising from backfilling of the limestone quarry using inert materials. The assessment considers the proposed phasing of the infilling, the waste types and any proposals for water management at the site. The methodology of the assessment is described in detail in Section 6.3.1.

6.1.3 Sources of Information

The following sources of information have been consulted in order to investigate the hydrogeology and hydrology of the area surrounding the application site:

- The Environmental Protection Agency for Ireland website (www.epa.ie) for maps and environmental information;
- Geological Survey of Ireland website (www.gsi.ie);
- Geology of Meath, Sheet 13, 1:100,000 scale, Geological Survey of Ireland, 1999;
- Groundwater Protection Schemes, Department of the Environment and Local Government, Environmental Protection Agency, and Geological Survey of Ireland, 1999, and Appendix Groundwater Protection Response for Landfills;

- The Water Framework Directive Website (www.wfd.ie); and
- Bog of the Ring Groundwater Source Protection Zones, GSI, 2005

6.1.4 Contributors

This study of surface water and groundwater was undertaken and prepared by:

- Les Brown, B.Sc., M.Sc. Ph.D., Hydrogeologist, SLR Consulting Ireland; and
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This study and assessment is based on site visits made in 2008, 2009, 2010 and 2014 by SLR personnel.

6.1.5 Guidance

The impact assessment presented herein has been completed having due regard to the EPA Guidelines on completing Environmental Impact Statements (2002) and the IGI Guidelines for the preparation of Soils, Geology and Hydrogeology chapters of Environmental Impact Statements (2013).

6.2 RECEIVING ENVIRONMENT

6.2.1 Available Information: Geology and Soils

A detailed description of the local and regional soil, subsoil and bedrock geology is provided in Section 5. A summary is provided below

Soils and Subsoils
The Environmental Protection Agency (EPA) website publishes soils and subsoils maps created by the Spatial Analysis Unit, Teagasc in collaboration with the Geological Survey of Ireland. These maps indicate that the majority of the site is underlain by shallow well drained mineral soils, which are classified as grey brown podzolics. These soils are derived from the underlying glacial till which extends across the region. The glacial till is derived from limestone and shale parent material (refer to Figure 5.1 in Chapter 5 of this EIS).

Solid Geology
The superficial deposits under the entire site and surrounding area are underlain by bedrock of the lower Carboniferous Holmpatrick Formation (refer to Figure 5.2 in Chapter 5 of this EIS). The Holmpatrick Formation forms part of the Milverton Group and comprises well-bedded bioclastic limestones.

Local Geology
Three groundwater monitoring wells (designated BH01, BH02 and BH03) were installed across the application site in December 2008. The location of these monitoring wells is shown in Figure 6.1. The monitoring wells were constructed using rotary drilling techniques, and therefore only general descriptions were obtained of bedrock encountered. As the boreholes were drilled within the quarry area where the subsoil had been stripped, they did not encounter soil and subsoil. However, BH03, encountered 13m of Made Ground and glacial till (described as sandy gravelly clay) before encountering rock head. The boreholes were drilled to a final depth of between 21m and 30m. Groundwater monitoring piezometers were installed so that the specified response zones were isolated from other water ingress. The materials encountered during drilling have been described as follows:

- MADE GROUND (Sandy gravelly clay);
- Sandy gravelly CLAY (Glacial Till); and
- Grey fine to medium grained LIMESTONE

The well construction records are presented in Appendix 6.1

6.2.2 Available Information: Hydrogeology

Aquifer Characteristics and Groundwater Vulnerability

The site is located within the Lusk Groundwater Body (GWB), which extends from Dunshaughlin in Meath to the North Dublin coast. The Lusk GWB includes the Bog of the Ring groundwater supply that abstracts a yield of 4ML/d from the Calp Limestone. The outer limit of the source protection zone for the Bog of the Ring lies 4km away from Milverton quarry in a westerly direction.

The bedrock at Milverton is limestone of the Holmpatrick Formation. As is typical of bedrock in the region, groundwater flow is controlled by secondary fissure permeability. The Holmpatrick Formation is classified by the GSI (GSI, 2005) as locally important karstified bedrock (Lk), as indicated on Figure 6.2. The bulk permeability of the formation is low, with groundwater storage and movement mainly constrained to the upper weathered horizons of this unit and fractures / faults. Based on a review of the GSI karst database, there are no karst landforms or caves within 1km of the application site. The nearest recorded karst landforms are two springs, both of which are located 2km to the west.

The Quaternary deposits that overlie the bedrock tend to be relatively thin but play an important role in groundwater recharge. Where Quaternary deposits comprise sand and gravel, they allow a high level of recharge and can provide additional storage to the underlying bedrock aquifer. In this region, the extent and thickness of sand and gravel deposits is insufficient for them to be considered an aquifer in its own right.

Groundwater vulnerability maps published on the EPA website indicate that the site is located in an area with high to extreme Groundwater Vulnerability status. An extract of the Groundwater Vulnerability map is presented as Figure 6.3. The groundwater vulnerability reflects the potential for rapid groundwater movement through the quaternary deposits into the underlying bedrock aquifer.

The excavation has intersected the groundwater table and had sequentially lowered it around the periphery of the excavation with each quarry bench. During quarrying operations water was pumped from the quarry floor as and when required in order to maintain dry conditions on the floor. The pumps had an estimated discharge rate of 5l/s in order to maintain dry conditions on the quarry floor.

The quarry void extends to between 8m and 12m below sea level. At present there is c. 10m of water in the quarry void and the water level is at approximately -2mOD. During quarrying there were a number of small groundwater seepages on the quarry faces, and both direct precipitation and influent groundwater was pumped out from a sump on the quarry floor.

Recharge Mechanisms

The published geological memoir reports that the rainfall in the area is around 900mm/year. Potential recharge to the aquifer ranges from 325mm/yr to 550 mm/yr. The bulk of this recharge occurs between late October and early March, when evaporation and evapotranspiration rates are at their lowest during the year.

Where vegetation and the soils / subsoils have been removed at the quarry site, recharge to the underlying groundwater will be significantly higher as evapotranspiration from vegetation has been lost.

Groundwater Levels and Flow

The published geological memoir reports that in this region of Ireland, groundwater is generally within 10m of the surface and has an annual fluctuation of less than 5m.

During the groundwater well installation works in December 2008, groundwater strikes were recorded in each well during drilling. A summary of water strikes is presented in Table 6.1 below:

Borehole ID	Water Strike (mbgl)	Water Strike(mOD)	Well depth (m)	Deposits recorded at water strike
BH01	18	-3	21	Grey fine grained LIMESTONE
BH02	19	0.5	30	Grey fine grained LIMESTONE
BH03	18	8	24	Grey fine grained LIMESTONE

Table 6.1 Groundwater Strikes Recorded during Drilling

Water levels were recorded at the site in January 2009 and May 2014 and are detailed below in Table 6.2.

Borehole ID	08/01/2009 (mbgl)	28/05/2014 (mbgl)
BH01	14.3	3.29
BH02	10.8	na.
BH03	12.18	12.02

Table 6.2 - Groundwater Levels

Groundwater contours based on the rest levels recorded in the groundwater monitoring wells BH01, BH02 and BH03 in 2009 have been used to determine groundwater flow contours, which are presented on Figure 6.4. These data indicate that when the quarry was being dewatered, the indicative groundwater flow direction was across the site, from north-east to south-west. These data indicate that the quarry floor (at that time at -12m AOD) was 27m below the groundwater table in the northern eastern part of the excavation and 17m below the water table at the south-western end of the excavation. The 2014 data indicate that, following cessation of quarry dewatering, groundwater continues to flow from north-east to south-west, albeit the hydraulic gradient is significantly reduced as groundwater levels in the quarry void rise gradually toward their original in-situ levels.

Groundwater Abstractions, Use and Quality

The GSI records two existing wells within 1km of the site boundary. Both wells are located within the Holmpatrick Formation, to the south of the site within the townland of Loughland. These wells service residences that lie along the local road between Baldongan townland and Skerries. All other local residences are connected to mains water.

Abstractions for the aggregate washing and processing at the site had historically been sourced from sumps on the quarry floor during operations at the site. It is estimated that approximately 5l/s (100m^3/day) was pumped from the site to maintain a dry quarry floor.

Samples were obtained from BH01, BH02 and BH03 in January 2009 and from BH01 and BH03 in May 2014 for hydrochemical analysis. The wells were purged prior to sampling and a copy of the sampling record and field sheets for the sampling undertaken are included in Appendix 6.1 (2009 data) and Appendix 6.2 (2014 data). Additionally, a water sample was collected from the surface watercourse upstream and downstream of the site as well as from the quarry sump. All samples were sent to an independent accredited laboratory (Alcontrol) for analysis. A summary of groundwater quality test parameters are presented in Table 6.3 and Table 6.4 below:

Parameters	Sampling Locations					
	8th January 2009			28th May 2014		
	BH01	BH02	BH03	BH01	BH02	BH03
Field Tests						
Temperature °C	9.8	10.6	10.48	11.8	-	12.6

Parameters	Sampling Locations					
	8th January 2009			28th May 2014		
	BH01	BH02	BH03	BH01	BH02	BH03
Conductivity µS/cm	739	943	968	520.8	-	937
pH	7.89	7.42	7.61	7.9	-	7.49
Dissolved Oxygen	9.28	6.77	6.81	2.46	-	2.29
Laboratory Tests						
Total Hardness (mg/l)	242	234	318	815	-	1840
Total Alkalinity (mg/l)	270	230	250	640	-	230
TOC (mg/l)	4	3	3	<3	-	<3
Dissolved Aluminium (ug/l)				2450	-	1030
Sulphide (mg/l)				<0.01	-	<0.01
Chloride (mg/l)	30	29	94	24.6	-	62.4
Ammoniacal-N (mg/l)	<0.2	<0.2	0.2	<0.2	-	<0.2
Nitrite (mg/l)	0.27	0.23	0.36	<0.05	-	<0.05
Nitrate (mg/l)	38.4	16.9	21.8	0.317	-	14.5
Sulphate (mg/l)	54	18	79	20.3	-	54.3
Phosphate (ortho) (mg/l)	0.04	1.08	0.07	0.078	-	0.051

Table 6.3 Summary of Groundwater Quality

The groundwater quality is considered to be good except for Aluminium which exceeds the guideline threshold values (Groundwater Regulations, 2010). There are no activities at the site which could result in an elevated value for Al as activities ceased in 2008 and it is not present in SW3 from the quarry void.

The hydrochemistry of the groundwater samples indicate hard calcium-type water with moderately low sodium and magnesium. This type of water is typical of groundwater from a limestone aquifer. Potassium, chloride, ammoniacal nitrogen, nitrite and nitrate are moderate indicating minimal organic contamination. The higher nitrate level at BH01, although still low, is most likely due to its closer proximity to agricultural land. There are a small number of hydrochemical variations between samples taken up gradient and down gradient of the quarry. However these are within the normal expected range for this type of aquifer.

Groundwater Protection

Groundwater in Ireland is protected by European Community and national legislation. The Geological Survey of Ireland (GSI) in conjunction with the Department of Environment and Local Government (DoELG) and the EPA have developed a methodology for the preparation of groundwater protection schemes to assist the statutory authorities and others to meet their responsibility to protect groundwater (DoELG / EPA / GSI, 1999). This methodology incorporates land surface zoning and groundwater protection responses.

The DoELG / EPA / GSI have developed a scheme (Groundwater Protection Response Matrix for Landfills) to assessing potential landfill sites on the basis of groundwater vulnerability and aquifer status. However, it should be noted that this scheme has largely been developed for new non-hazardous landfills and is therefore not an appropriate tool for assessment of inert soil recovery facilities such as that at Milverton.

Notwithstanding this, review of the Groundwater Vulnerability Map (Figure 6.3) and the Aquifer Map (Figure 6.2) in accordance with the DoELG / EPA / GSI methodology indicates that the Milverton site is located within an area of High Vulnerability and a Locally Important Karstified

Bedrock Aquifer. These classifications have been compared against the matrix for non hazardous landfills; which indicates that the site setting falls within a response category of R3[1], which is described as being 'Not generally acceptable (for non-hazardous landfills), unless it can be shown that :

- The groundwater in the aquifer is confined; or
- There will be no significant impact on the groundwater; and
- It is not practicable to find a site in a lower risk area'.

Given that site backfilling and restoration activities (such as those envisaged for this site) can only be undertaken where previous activities have created void space in the landscape, the requirement to identify other sites in lower risk areas does not apply. The proposed backfilling of the existing quarry using predominantly cohesive inert glacial till will provide an enhanced degree of protection, over and above that which exists at present.

Given the limited risk to groundwater associated with the placement and compaction of inert soil and stones compared to those presented by non-hazardous landfills, it is considered that the site setting is appropriate for an inert soil recovery facility. It is also reiterated that the DoELG / EPA / GSI groundwater protection methodology has not been developed for inert recovery facilities. Further to this, the significance of the impact of the development on groundwater is fully explored in Section 6.3 of this EIS Chapter.

6.2.3 Available Information: Hydrology

Local Hydrology and Surface Water Quality

The nearest watercourse is the Mill Stream adjacent to the quarry entrance, which discharges to the Irish Sea at Skerries. Ordnance Survey mapping indicates that the Mill Stream has its headwaters in the Baldongan and Balcunnin townlands approximately 2km south-west of the application site. The EPA does not maintain a record of water quality in this stream.

Under the Water Framework Directive (WFD) the overall status of the Mill Stream is classified as being 'Good', both in terms of its physio-chemical status as well as its overall ecological status. The stream is however classified as being at risk of not maintaining good status by 2015 due to diffuse inputs within the catchment.

Water quality samples were taken from the Mill Stream (SW01 and SW02) and from the quarry void (SW03) in January 2009, November 2010 and again in May 2014 and tested for physiochemical parameters, see Table 6.4 below.

Parameters	Sampling Locations						
	08/01/2009	26/11/2010			28/05/2014		
	SW01	SW01	SW02	SW03	SW01	SW02	SW03
Field Tests							
Temperature °C	1.33				12.5	12.6	16.1
Conductivity µS/cm	300				578	580	534.7
pH	8.59				8.66	8.71	8.71
Dissolved Oxygen %	14.94				31.8	32.6	36.2
Laboratory Tests							
Total Hardness (mg/l)	354				360	318	180
Total Alkalinity (mg/l)	300				295	380	160
Dissolved Solids (mg/l)		463	453	338	517	513	357
COD (mg/l)		11.6	9.54	<7	<7	<7	<7
TOC (mg/l)	-				381	3.98	4.1

Parameters	**Sampling Locations**						
	08/01/2009	**26/11/2010**			**28/05/2014**		
	SW01	**SW01**	**SW02**	**SW03**	**SW01**	**SW02**	**SW03**
BOD (mg/l)	4	1.15	1.11	1.43	<1	<1	2.19
DRO (µg/l)	<10				-	-	-
PRO (µg/l)	<10				-	-	-
EPH (C10-C40) (ug/l)					<46	<46	<46
Mineral Oil (µg/l)	<10				<10	<10	<10
Benzene (µg/l)	<10				<7	<7	<7
Toluene (µg/l)	<10				<4	<4	<4
Ethylbenzene (µg/l)	<10				<5	<5	<5
Total Xylene (µg/l)	<10				<8	<8	<8
TPH / oil and Greases (mg/l)		<1	<1	<1			
Sulphide (mg/l)					<0.01	<0.01	<0.01
Dissolved Aluminium (ug/l)					14.5	8.34	<2.9
Dissolved Sodium (mg/l)	21.9				20.6	19.4	23.3
Dissolved Potassium (mg/l)	2.7				1.88	2.12	6.85
Dissolved Calcium (mg/l)	119.3				138	132	65.2
Dissolved Iron (ug/l)	40				0.0717	0.0581	<0.019
Dissolved Magnesium (mg/l)	13.69				13.8	13	12.2
Dissolved Manganese (ug/l)	<1				34	17.5	84.4
Chloride (mg/l)	50	37.5	37.6	37	41.4	42.2	42.3
Ammoniacal-N (mg/l)	<0.2	0.496	0.156	0.122	<0.2	<0.2	<0.2
Nitrite (mg/l)	0.11				0.089	0.091	0.124
Nitrate (mg/l)	45.3	30.5	30.7	25.2	24.1	24.9	10.4
Sulphate (mg/l)	62	60.9	62	53.7	49.8	50.3	50
Phosphate (ortho) (mg/l)	0.07				0.214	0.209	<0.05
Phosphorus (infiltered)(ug/l)		99.1	195	<20			
Total Suspended Solids (mg/l)		8	7.5	<2	9	6	2

Table 6.4 Summary of Surface Water Quality

Two water samples were taken from the Mill Stream on 26th November 2010, one upstream from the site (SW1) and one downstream from the site (SW2), at the discharge point. There was no discharge from the quarry to the Mill Stream at the time the samples were taken. The test results are presented in Appendix 6.3 attached.

The recorded concentration of nitrate in the surface water (SW01 and SW02) is particularly high at 45.3 mg/l in 2008 and 24 mg/l in 2014. This is most likely as a result of agricultural activities on the surrounding lands and not from quarry operations which suspended production in 2008. Analyses for Diesel and Petrol Range Organics, Mineral Oils, Benzene, Toluene, Ethylbenzene and Total Xylene, were carried out on the samples obtained from the Mill Stream and quarry void, and no evidence of any contamination was detected, see Appendix 6.3.

The sample results indicate that water in the Mill Stream is generally of good quality, with some suspended solids. The slightly elevated chloride in the stream is likely to be associated with the coastal location of the catchment and the elevated nitrates most likely reflect runoff from agricultural lands in the catchment. The elevated Phosphorus levels in the Mill Stream most likely reflect human activities in the catchment.

Water samples (SW03 / D1) were also taken from the quarry floor / pond. These samples are deemed to be characteristic of water likely to be discharged from the quarry floor to the Mill Stream. These tests results are also presented in Appendix 6.3.

The water quality test results indicate that the ponded water within the quarry is of good quality with slightly elevated chloride (associated with the coastal location) and elevated nitrates (reflecting runoff from agricultural lands immediately up-gradient of the quarry). The low phosphorus levels, below the laboratory detection level, in the sample indicate no human impacts on the water quality in the quarry void. There were no hydrocarbons recorded in the sample.

Surface Water Flows

The EPA website indicates that there are no hydrometric stations within 5km of the site, and therefore no flow statistics are available for the watercourses close to the site. A summary flow report for the Mill Stream at the discharge point was generated using the EPA Hydro Tool for flow estimation in ungauged catchments, a copy of which is included in Appendix 6.4. The flow report indicates that the 50%ile flow in the stream is approximately 0.062m^3/sec while the 95%ile flow is estimated to be 0.028m^3/sec based on a catchment area of 8.2km^2. There is currently no information or record of abstraction or discharge consents in the vicinity of the site.

When the quarry is dewatered to facilitate backfilling, surface water and groundwater ingress collecting on the quarry floor will be collected in a sump at a low point on the quarry floor and pumped via flexible pipework and buried drainage infrastructure to the Mill Stream a short distance beyond the north-eastern corner of the quarry, as indicated on Figure 6.5.

Discharge

There is an existing Discharge Licence (Licence Permit Ref. No. WPW/F/074) for the quarry, see Appendix 6.5. Although the discharge licence was issued in May 2011, no discharge from the site has occurred since that time, given that activity at the quarry has been suspended since summer 2008. The discharge licence covers the discharge of treated effluent (primarily rainfall runoff) from the site. A copy of the Discharge Licence Application and supporting documentation submitted is included in Appendix 6.6.

The discharge to the Mill Stream largely comprises direct rainfall to the quarry void with some limited surface water run-off from within the site to the quarry void also. There is relatively slow groundwater ingress through the limestone faces in the quarry. This is evidenced by the depressed level of water ponding within the quarry void several years after pumping ceased. The current water level in the quarry void (-2mOD) is still considerably lower that the surrounding groundwater levels.

The rate, timing and volume of discharge from the sump in the quarry floor to the Mill Stream will be controlled by precipitation patterns over the quarry footprint. For a quarry void of approximately 5.41 hectares, with an annual average rainfall of 802mm/year and assuming zero evapotranspiration (on account of absence of vegetation), the average run-off volume, and volume discharged to the stream is approximately 119m^3/day or 1.38litres/sec. In practice, the discharge volume will vary between 0 litres/sec when no rain falls and approximately 15.7litres/sec during a 1 in 50 year storm event (50mm rainfall in 48hours).

The water in the quarry void will need to be pumped out before the infilling of the quarry void can commence. The discharge water will be treated and will not exceed the volume limit of 1,296 m^3/day as set out in the discharge licence, see Appendix 6.5.

The treated water from the settlement ponds will be monitored prior to being discharged via the existing buried discharge pipe to the Mill Stream. The parameters to be monitored will be as set out in the Discharge Licence, see Appendix 6.5.

The existing surface water discharge pipe between the quarry and the Mill Stream will continue in service during the quarry backfilling and restoration phase to discharge treated water from the settlement lagoons.

The discharge route was surveyed. The start point for the 150mm diameter discharge pipe is located at the base of a manhole in the former retail centre (at Grid Reference 324648E and 259158N), located at the front (northern end) of the quarry. The invert level of the pipe at this point lies approximately 4.5m below the ground surface, at 16.56mOD.

The end point for the discharge pipe daylights as a stone culvert in the bank of the tributary to the Mill Stream, beyond the north-eastern boundary of the quarry and close to a right angle bend in the channel (at Grid Reference 324838E and 259329N). It is known that quarrying activity has been undertaken at the application site since the mid-1800's and the presence of the stone culvert would suggest that this discharge has been in use for a considerable period of time. The invert level at the discharge point is 15.36mOD, 1.2m lower than the invert level of the pipe at the quarry, giving an average pipe gradient of approximately 1 in 200 (0.0005). Figure 6.5 indicates the inferred alignment of the discharge route between the surveyed start and end points.

Flooding

The Office of Public Works (OPW) website (www.floodmaps.ie) indicates that there are two records of historic flooding recorded in the vicinity of the site, one in November 1982 and one in August 1986. Both reported flood incidents occurred 400m north of and down hydraulic gradient of the site.

The OPW 1% Annual Exceedance Probability (AEP) flood envelope, derived from the Provisional Flood Risk Assessment (PFRA) maps, are shown on the planning website of the Department of the Environment, Community and Local Government (DoECLG) www.myplan.ie. The published flood data for a 1% AEP event indicates out of bank flooding along the Mill Stream to the north of the application site, much as would be expected along the floodplain of such a stream. The OPW flood outline however is not indicated to extend across the R127 road into the application site.

The proposed development is not considered to be at risk of flooding. Surface water run-off and discharge at site are, and will be managed so that they do not increase the risk of flooding in the vicinity of the application site.

6.2.4 Field Surveys

Site visits were undertaken by a senior SLR hydrogeologist between the 1st and 12th December 2008 (during the monitoring well installation works). In the course of these visits, some minor groundwater inflows into the quarry were observed from fractures. However, these only occurred at approximately 10mOD and only on the northern quarry face. Photographs of the features of note at the site are presented as plates at the end of this Chapter.

Additional site visits were also made in 2010 and 2014, when sampling was undertaken at the site and Mill Stream.

6.2.5 Limitations

The assessment is based on visual observations from site visits, available published information, and discussions on site and is a qualitative assessment.

6.3 IMPACT OF THE RESTORATION WORKS

6.3.1 Evaluation Methodology

The impact of the proposed development (as detailed in Chapter 2) are assessed in this section. The methodology applied in the assessment is a qualitative risk assessment methodology in which the probability of an impact occurring and the magnitude of the impact, if it were to occur, are considered. This approach provides a mechanism for identifying the areas where mitigation measures are required, and for identifying mitigation measures appropriate to the risk presented by the development. This approach allows effort to be focused on reducing risk where the greatest benefit may result. The assessment of risk is as outlined in Table 6.5 below.

Probability of Occurrence	**Magnitude of Potential Impacts**			
	Severe	Moderate	Mild	Negligible
High	High	High	Medium	Low
Medium	High	Medium	Low	Near Zero
Low	Medium	Low	Low	Near Zero
Negligible	Low	Near Zero	Near Zero	Near Zero

Table 6.5: Matrix Used to Assess Potential Impacts

The magnitude of potential impacts in relation to geology, hydrogeology and hydrology are detailed in Table 6.6 below:

Magnitude	**Potential Impact**
Negligible	No impact or alteration to existing important geological environs or important soil settings (i.e. valuable agricultural land) No alteration or very minor changes with no impact to watercourses, hydrology, hydrodynamics, erosion and sedimentation patterns; No alteration to groundwater recharge or flow mechanisms; and No pollution or change in water chemistry to either groundwater or surface water.
Mild	Some loss of important soils or peat, but which has no long term impact Minor or slight changes to the watercourse, hydrology or hydrodynamics; Changes to site resulting in slight increase in runoff well within the drainage system capacity; Minor changes to erosion and sedimentation patterns; and Minor changes to the water chemistry.
Moderate	Slope failure or instability which may cause foundation problems, loss of extensive areas of important soils or peat, damage to important geological structures / features Some fundamental changes to watercourse, hydrology or hydrodynamics; Changes to site resulting in an increase in runoff within system capacity; Moderate changes to erosion and sedimentation patterns; and Moderate changes to the water chemistry of surface runoff and groundwater.
Severe	Slope failure or instability which results in loss of life, permanent degradation and total loss of peat environment across the entire development site, loss of important geological structure/feature. Wholesale changes to watercourse channel, route, hydrology or hydrodynamics; Changes to site resulting in an increase in runoff with flood potential and also significant changes to erosion and sedimentation patterns; and

	Major changes to the water chemistry or hydro-ecology.

Table 6.6: Magnitude of Potential Geological, Hydrological and Hydrogeological Impacts

In addition to their nature and significance, the potential impacts will be assessed in terms of their duration, whether they are direct or indirect impacts, and also if the impact will be cumulative.

The following sections identify the potential impacts of the proposed development on the geological, hydrogeological and hydrological environments. It also assesses the likelihood of occurrence of each identified impact in accordance with Tables 6.5 and 6.6. It should be noted that the impacts are initially assessed with no mitigation or design measures incorporated to reduce the risk.

6.3.2 Potential Impacts on Geology

Given the geological setting of the proposed development, (i.e. an existing limestone quarry) and the type of the proposed development (i.e. backfilling the pit with inert wastes, specifically inert soil and stones and recovered secondary aggregate), it is considered that there is a negligible potential impact on the geological environment associated with developing the site. The area of the site is small compared to the local and regional extent of the limestone bedrock.

The impact on the geological heritage (County Geological Site) at the site is discussed in detail in Section 5.

6.3.3 Potential Impacts on Groundwater

Given the hydrogeological setting, it is considered that the proposed development has the potential to impact on groundwater in terms of both the groundwater quality and the groundwater flow regime. These are considered separately below.

Groundwater Quality

During the development and operation of the site there is a risk of groundwater pollution from the following potential sources:

- Accidental spillage of fuels and lubricants by construction plant placing the inert fill and other operational procedures;
- Increase in suspended solids and potential for contaminated runoff entering groundwater during development of the site; and
- Rogue loads of contaminated material being deposited at the site.

It is considered that without mitigation the probability of occurrence of spillage of fuels, lubricants and other potentially contaminative liquids is 'medium' due to the area of the site and number of vehicles that will be using the site and the magnitude of impact is 'moderate'. Therefore the overall risk to groundwater, without mitigation, is '*medium*'.

It is considered that without mitigation the probability of occurrence of an increase in suspended solids and potential for contaminated runoff entering groundwater during operation of the facility is 'medium' to 'high' due to the time frame over which this may occur and the potential for infiltrating rainfall to mobilise fines in loose backfilled materials and carry them into the groundwater body (much of the imported fill will be high in silt / clay content). The magnitude of impact is 'moderate' and therefore the overall risk is '*medium*' to '*high*'.

Without mitigation the probability of occurrence of a rogue load which may have the potential to contaminate groundwater at the site is 'medium' and the magnitude of impact is 'mild' to 'moderate' depending on where the rogue load is deposited. The overall impact is considered to be '*low*' to '*medium*'.

Groundwater Flow

Without mitigation, or consideration of operational procedures, infilling the site with low permeability inert fill material has the potential to create a low permeability zone. This could alter the groundwater flow pattern around the site, leading to higher groundwater levels upstream of the site and lower levels downstream of the site. Without mitigation the probability of occurrence is 'moderate' due to the thick unsaturated zone of the aquifer.

Is noted that (a) the regional permeability of the unsaturated zone of the aquifer is moderately high which will maintain regional groundwater flow direction, and (b) runoff shed from the proposed restoration landform will infiltrate to form groundwater recharge on the downstream site boundary which will maintain aquifer recharge. The overall impact is therefore considered to be '*low*'.

6.3.4 Potential Impacts on Surface Water

Surface Water Flow

The resumption of discharge from Milverton Quarry to the Mill Stream in order to remove the water from the quarry void has the potential to impact directly on the quantity of water flowing in the stream, as an additional volume is added from the quarry. A summary flow report for the Mill Stream at the discharge point was generated using the EPA Hydro Tool for flow estimation in ungauged catchments, a copy of which is included in Appendix 6.4.

The annual average discharge of approximately 1.38litres/sec (0.0013m^3/sec) from the quarry accounts for approximately 2% of the estimated 50%ile flow in the stream and 5% of the estimated 95%ile flow (assessed using the EPA Hydro Tool). It is therefore considered that the resumption of quarry discharge, in order to remove the existing water in the quarry void, will have no significant adverse impact on flows in the Mill Stream.

Surface Water Quality

Based on the available water quality results for the water ponding in the quarry and the existing surface water quality in the Mill Stream, the discharge of the ponded water from the quarry could potentially result in a minor improvement in the quality of water in the Mill Stream, at least as regards its phosphorus loading.

There are no surface water features within the site boundary and limited artificial features such as temporary channels, sumps and/or ponds required for surface water management. It is considered that the potential impact of backfilling the quarry with inert fill in the short to medium term could have a potentially *moderate* to *high* impact on surface water in the area if suspended soil particles in surface water run-off collecting in sumps and/or closed depressions is pumped through pipelines and/or existing buried drains to the Mill Stream watercourse beyond the north-eastern site boundary. The potential also exists for deterioration in water quality in the Mill Stream from hydrocarbon contamination in the discharge arising from accidental leaks or spillages in the quarry void.

In the longer term, the run-off from the completed landform will generally recharge to ground within the site boundary. Some run-off collecting in the closed depression in front of the rock face will however fall via a gravity drain toward the watercourse beyond the northern site boundary and could potentially carry some suspended solids in the short term while vegetation takes hold on the final landform. This is considered to be a potentially *moderate* impact.

6.3.5 Summary of Potential Impacts

A summary of potential impacts *without mitigation* is presented in Table 6.7 below:

Potential Impact	Spatial Impact, Duration, Direct/Indirect	Probability of Occurrence	Magnitude of Impact	Significance of Impact	Mitigation Required?
Groundwater Quality					
Fuel Spillages	Local, Short Term, Direct	Medium	Moderate	Medium	Yes
Release of suspended solids	Local, Long Term, Direct	Medium to High	Moderate	Medium to High	Yes
Rogue load of contaminated	Local, Short Term, Direct	Medium	Mild to Moderate	Low to Medium	Yes

material					
Groundwater Flow/Recharge to Aquifer					
Impermeable barrier to groundwater flow	Local, Long Term, Direct	High	Moderate	Low	No
Reduction in recharge to aquifer	Local, Long Term and Direct	High	Moderate	High	Yes
Surface Water Quality					
Fuel Spillages	Local, Short Term, Direct	Medium to High	Moderate	Medium to High	Yes
Release of suspended solids	Local, Short and Long Term, Direct	Medium to High	Moderate	Medium to High	Yes

Table 6.7 Summary of Unmitigated Risk and Magnitude of Potential Impacts at Milverton

Review of Table 6.7 indicates that if no mitigation measures are incorporated into the quarry backfilling operation, there is potential for the site to cause detrimental and direct impacts to the superficial aquifer by locally polluting groundwater and creating a low permeability zone to groundwater flow. The impacts are all local, but range from short-term to long-term. It is considered that if the identified potential impacts on either groundwater quality or groundwater flow were all to occur there would be a cumulative effect, which would increase the significance of the impact.

Similarly, in the absence of a functioning surface water management system, the quarry backfilling operation at the site has the potential to cause detrimental and direct impacts to the existing watercourse beyond the northern site boundary.

It is therefore recommended that the mitigation measures outlined in the following section are incorporated to reduce the potential impact.

6.3.6 Do Nothing Scenario

Were the proposed backfilling of the application site not to proceed as envisaged, it is unlikely that a portion of the land at least could ever be put to productive use and that it would remain as a scar on the landscape. Ongoing vigilance will be required to ensure no potential contaminating activities occur on or in the vicinity of the quarry floor.

6.4 MITIGATION MEASURES

Proposed mitigation measures required to reduce the potential impacts to acceptable levels are identified in this section. These measures either reduce the likelihood of an event occurring, or reduce the magnitude of the consequences if the event does occur. It should be noted that several of the mitigation measures proposed would have a positive effect on more than one potential impact.

6.4.1 Proposed Mitigation Measures

In order to mitigate against the risk of pollution to groundwater and surface water occurring during operation of the site, the following management measures would be included:

- Wherever possible a traffic management system would be put in place to reduce the potential conflicts between vehicles, thereby reducing the risk of a collision;
- A site speed limit would be enforced to further reduce the likelihood and significance of collisions;
- All plant would be regularly maintained and inspected daily for leaks of fuels, lubricating oil or other contaminating liquids/liquors;

- Refuelling of vehicles would either be undertaken in a surfaced compound area from a fuel tank(s) that is bunded or be undertaken off-site to minimise the risk of uncontrolled release of polluting liquids/liquors;
- Maintenance of plant and machinery would be undertaken within a site compound area or off-site, as appropriate, to minimise the risk of uncontrolled release of polluting liquids;
- Spill kits would be made available on-site to stop the migration of spillages, should they occur;
- The ponded areas on the pit floor should be drained prior to the waste being deposited to minimise the mobilisation of fines,
- Waste loads should be inspected and tested to confirm they are inert prior to deposition at site.
- Diverting all surface water run-off collected in sumps via settlement ponds and/or interceptor tanks prior to discharge to surface watercourses in order to reduce concentration of suspended solids and/or hydrocarbons.

It is further envisaged that the quality of the surface water discharging from the settlement ponds will be monitored prior to being discharged via the existing buried discharge pipe to the Mill Stream. The parameters to be monitored will include physical parameters (temperature, pH, dissolved oxygen, electrical conductivity, suspended solids, and visual/odour), chemical parameters (nitrate, ammoniacal nitrogen, chloride, sulphate, dissolved metals, non-metals, total hydrocarbons and List I/II substances) and biochemical oxygen demand (BOD).

It is considered that installation of an interceptor and construction of settlement ponds upstream of the existing manhole, as proposed, and a requirement to limit suspended solids to a maximum of 20 mg/litre (as set out in the Discharge Licence), will adequately mitigate potential risks from suspended solids and hydrocarbons to water quality in the stream.

These measures would reduce the potential impact of

(i) spillage of fuels and lubricants from '*medium*' to '*low*';

(ii) an increase in suspended solids from '*medium to high*' to '*low*'; and

(iii) contamination from rogue loads from '*low to medium*' to '*near zero*'.

6.4.2 Residual Impacts

A summary of the proposed mitigation methods, together with the predicted effects and residual impacts is presented in Table 6.8 overleaf.

Examination of Table 6.8 confirms that there are no significant residual impacts with respect to groundwater and/or surface water provided the appropriate mitigation measures are undertaken. It is therefore considered that the siting of an inert recovery facility in this location is acceptable and it has been shown that there will be no significant impact on groundwater and/or surface water.

6.5 INTERACTIONS

It is considered that the groundwater and surface water are not interconnected, and that the Mill Stream is not in continuity with groundwater at the application site. Groundwater at site drains into the quarry void while that surrounding it drains south eastwards, towards the Irish Sea. Although there were previously surface water discharges from the site, there are none currently. Discharges will be maintained during the backfilling of the quarry void as and when required.

Potential Impact	Spatial Impact, Duration, Direct/Indirect	Probability of Occurrence	Magnitude of Impact	Significance of Impact	Mitigation Required?	Mitigation Measures	Mitigated Probability of Occurrence	Mitigated Magnitude of Impact	Residual Magnitude of Impact
Groundwater Quality									
Spillages of fuel	Local, Short Term, Direct	Medium	Moderate	Medium	Yes	Traffic systems, maintenance, bunding and spill kits	Low	Moderate	Low
Release of suspended solids	Local, Long Term, Direct	Medium to High	Moderate	Medium to High	Yes	Minimisation, management, and waste deposition measures	Low	Moderate	Low
Rogue load of contaminated material	Local, Short Term, Direct	Medium	Mild to Moderate	Low to Medium	Yes	Inspection and testing of waste loads	Negligible	Low to Medium	Near Zero
Groundwater Flow / Recharge to Aquifer									
Impermeable barrier to groundwater flow	Local, Long Term, Direct	High	Moderate	Low	No				
Reduction in recharge to aquifer	Local, Long Term and Direct	High	Moderate	High	Yes	Soakaway and engineering measures	Negligible	Moderate	Near Zero
Surface Water Quality									
Spillages of fuel	Local, Short Term, Direct	Medium to High	Moderate	Medium to High	Yes	Traffic systems, maintenance, bunding and spill kits	Low	Moderate	Low
Release of suspended solids	Local, Short and Long Term, Direct	Medium to High	Moderate	Medium to High	Yes	Surface water management measures	Low	Moderate	Low

Table 6.8 Summary of Mitigation and Residual Impacts at Milverton

6.6 MONITORING

Groundwater

Details of the groundwater monitoring and sampling to be undertaken at the proposed waste recovery facility are provided in Section 2.6.4 of this EIS.

The proposed monitoring locations at existing groundwater wells are shown in Figure 6.1.

Monitoring Reference No.	Parameter	Monitoring Frequency	Location (Grid Co-ordinates)	Accessibility of Sampling Points
BH01	Note 1	Bi-annually	324617E 258974N	Easy : open ground
BH02	Note 1	Bi–annually	324803E 259107N	No Access
BH03	Note 1	Bi-annually	324672E 259123N	Easy : open ground

Note 1: Groundwater test parameters to include Temperature, pH, Dissolved Oxygen, Conductivity, Sodium, Potassium, Chloride, Ammoniacal Nitrogen, Sulphate, Dissolved Metals (Al, Ca, Cu, Fe, Pb, Mg, Mn, Ni and Zn) and Total Alkalinity

Table 6.8 Groundwater Monitoring Points

Surface Water

Details of the surface water monitoring and sampling to be undertaken at the proposed waste recovery facility are provided in Section 2.6.10 of this EIS.

Sampling and testing of surface water at the existing watercourse upstream and downstream of the application site will continue during quarry backfilling activities and for a short time thereafter.

Monitoring locations are detailed below and shown in Figures 6.1 and Figure 6.5.

Monitoring Reference No.	Parameter	Monitoring Frequency	Location (Grid Co-ordinates)	Accessibility of Sampling Points
SW1	Note 1	Bi-annually	324582E 259158N	Easy : at gate to field
SW2 (Discharge)	Note 1	Bi-annually	324839E 259330N	Easy : across open field *(subject to landowner consent)*

Note 1: As per Discharge Licence WPW/F/074 (see Appendix 6.5)

Table 6.9 Surface Water Monitoring Points Including Discharge

FIGURES

Figure 6.1 -
Site Layout including Borehole and Surface Water Monitoring Locations

Figure 6.2 -
Bedrock Aquifer Map

Figure 6.3 -
Groundwater Vulnerability Map

Figure 6.4 -
Groundwater Contour Map

Figure 6.5 -
Water treatment and Discharge

APPENDICES

APPENDIX 6.1
Well Construction Records, Sampling Records and Water Quality Results (2009)

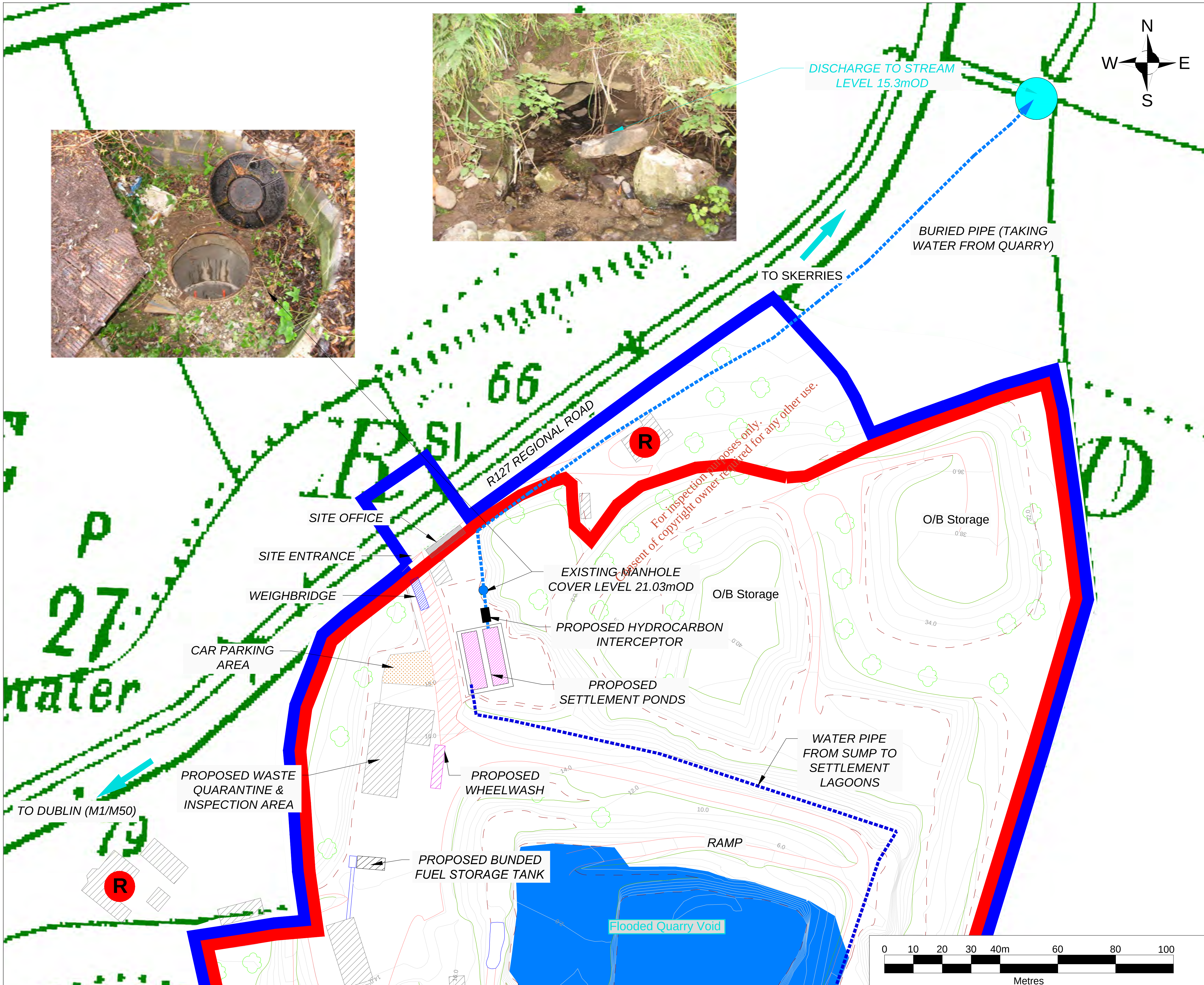
APPENDIX 6.2
Sampling Records (2009)

APPENDIX 6.3
Water Quality Results (2010 & 2014)

APPENDIX 6.4
EPA Ungauged Catchment Report

APPENDIX 6.5
Discharge Licence WPW/F/074

APPENDIX 6.6
Discharge Licence Application



00180.00089.18.FIG 6.5.R0.SITE INFRASTRUCTURE LAYOUT

NOTES

1. Based on OSi 25inch Dublin Sheet No. 5 & 5a

2. Ordnance Survey of Ireland Licence No. SU 0000714 (c) Ordnance Survey of Ireland & Government of Ireland

LEGEND

- Applicant's Land Interest (c. 8.6ha)
- Waste Licence Application Area (c. 7.9ha)
- Buried Pipe
- Top of Bank
- Bottom of Bank
- Road
- Contour Line
- Building
- Internal Unpaved Road
- Internal Paved Road
- R Location of Residence

roadstone

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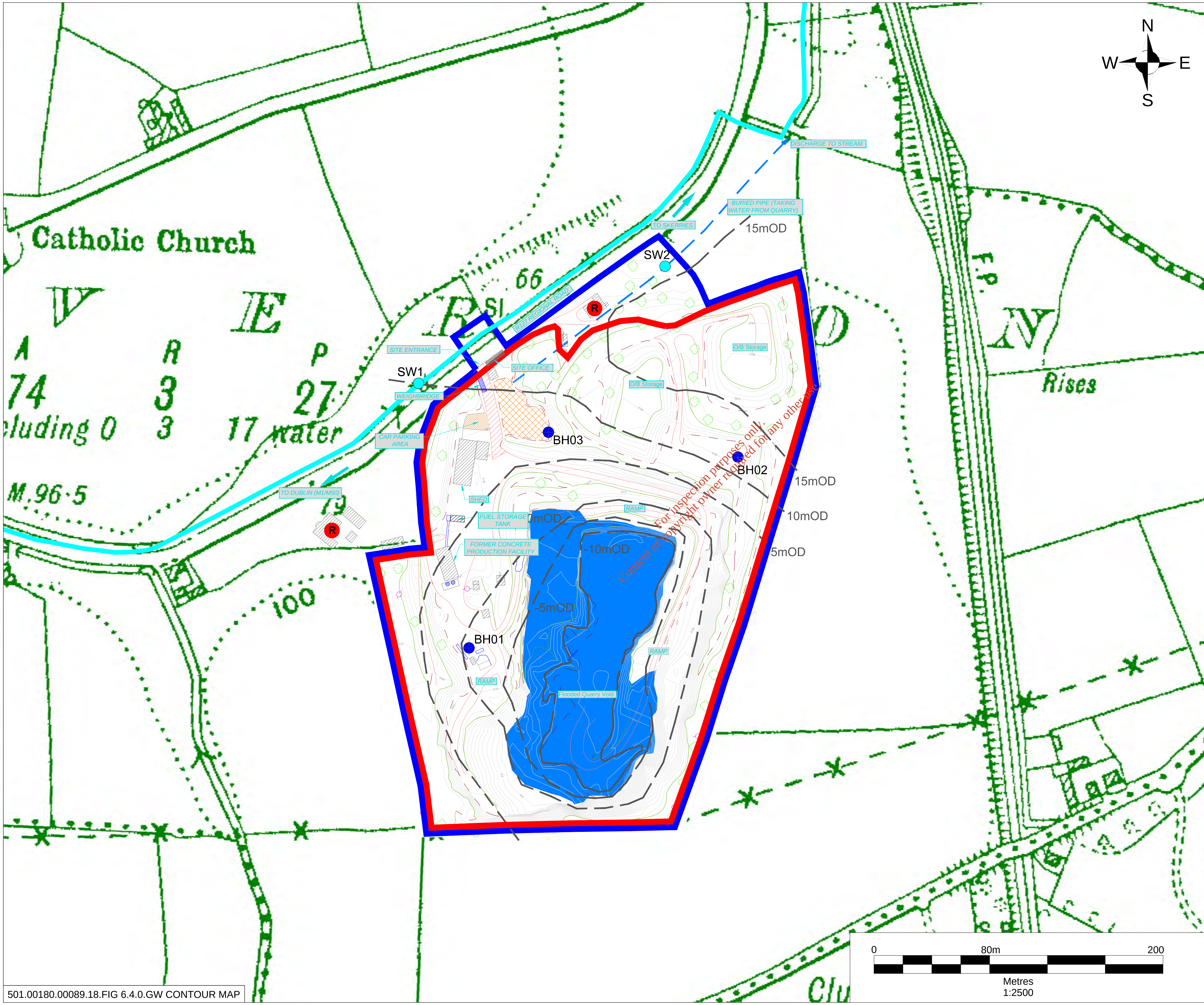
SITE INFRASTRUCTURE LAYOUT

FIGURE 6.5

Scale	Date
1:1,1250 @ A3	JUNE 2014



NOTES

1. Based on OSi 25inch Dublin Sheet No. 5 & 5a

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LEGEND

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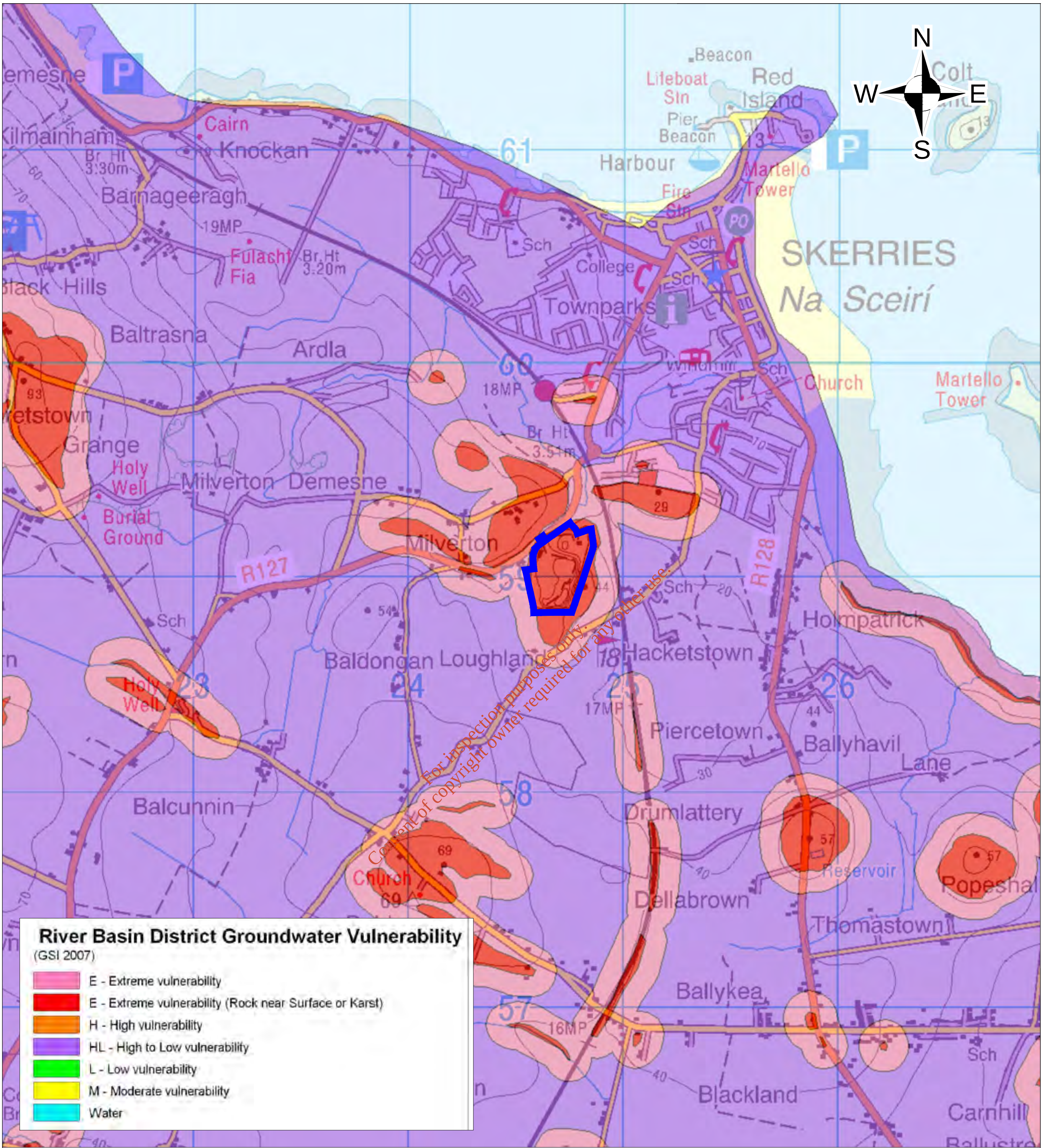
GROUNDWATER CONTOUR MAP

FIGURE 6.4

0 80m 200
Metres
1:2500

Scale: 1:2,500 @ A3
Date: JUNE 2014

501.00180.00089.18.FIG 6.4.0.GW CONTOUR MAP



LEGEND

Applicant's Land Interest (c.8.6 ha)

roadstone

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NOTES

1. Extract from Ordnance Survey Discovery Map No. 43

2. Ordnance Survey Ireland Licence No. SU 0000714 (c) Ordnance Survey Ireland / Government of Ireland

0 800m 2000

Metres
1:25,000

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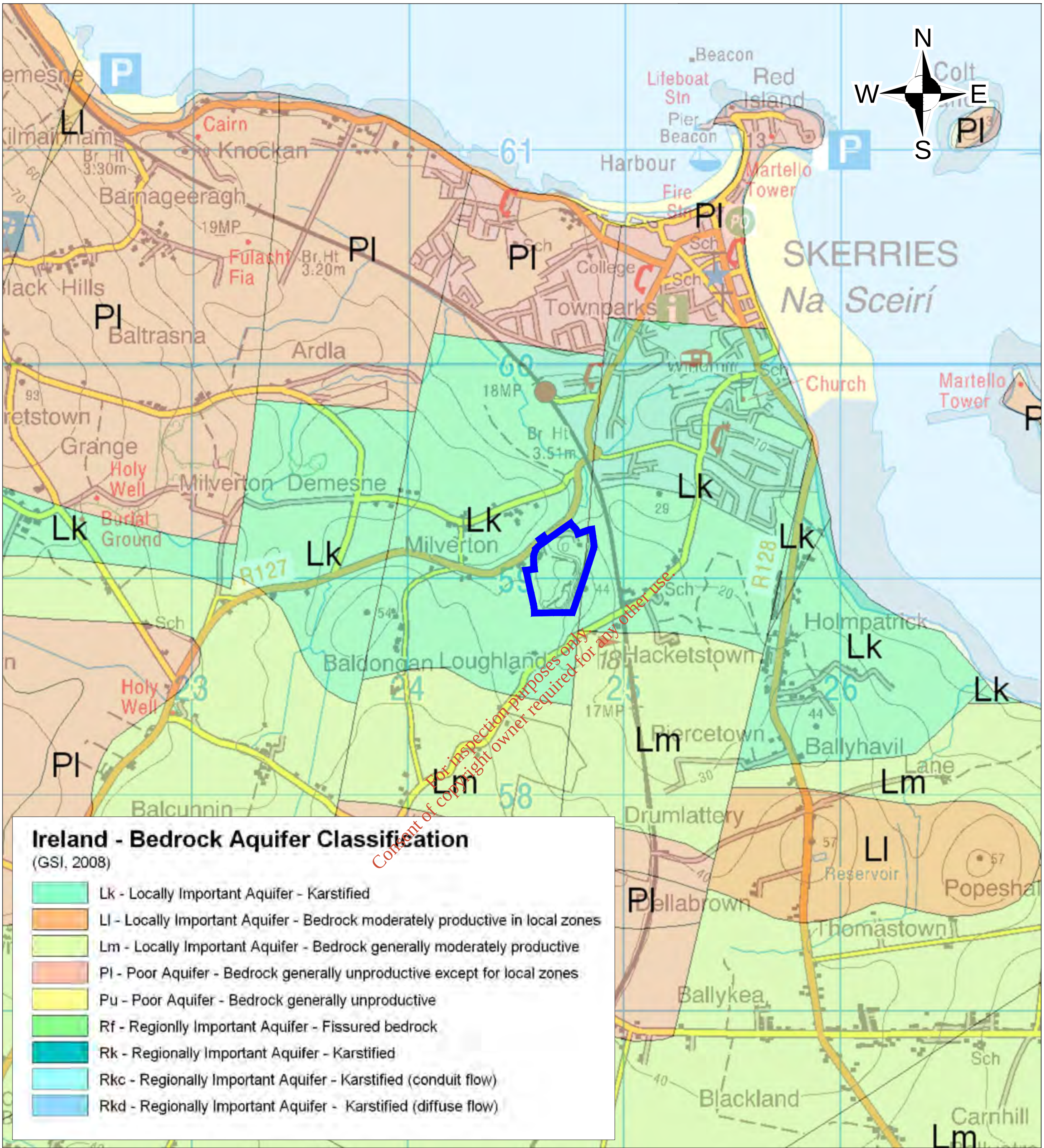
GROUNDWATER VULNERABILITY MAP

FIGURE 6.3

Scale	Date
1:25,000 @ A4	JUNE 2014

00180.00089.18.FIG 6.3.0.GW VULNERABILITY MAP



LEGEND

Applicant's Land Interest (c.8.6 ha)

roadstone

NOTES

1. Extract from Ordnance Survey Discovery Map No. 43

2. Ordnance Survey Ireland Licence No. SU 0000714 (c) Ordnance Survey Ireland / Government of Ireland

0 | 800m | 2000

Metres
1:25,000

00180.00089.18.FIG 6.2.0.BEDROCK AQUIFER MAP

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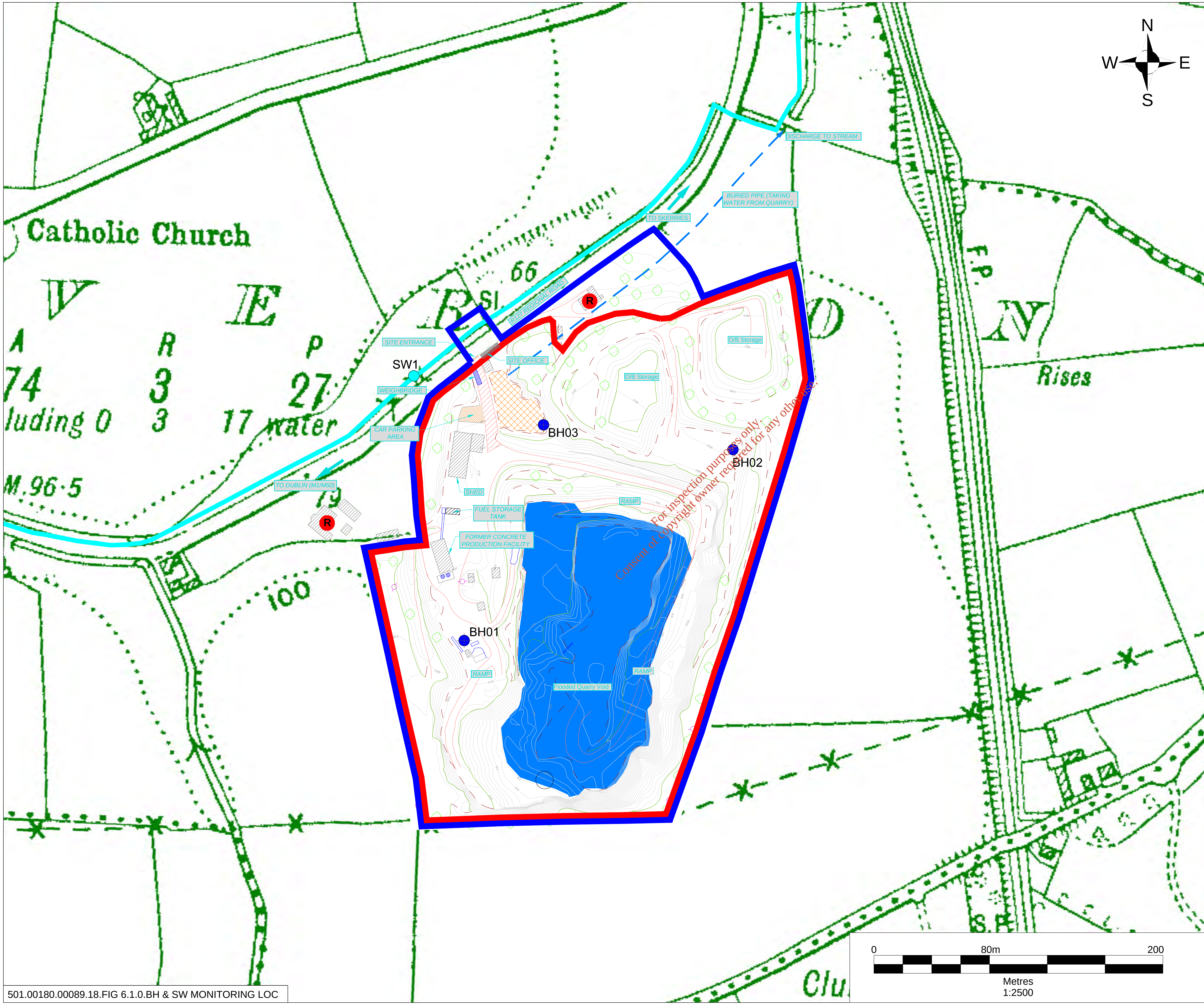
BEDROCK AQUIFER MAP

FIGURE 6.2

Scale 1:25,000 @ A4

Date JUNE 2014



NOTES

1. Based on OSi 25inch Dublin Sheet No. 5 & 5a

2. Ordnance Survey of Ireland Licence No. SU 0000714 (c) Ordnance Survey of Ireland & Government of Ireland

LEGEND

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BH and SW MONITORING LOCATIONS

FIGURE 6.1

Scale	Date
1:2,500 @ A3	JUNE 2014

501.00180.00089.18.FIG 6.1.0.BH & SW MONITORING LOC