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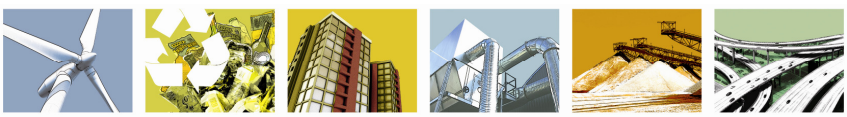

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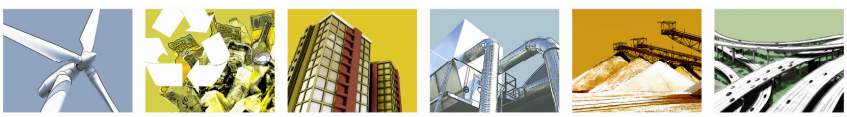


INTRODUCTION

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

6.2 This report presents information on the local hydrology and hydrogeology of the application site and surrounding area (up to 5km radius around the site boundary) and identifies potential hydrological and hydrogeological impacts which are likely to arise from the proposed development.

6.3 Unmitigated impacts, assuming that no mitigation is in place, are considered for the initial assessment, before discussing appropriate mitigation measures and reassessing the potential impacts.

Background

6.4 There are currently separate three quarry voids at the Huntstown Quarry complex, at which limestone has been, or continues to be extracted. Two of these void areas, known as the North Quarry and Central Quarry have essentially been extracted to their near-maximum extent, due to constraints imposed by their geometry and/or geology. One void area, known as the south quarry, is still being actively worked.

6.5 It is proposed to restore the North Quarry to its original ground level over an extended time period using imported inert fill, principally soil and stones. The proposal to restore the quarry in this fashion 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.

6.6 This Chapter of the EIS 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 report.

Scope of Work

6.7 This chapter identifies the local hydrological and hydrogeological 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 imported inert materials.

6.8 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 later in this chapter.

Sources of Information

6.9 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 (1999), and Geology of Kildare-Wicklow (1994) 1:100,000 scale, Geological Survey of Ireland
- Groundwater Protection Schemes. Department of the Environment and Local Government, Environmental Protection Agency, and Geological Survey of Ireland, 1999.
- Water Maps, Water Framework Directive online mapping (www.wfdireland.ie)

Contributors

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

- Oliver Higgins MSc., Senior Hydrogeologist, SLR Consulting Ireland

RECEIVING ENVIRONMENT

Available Information : Soil and Geology

6.11 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

6.12 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 application site at Huntstown and the surrounding area is typically underlain by deep well drained mineral soils. These soils are derived from the underlying glacial till which extends across the North Dublin region. The glacial till is derived from limestone parent material (refer to Figures 5-1 and 5-2 in Chapter 5 of this report).

Solid Geology

6.13 The superficial deposits at the site and surrounding area are underlain by bedrock of several lower Carboniferous Formations (refer to Figures 5-3 and 5-4 in Chapter 5 of this report). Regional geological maps indicate that there are four bedrock formations recorded across the Huntstown Quarry complex. These are:

- The Boston Hill Formation: described as a rather uniform, thick successions of nodular diffusely bedded, argillaceous fossiliferous limestones (and their dolomitised equivalents) and subordinate thin shales. Improved understanding of local structural geology means that this formation is now recognised as part of the Malahide Formation.
- The Waulsortian Limestone is described as mainly pale grey biomicrite.

- The Tober Colleen formation described as very gradationally-interbedded calcareous mudstone and very argillaceous micrite. It overlies, and fills in the gaps between depressions of the Waulsortian Limestones.
- The Malahide Formation: at its top, is described as a fossiliferous limestone and shale with some oolites and sandstone, biomicrites and biosparites.

Local Geology

6.14 Six groundwater monitoring wells (designated GW01 – GW06) were installed across the Huntstown Quarry complex in July 2010. The locations of these monitoring wells are shown in Figure 6-1. The well construction records are presented in Appendix 6-1.

6.15 The monitoring wells were constructed using rotary percussion drilling techniques, and therefore only general descriptions were obtained of bedrock encountered. Where not affected by quarrying activities, the depth to bedrock across the quarry complex ranges from 1.9m to 13m. The boreholes were drilled to a final depth of between 49m and 80.5m. Groundwater monitoring piezometers were installed so that specific response zones could be isolated from other water ingress.

Available Information : Hydrogeology

Aquifer Characteristics and Groundwater Vulnerability

6.16 The site is located within the Dublin Groundwater Body (GWB), which extends from Kilcock in the west to the Dublin coastline, and from the foothills of the Dublin mountains in the south, to Dublin Airport in the North. There are no major abstractions for groundwater supply from the Dublin GWB. The source protection area for a wellfield at Dunboyne extends marginally into the groundwater body. The source protection zone for this wellfield is 8.5 km from the Huntstown Quarry complex. Huntstown Quarry itself represents probably the largest groundwater abstraction from the Dublin GWB.

6.17 The bedrock geology of the Huntstown area is complex. It has however been extensively studied and is the subject of published research, summarised in Section 5 of this report. The predominant bedrock at Huntstown is limestone, grouped into the Waulsortian, Malahide (Boston Hill) and Tober Colleen Formations, as previously described. As is typical of Irish bedrock, groundwater flow through these formations is controlled by secondary fissure permeability. The bulk permeability of the formations are relatively high, with groundwater storage and movement mainly constrained to the upper weathered horizons of each unit and to discontinuities (such as such as joints, fractures and faults).

6.18 Bedrock aquifer maps published on the GSI website indicate that the Huntstown Quarry complex straddles bedrock formations which are generally considered to be locally important karstified aquifers. Of the three bedrock formations exposed at Huntstown, both the Waulsortian and Malahide (Boston Hill) Formations are considered to be locally important aquifers, while the Tober Colleen Formation is considered to be a poor aquifer. An extract of the bedrock aquifer map is presented as Figure 6-2.

6.19 The subsoil deposits that overlie the bedrock at Huntstown tend to be relatively thin but play an important role in groundwater recharge. Where the subsoil comprises sand and gravel deposits, it permits a high level of recharge and can provide additional storage to the underlying bedrock aquifer. In the Huntstown area however, the extent and thickness of sand and gravel deposits is insufficient for it to be considered an aquifer in its own right.

6.20 A review of the GSI karst database indicates that there are no karst landforms or features within 5 km of the Huntstown Quarry complex.

6.21 Groundwater vulnerability maps published on the GSI website indicate that the Huntstown Quarry complex is located within an area with high to extreme groundwater vulnerability status. This is principally due to the fact that subsoil has been removed over virtually the entire site. An extract of the groundwater vulnerability map is presented as Figure 6-3. The groundwater vulnerability reflects the exposed nature of the quarry area, owing to the removal of subsoils.

6.22 The quarry excavations have intersected the groundwater table and lowered it around the periphery with the excavation of each quarry bench. There are minor groundwater inflows to each of the quarries that drain to the quarry floor, where they are contained. Water is pumped from the quarry floor as and when required in order to maintain dry conditions on the floor. When pumps are active, the northern quarry has an estimated discharge rate of around 20l/sec.

Recharge Mechanisms

6.23 Dublin Airport meteorological monitoring station receives a mean annual rainfall of 732 mm (based on the 1961 – 1990 average). The potential groundwater recharge is obtained by taking the rainfall and subtracting the actual evaporation/evapotranspiration (AE). In the Dublin area, potential groundwater recharge to the aquifer ranges from 325mm/yr to 550 mm/yr.

6.24 The Water Framework Directive's Working Group on Groundwater (2005) however has suggested that a reasonable 'cap' on recharge to locally important aquifers would be 150mm/year to 200 mm/year and that any incident rainfall in excess of this will be rejected as run-off. The bulk of this groundwater recharge would be likely to occur between late October and early March.

6.25 At the existing quarry, the AE will be much lower due to the absence of significant vegetation cover and therefore the AE is assumed to be approximately 50mm/yr and therefore potential aquifer recharge at the quarry void is approximately 682mm/yr.

Groundwater Levels and Flow

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

6.27 During the groundwater well installation works in July 2010, groundwater strikes were recorded at all wells during drilling. A summary of water strikes is presented in Table 6-1 below, along with other pertinent information:

Table 6-1
Groundwater Strikes Recorded during Well Drilling

Borehole Name	Well depth (m)	Water Strike (mbgl)	Water Strike (mOD)	Water Level (mbgl) 05/08/10	Water Level (mOD) 05/08/10
GW01	61	54	26.98	25.47	56.27
GW02	55	32	49.51	11.99	70.34
GW03	49	31	46.94	20.46	58.01
GW04	61	54	26.88	29.59	52.14
GW05	55	14.5	70.01	10.81	74.52
GW06	80.5	49	33.16	40.46	42.32

6.28 Water levels presented here were recorded on the 5 August 2010, approximately three weeks after the completion of drilling and groundwater monitoring well installation. Groundwater level monitoring is ongoing on at least a monthly frequency.

6.29 Groundwater contours based on the rest levels recorded in the groundwater monitoring wells have been used to determine groundwater flow contours, which are presented on Figure 6-1. These data identify the indicative groundwater flow directions across the Huntstown Quarry Complex. These data indicate that the floor of the deepest quarry (the South Quarry) quarry floor (at 27 mOD) is 15 m below the groundwater table at a distance of 80m (i.e. from GW06).

6.30 The depths to groundwater indicate that the existing dewatering operations at the site have lowered groundwater levels over a significant area. Based on the distance-drawdown method, it is estimated that a reduction of 10m in groundwater levels extends from the quarry faces to 1.1 km from the site.

Groundwater Abstractions : Use and Quality

6.31 The GSI national well database records indicate that there are 12 wells or drillholes within 1 km of the Huntstown Quarry complex. Of these, only 2 appear to be wells used for groundwater abstraction: one is in the Waulsortian Limestone Formation to the west of the site, and one, also in Waulsortian Formation is to the south of the site.

6.32 Much of the potable water demand in Huntstown and the surrounding area is satisfied by a Local Authority mains supply. The adjoining Huntstown Power Station sources approximately 150m^3/day of water from an on-site well for operational use.

6.33 Under Ireland's obligations for the Water Framework Directive, the status of groundwater bodies nationally has been assessed, both on the basis of their

quality and availability. This information is only currently available in draft form, but for the Dublin GWB, it suggests the following:

- That it is at significant risk from point source pollution (risk category 1a)
- That it is probably at significant risk from diffuse source pollution (risk category 1b)
- That it not at significant risk from abstraction and saline intrusion (risk category 2a)

The overall risk category for the GWB is therefore set at '1a'. However, because the Dublin GWB is situated beneath a large urban area, it will probably be the subject of less stringent management objectives (in the river basin management plan) than other areas.

6.34 At the quarry itself, water abstraction for the concrete, aggregate washing and processing is sourced from sumps on the quarry floor which collect groundwater ingress and run-off water. These sumps are continually pumped to maintain dry conditions on the quarry floor.

6.35 Groundwater samples were obtained at the recently installed monitoring wells (identified as GW01 – GW06) in August 2010 and forwarded for hydrochemical analysis. All wells were purged prior to sampling. Additionally, a water sample was collected from the surface watercourse to the north of the site, adjacent to Kilshane Cross. All samples were sent to an independent accredited laboratory for analysis. A summary of water quality test parameters is presented in Table 6-2 below. Detailed results are presented in Appendix 6-2.

Table 6-2
Summary of Groundwater Quality (August 2010)

	GW01	GW02	GW03	GW04	GW05	GW06	IGV*
pH	7.34	6.84	7.46	7.32	6.86	7.12	6.5 -9.5
Conductivity	114	229	376	512	681	354	1000
Sodium	24.52	17.89	28.62	25.42	16.89	18.45	150
Potassium	3.54	2.99	4.01	3.12	1.58	2.57	5
Calcium	80.7	75.45	92.52	85.42	68.57	78.45	200
Magnesium	17.54	15.42	20.27	19.85	14.56	20.12	50
Chloride	19.23	24.68	43.11	27.49	19.51	34.16	30
Sulphate	48.96	12.09	17.24	36.11	24.66	18.71	200
Total Alkalinity	301	292	351	332	247	313	NAC
Total Hardness	340	352	440	494	220	252	200
Nitrate	18.66	12.45	24.77	16.62	9.32	6.44	25
Nitrite	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.1
Ammoniacal Nitrogen	0.02	0.01	0.04	0.02	0.01	<0.01	0.15
Iron	0.006	<0.001	0.052	<0.001	<0.001	0.067	0.2
Manganese	0.001	<0.001	0.013	<0.001	<0.001	0.021	0.05
Orthophosphate	0.1	0.09	0.06	0.02	<0.01	0.01	0.08
Total Organic Carbon	4.1	4.4	1.5	0.5	3.2	9.9	NAC

Shaded — Maximum admissible concentration exceeded

IGV — Interim Guideline Value for groundwater, as set out in the EPA Publication 'Towards setting Guideline values for the Protection of Groundwater in Ireland'.

6.36 The groundwater quality data presented above indicate that the groundwater at Huntstown can be considered to be of good status. Virtually all parameters analysed had ion concentrations lower than the Interim Guideline Values (IGV) set out in the EPA Publication '*Towards setting Guideline values for the Protection of Groundwater in Ireland*'. The guideline value for chloride was exceeded at two locations, but this may be due to proximity to the coast (12-km), and its seawater. All samples exceeded the guideline for hardness, but it should be noted that hardness occurs naturally at high concentrations in limestone bedrock: about 65% of all groundwater samples from the recent national database have hardness in excess of 200 mg/l. Values of orthophosphate exceeding the guideline value may be the result of local fertiliser application.

6.37 The hydrochemistry of the groundwater samples indicate hard calcium-magnesium-bicarbonate waters with moderately low sodium and magnesium. This type of water is typical of groundwater from a dolomitised 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 quarried sites. However these are within the normal expected range for this type of aquifer.

Groundwater Protection

6.38 The term 'groundwater protection' refers to the ability of subsoils to reduce an influent contaminant load through a variety of biological, physical and chemical processes. The thickness of unsaturated subsoil above an aquifer is therefore a key parameter in determining how well-protected it is. However, the importance of the resource to be protected (i.e. the size of the aquifer) is also fundamental to the magnitude of the risk. 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.

6.39 The DoELG / EPA / GSI has 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 (i.e. receiving a 'traditional' waste stream of municipal solid wastes, and commercial and industrial wastes). It is therefore not a directly applicable tool for assessment of inert soil recovery facilities such as proposed at Huntstown.

6.40 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 Huntstown site is located within an area of extreme 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 R2[2], which is described as being 'acceptable subject to guidance outlined in the EPA Landfill Design Manual or conditions of a waste licence'.

6.41 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 compared to those presented by non-hazardous landfills, it is considered that the site setting is appropriate for an inert soil recovery facility.

Available Information : Hydrology

Local Hydrology : Quality

6.42 The Huntstown quarry complex straddles two river catchments, that of the Ward River and that of the Tolka River, with approximately equal areas of the landholding in each, as shown in Figure 6-4. The inert soil recovery facility to be located in the North Quarry lies in the northern part of the landholding, entirely within the Ward River catchment. Therefore, this assessment will make no further reference to the Tolka River or its catchment.

6.43 The northern portion of the River Ward (known as the Ballystrahan sub-catchment) is classified in the latest assessment of Ireland's rivers (EPA, 2010) as being at 'Poor' status. The River Ward itself has a median Q-rating of 3 (unsatisfactory). Siltation by agriculture and urban wastewater discharges are believed to be the principal contributors to reduced water quality in the stream.

6.44 The Draft River Basin Management Plan, as prepared for as part of Ireland's obligations under the Water Framework Directive, has also reported the status of the river sub-catchment as 'poor'. In other parts of the Ward catchment, the status of sub-catchments range from 'moderate' to 'bad'.

Local Hydrology : Flows

6.45 The EPA hydrometric website indicates that there was a hydrometric station on the River Ward at Owens Bridge, approximately 4.5 km north-east of the Hunstown Quarry complex. The hydrometric station is no longer in operation. It had recorded flow from a catchment area of approximately 36 km^2, but this does not include the Ballystrahan sub-catchment (in which the application site is situated).

6.46 As part of work for the Water Framework Directive, the EPA has prepared an internet-based model for the calculation of ungauged catchments (http://watermaps.wfdireland.ie/HydroTool/), and, for a 7 km^2 area of the Ballystrahan catchment at St. Margaret's, the flows in Table 6-3 (below) have been estimated. Note that the error associated with this model can be in the region of 50%, but is an improvement on other desk-based methods.

Table 6-3
Flows Estimated for the Ballystrahan Sub-Catchment at St. Margarets

Flows equalled or exceeded for the given percentage of time (litres/sec)										
5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%
317	209	131	92	71	66	50	36	25	15	11

Discharge Consents

6.47 There are currently four monitored discharge points at and adjacent to the Huntstown Quarry complex, as shown on the schematic representation of the surface water management system presented in Figure 6-5 and described below:

- A discharge to the south (from the southern quarry and surrounding areas), into the River Tolka catchment, designated W3. This discharge is not within the catchment for the proposed inert waste recovery facility operation, and so will not be discussed further.
- A discharge from the central quarry, northwards to the Ward catchment, designated W2. This discharge mixes with discharge from the northern quarry and concrete production plant.
- A discharge from settlement ponds which receive influent groundwater and rainwater from the northern quarry and wastewaters from concrete production activities. This discharge ultimately discharge to the Ward River catchment and is designated W1. This discharge is the one of most relevance to the proposed development.
- A discharge from Huntstown Power Station, which discharges to the stream. This is designated HPW1.

Locations of surface water monitoring points are identified on Figure 6-6.

6.48 At the present time, no discharge monitoring is undertaken of the influent groundwater and rainwater from the northern quarry after it has passed out of dedicated settlement ponds to mix in settlement ponds further downstream with wastewater from concrete production activities.

6.49 It is envisaged that discharge from the dedicated settlement ponds which only accept inflows from the northern quarry will be commenced when infilling / backfilling using imported inert soil commences. It is envisaged that this discharge will be designated W4.

6.50 The quality of the two existing quarry discharges to the Ward River catchment, W1 and W2, are summarised in Table 6-4 overleaf:

Table 6-4
Average / Median Quarry Discharge Monitoring Results

	Year	Number of Samples	pH	BOD*	Suspended Solids	Temperature	Ammonia (NH4)*	Calcium	Phosphorus*	Sulphate
W1	2002	17	7.99	<2	13.9	11.3				
	2003	23	7.98	<2	9.4	10.9	<0.1	122	<0.05	161
	2004	21	8.08	<2	12.0	11.5	<0.1	140	<0.05	193
	2005	13	8.04	<2	16.9	10.8	<0.1	137	<0.05	213
	2006	11	8.01	<2	12.1	12.0	<0.1	152	<0.05	214
	2007	11	8.04	<2	20.5	12.8	<0.1	180	<0.05	235
	2008	12	7.97	<2	18.0	10.3	<0.1	160	<0.05	248
	2009	11	7.75	<2	17.9	11.7	<0.1	146	<0.05	236
W2	2003	38	8.15	<2	11.2	10.8	<0.1	160	<0.05	171
	2004	36	8.16	<2	13.2	11.2	<0.1	147	<0.05	160
	2005	25	8.12	<2	16.0	10.3	<0.1	152	<0.05	136
	2006	24	8.17	<2	30.3†	12.4	<0.1	149	<0.05	129
	2007	23	8.22	<2	16.2	14.2	<0.1	162	<0.05	142
	2008	24	8.07	<2	27.9†	13.4	<0.1	131	<0.05	148
	2009	13	7.84	<2	28.2	13.3	<0.1	142	<0.05	168

All values are in mg/l except for pH, which is in pH units
* - Median Values, since most values were below the detection limit
† - outlier values of 534 mg/l and 1200 mg/l were omitted from 2006 and 2008 data, respectively, for suspended solids

6.51 It can be seen that the discharge monitoring results are, on average, of acceptable quality. Monitoring of existing discharges from the Huntstown quarry complex is continuing, and will be augmented with at least one additional monitoring location in the future. The additional monitoring point, W4, will provide a representative value for the quality of water collected and discharged from the North Quarry during the infilling operation.

6.52 In the interim, water quality at both the central and northern quarry sumps has been monitored. The results are presented in Table 6-5 overleaf, along with the discharge licence limits for the North Quarry:

Table 6-5
Discharge Estimates and Measurements at W1 (Northern Quarry)

	Central Sump	Northern Sump	SW01	Discharge Limits
Temperature	13.9	16.4	15.2	25
pH	7.04	7.11	6.96	6 – 9
Conductivity	227	329	459	-
Sodium	12.56	20.54	31.2	-
Potassium	1.21	4.89	3.12	-
Calcium	54.3	102.4	80.4	-
Magnesium	0.95	3.25	2.45	-
Chloride	24.7	30.21	56.74	-
Sulphate	8.16	19.27	20.4	-
Total Alkalinity	151	209	210	-
Total Hardness	330	430	424	-
Nitrate	4.66	3.27	11.24	-
Nitrite	0.05	<0.05	<0.05	-
Ammoniacal Nitrogen	0.04	0.02	0.01	1
Iron	<0.001	0.016	<0.001	-
Manganese	<0.001	0.002	<0.001	-
Orthophosphate	0.07	0.04	0.08	-
BOD	2	1	1	20
DRO	<0.01	<0.01	<0.01	-
Mineral Oil	<0.01	<0.01	<0.01	-
Suspended Solids	N/T	N/T	N/T	30

Note: Suspended solids were not analysed as tested samples were grab analyses from the top of the sump, (and are not therefore representative of pumped water).

6.53 The flows from the North Quarry are not monitored at present, but estimations have been made at several stages in the history of the quarry, and a flow measurement was made for the purposes of this project. Flow estimates and/or measurements at W1 are indicated on Table 6-6 below:

Table 6-6
Discharge Estimates and Measurements at W1 (Northern Quarry)

	Discharge amount (m^3/day)
1999 Average Estimate	1,870
2003 Average Estimate (half of maximum estimate)	3,710
2009 Average Estimate	2,600
2010 Measurement (February)	1,470

6.54 In recent years, it has been observed that groundwater inflow at the northern quarry has reduced as development of the southern quarry has expanded and deepened below the level of the northern quarry.

6.55 The monitoring of discharge from Huntstown Power Station is regulated by the EPA under IPPC licence P0777-01. The average discharge parameters are indicated in Table 6-7 below:

Table 6.7
Average Power Station Discharge Monitoring Results (HPW1)

Parameter	Unit	Average Value	Licence Limit
Discharge volume	m^3/day	99.96	600
Total Suspended Solids	mg/l	11.32	30
Nitrate	mg/l NO_3	2.62	-
BOD	mg/l	1.01	20
COD	mg/l	10.31	50
Total Dissolved Solids	mg/l	784.5	2000
Total Nitrogen	mg/l N	1.49	-
Total Phosphorus	mg/l P	0.028	0.1
Ammonia	mg/l NH_3	0.16	1.5

6.56 It can be seen that the flow quantities from the power station average <3% to 7% of the total quarry related flow. Flows from the power station contribute to a marginal increase in ammonia, but are within licence limits.

Flooding

6.57 The Office of Public Works website (www.floodmaps.ie) indicates that there is a record of one historic flood event in the vicinity of Huntstown, at Kilshane Cross in November 2002. This flood was attributed to 'runoff from adjacent grasslands', and was not related to quarrying activities at Huntstown.

6.58 Surface water run-off and discharges at the Huntstown Quarry complex are managed on a continual basis so that they do not increase the risk of flooding in the surrounding area.

Field Surveys

6.59 Site visits and inspections of the North Quarry and application site were undertaken by an SLR senior hydrogeologist during 2010 at the time groundwater wells were being installed in July 2010. The key objective of these site visits was to assess the existing hydrological and hydrogeological environment and establish existing surface water management activities.

6.60 On several site visits, groundwater inflows into the quarry were observed from fractures in the quarry faces.

Limitations

6.61 The assessment of the hydrological and hydrogeological environment presented above is based on visual observations from site visits, available monitoring records, published information and discussions with personnel employed on site. It should be viewed as a largely qualitative assessment.

IMPACT OF THE PROPOSED WASTE FACILITY

Evaluation Methodology

6.62 The impacts of the proposed inert waste recovery facility on the local surface water and groundwater environment are assessed in this section. The methodology applied here 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.

6.63 The assessment of risk is based on the matrix outlined in Table 6-8 below.

Table 6-8
Matrix Used to Assess Potential Impacts

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

6.64 The assessment of likely magnitude of potential impacts in relation to hydrogeology and hydrology is assessed in accordance with criteria detailed in Table 6.9 overleaf:

Table 6-9

Magnitude of Potential Hydrological and Hydrogeological Impacts

Magnitude	Potential Impact
Negligible	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	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 of surface runoff and groundwater. .
Moderate	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	Wholesale changes to watercourse channel, route, hydrology or hydrodynamics; Changes to site resulting in an increase in runoff with flood potential Significant changes to erosion and sedimentation patterns; and Major changes to the water chemistry or hydro-ecology.

6.65 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 impacts will be cumulative.

6.66 The following sections identify the potential impacts of the proposed development on the hydrogeological and hydrological environments. It also assesses the likelihood of occurrence of each identified impact in accordance with Tables 6-8 and 6-9. It should be noted that the impacts are initially assessed with no mitigation or design measures incorporated to reduce the risk.

Potential Impacts on Groundwater

6.67 The proposed inert waste recovery facility has the potential to impact on groundwater in terms of both the groundwater quality and the groundwater flow regime. The potential impacts are considered qualitatively below:

Groundwater Quality

6.68 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 during placement of inert fill and other operational procedures;

- increase in suspended solids and potential for contaminated runoff entering groundwater during development of the site; and
- deposition of rogue loads of contaminated material at the site.

6.69 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 use the site. The magnitude of such an impact would be '**moderate**'. Therefore, the overall risk to groundwater, without mitigation, is '***medium***'.

6.70 It is considered that without mitigation the probability of occurrence of contaminated run-off entering groundwater during operation of the facility is '***medium***' to '***high***' due to the time frame over which this may occur.

6.71 There is low risk of excessive suspended solids impacting groundwater quality as mobilisation and transport of suspended solids requires a flow velocity greater than that usually achievable in the groundwater environment. The magnitude of impact is '***mild***' and therefore the overall risk is '***low***' to '***medium***'.

6.72 Without mitigation, the probability of occurrence of a rogue load which may have the potential to contaminate groundwater at the site is '**medium**'. 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 / Recharge

6.73 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. The probability of occurrence is '**moderate**'.

6.74 The available baseline information indicates that

(a) pumping from existing sumps at the floor of the quarry reduces groundwater throughput and diverts much of the existing groundwater recharge to surface water.

(b) it is likely that some rain falling over the backfilled quarry during and after backfilling operations will infiltrate as groundwater recharge and that the remainder will run-off over the restored landform to drainage channels feeding to the tributary of the Ward River

(c) the regional permeability of the unsaturated zone of the aquifer at Huntstown is moderately high, which will maintain regional groundwater flow direction around and beneath the backfilled quarry and

(d) the reduction in, and ultimate cessation, of dewatering around the North Quarry as backfilling works progress will effect a local rise in groundwater level and contribute to increased flow around or beneath the quarry (though both level and flow would still be influenced by continued dewatering of the South Quarry).

6.75 It is considered that the net effect of any change to groundwater flow and recharge caused by a low permeability zone at the North Quarry will be at least, if not fully, offset by a reduction in dewatering activities. The magnitude of the

impact is therefore assessed as '**mild**' and the overall impact is considered to be '**low**'.

Potential Impacts on Surface Water

6.76 There are several permanent surface water features within the Huntstown Quarry complex including natural or modified watercourses and artificial features such as ditches, temporary channels, sumps and/or settlement ponds required for surface water management. It is considered that there is a potential short to medium-term impact that backfilling of the quarry void could result in waters contaminated with elevated suspended solids being discharged to existing watercourses. The probability of such an event occurring is considered to be '**medium**' to '**high**' and the magnitude of impact is '**moderate**'. The overall impact on surface waters is therefore assessed as '***medium***' to '***high***' if mitigation measures were not in place.

6.77 In the longer term, it is likely that much of the run-off from the completed landform will generally recharge to ground within the application site or run-off over the completed landform to the watercourse on the eastern side of the proposed recovery facility. The surface water run-off could potentially carry some suspended solids toward the watercourse beyond the northern site boundary. The probability of such an event occurring is considered to be '**medium**' to '**high**' and the magnitude of impact is '**moderate**'. The overall impact on surface waters is therefore assessed as '***medium***' to '***high***' if mitigation measures were not in place.

6.78 It is considered that the potential impact on surface water flow quantities arising from the operation of the proposed waste recovery facility are negligible and, as such, it is not considered further.

Summary of Potential Impacts

6.79 A summary of potential impacts *without mitigation* is presented in Table 6-10 below:

Table 6-10

Summary of Unmitigated Risk and Magnitude of Potential Impacts at Huntstown

Potential Impact	Spatial Impact, Duration, Direct/Indirect	Probability of Occurrence	Magnitude of Impact	Significance of Impact	Mitigation Required?
Groundwater Quality					
Spillages of fuel	Local, Short Term, Direct	Medium	Moderate	Medium	Yes
Release of suspended solids	Local, Short-Term, Direct	Medium to high	Mild	Low to medium	Yes
Rogue load of contaminated material	Local, Short Term, Direct	Medium	Mild to Moderate	Low to Medium	Yes
Groundwater Flow / Recharge to Aquifer					
Impermeable barrier to groundwater flow	Local, Long Term, Direct	Medium	Mild	Low	No
Reduction in recharge to aquifer	Local, Long Term and Direct	Medium	Mild	Low	No
Surface Water Quality					
Release of suspended solids	Local, Short and Long Term, Direct	Medium to High	Moderate	Medium to High	Yes

6.80 Table 6-10 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 aquifer by locally polluting groundwater and creating a low permeability zone to groundwater flow. The impacts are local to regional, and range from short-term to long-term. 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.

6.81 Similarly, in the absence of an effective surface water management system, the quarry backfilling operation at the site has the potential to cause detrimental and direct impacts to the existing watercourse flowing northwards toward the Ward River.

6.82 It is therefore recommended that the mitigation measures outlined in the following section are incorporated into the development proposal to reduce the potential impacts.

Do-Nothing Scenario

6.83 The site is currently a large void, and actively dewatered. Planning conditions preclude the restoration of the site through water-table rebound and the creation of a man-made lake. Open water bodies attract bird populations that would pose a risk to air traffic at the adjacent Dublin Airport. To do nothing with the existing site would therefore result in only a limited natural colonisation and re-vegetation of slopes, and would require dewatering in perpetuity. The worked-out quarry would remain a significant visual intrusion, and the range of future land-uses for the site would remain severely restricted. Ongoing vigilance would also be required to ensure no potential contaminating activities occur on or in the vicinity of the quarry floor.

Interactions

6.84 It is considered that the groundwater and surface water at Huntstown are not interconnected at the present time (while dewatering continues), and that the local tributary of the Ward River is not in continuity with regional groundwater at the application site.

6.85 There are currently surface water discharges from the site and these will be maintained during the backfilling of the quarry void as required.

MITIGATION MEASURES

6.86 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.

Proposed Mitigation Measures

6.87 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 at a surfaced area from a fuel tank(s) that is bunded or from a mobile double skinned fuel bowser in order to minimise the risk of uncontrolled release of polluting liquids / liquors;

- maintenance of plant and machinery would be undertaken within existing site maintenance sheds 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 (see Appendix 6-3 for details of spill kit);
- any 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.

6.88 These measures would reduce the potential impact of

- spillage of fuels and lubricants from '*medium*' to '*low*',
- an increase in suspended solids from '*medium to high*' to '*low*' and
- contamination from rogue loads from '*medium to low*' to '*low*'.

Monitoring

6.92 A number of measures are proposed in order to monitor any potential impact of the proposed inert waste recovery operations on groundwater or surface water.

Groundwater Monitoring

6.93 At the present time, it is envisaged that groundwater sampling and testing will be undertaken on a bi-annual basis at the 6 No. groundwater monitoring wells installed around the Huntstown Quarry complex. Groundwater levels in the wells will be recorded on a quarterly basis. The existing groundwater monitoring well locations at the Huntstown Quarry complex are shown on Figure 6-6.

6.94 Groundwater samples will be tested for a range of physical and chemical parameters in order to assess water quality and detect possible contamination at the site. The groundwater quality in the monitoring wells will be tested for the following parameters:

- Conductivity
- pH value
- Total Coliforms cfu/100mls
- Ammonia mg/l NH_3-N
- Nitrate mg/l NO_3
- Nitrite mg/l
- Ortho Phosphate / Ortho Phosphate mg/l as P
- TPH mg/l
- PRO mg/l
- DRO mg/l

6.95 It is currently envisaged that the existing groundwater monitoring regime will remain in place for the duration of the quarry backfilling and restoration works. Groundwater sampling and monitoring will continue as long as backfilling activities continue and for a short period thereafter.

Surface Water Monitoring

6.96 Surface water at the site is currently tested for a range of physical and chemical parameters in order to assess water quality and detect possible contamination at the site.

6.97 It is envisaged that surface water sampling and testing will be undertaken on a bi-annual basis (i.e. six monthly) basis at any temporary surface water features which may either be created or form naturally at low points within the application site.

6.98 Surface water sampling and chemical testing will also be undertaken at the discharge from the settlement ponds which receive influent groundwater and rainwater from the North Quarry and at the discharge to the tributary stream of the Ward River. The proposed surface water monitoring locations across the Huntstown Quarry complex are shown on Figure 6-6.

6.99 Surface water samples will be tested for a wide range of physical and chemical parameters in order to assess water quality and detect possible contamination at the site. The test parameters will be as for groundwater, with the following additional parameters:

- BOD mg/l
- COD mg/l
- Suspended Solids mg/l

6.100 It is currently envisaged that the surface water monitoring regime will remain in place for the duration of the quarry backfilling and restoration works and for a short period thereafter.

RESIDUAL IMPACTS

6.101 A summary of the proposed mitigation methods, together with the predicted effects and residual impacts is presented in Table 6-11 overleaf.

6.102 Examination of Table 6-11 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 waste 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.

Table 6-.11

Summary of Mitigation and Residual Impacts at Huntstown

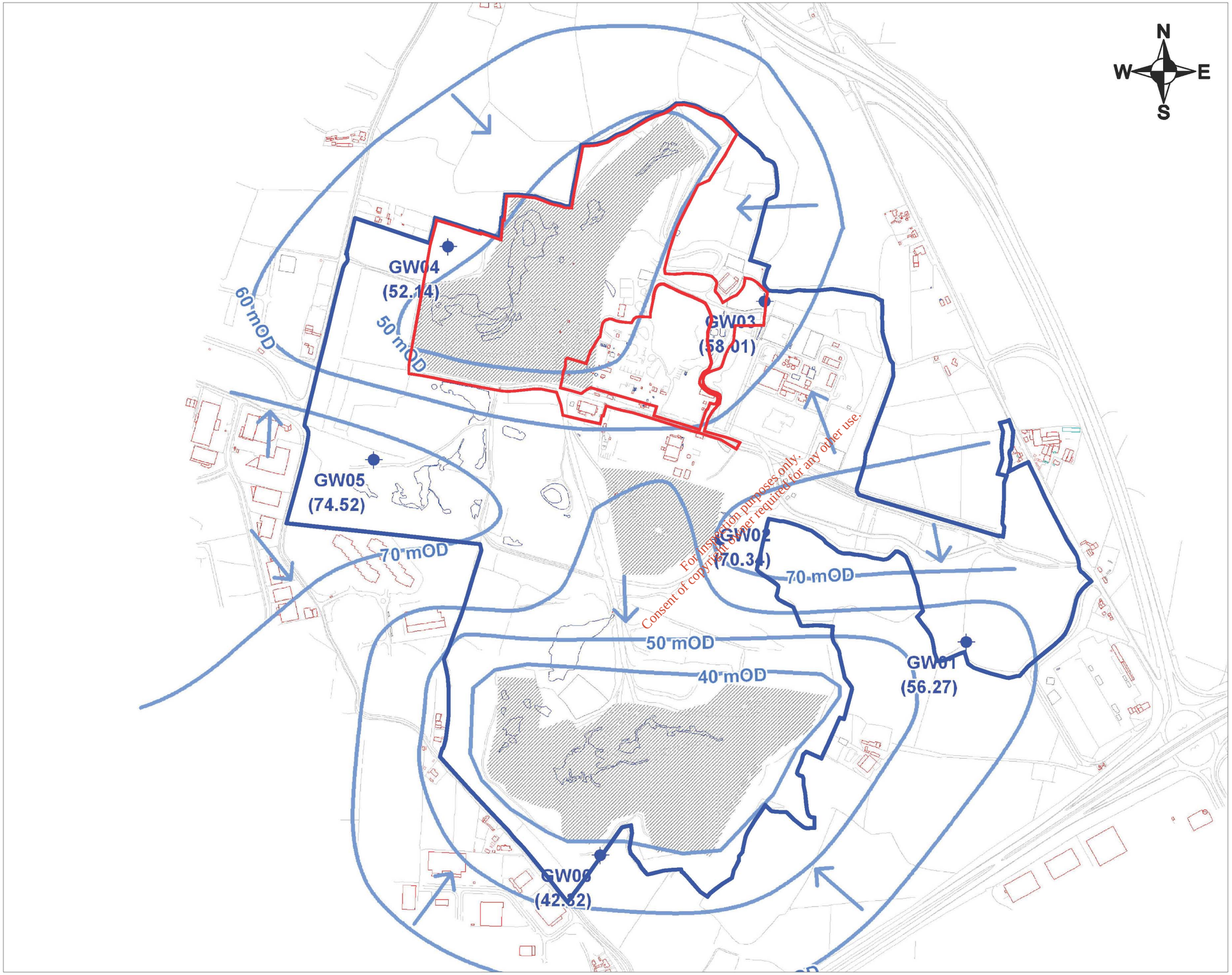
Potential Impact	Spatial Impact, Duration, Direct/Indirect	Probability of Occurrence	Magnitude of Impact	Significance of Impact	Mitigation Required?	Mitigation Measures	Mitigated Probability of Occurrence	Mitigated Magnitude of Impact	Residual Magnitude of Impact
Groundwater Quality									
Spillages 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	Mild	Low to Medium	Yes	Minimisation, management, and waste deposition measures	Low	Mild	Low
Rogue load of contaminated material	Local, Short Term, Direct	Medium	Mild to Moderate	Low to Medium	Yes	Inspection and testing of waste loads	Low	Mild to Moderate	Low
Groundwater Flow / Recharge to Aquifer									
Impermeable barrier to groundwater flow	Local, Long Term, Direct	Medium	Mild	Low	No				
Reduction in recharge to aquifer	Local, Long Term and Direct	Medium	Mild	Low	No				
Surface Water Quality									
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

CONCLUSIONS

6.103 The groundwater and surface water regimes at the application site have been assessed with reference to information held by the Geological Survey of Ireland, the Environmental Protection Agency and others. This information has been supplemented with site specific investigation information.

6.104 The potential impacts of the proposed development upon hydrogeological and hydrological environment have been identified and assessed, and where appropriate, mitigation measures have been incorporated into the design of the development.

FIGURES



LEGEND

- ROADSTONE WOOD LTD. LANDHOLDING (c. 201.8 ha)
- **WASTE LICENCE APPLICATIC AREA (c. 35.9 ha)**
- Quarried Areas
- Monitoring Wells (Groundwater Elevation on 05 Aug 10)
- Groundwater Flow Direction
- Contours of Equal Groundwater Elevation

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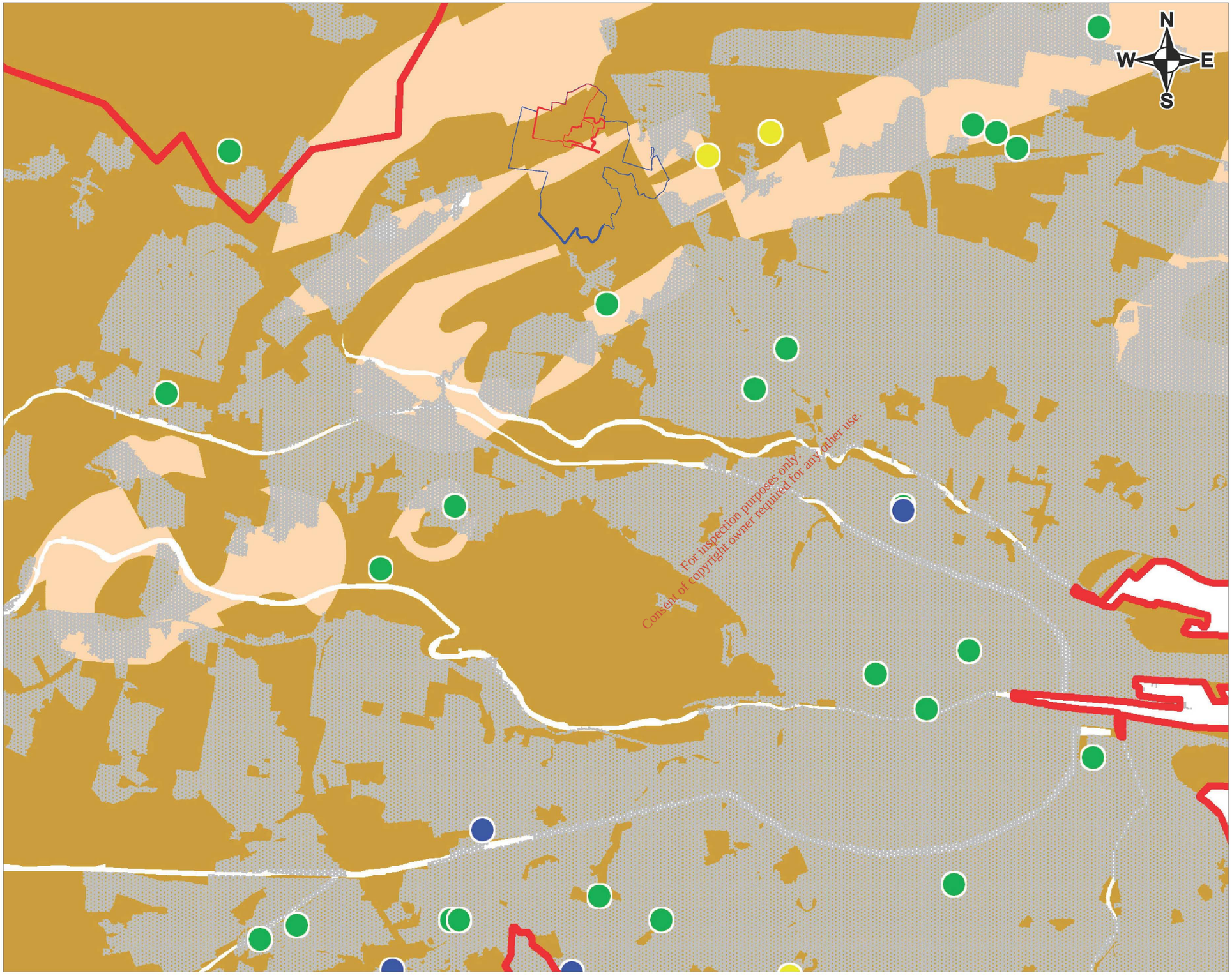
GROUNDWATER CONTOURS

FIGURE 6-1

Scale: 1:1,000

Date: FEBRUARY 2011

00180.00015.18.6-1.RD.GROUNDWATER CONTOUR8.dwg



LEGEND

ROADSTONE WOOD LTD. LANDHOLDING (c. 201.8 ha)

WASTE LICENCE APPLICAT AREA (c. 35.9 ha)

LEGEND
GSI Aquifer Classification - Importance

- LI: Local - Locally productive
- Pl: Poor- Unproductive except local zor
- Pu: Poor - Generally unproductive
- Urban Areas
- Groundwater Body Boundary
- Site Boundary

GSI Well Yields
(cu. m/day)

- 0 to 40
- 40 to 100
- 100 to 400
- 400 +

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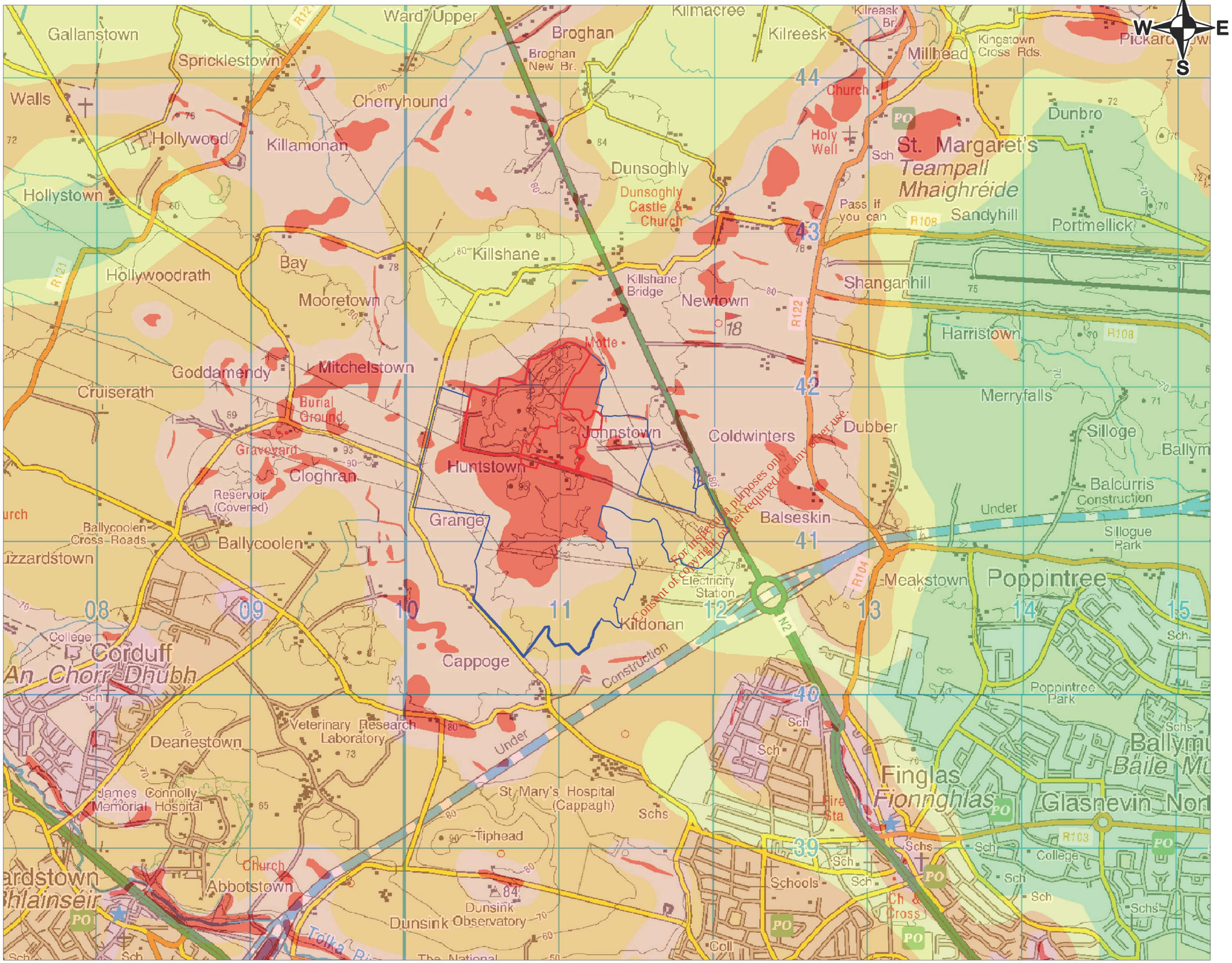
BEDROCK AQUIFER MAP

FIGURE 6-2

Scale: 1:50,000

Date: FEBRUARY 2011

00160.00015.18.6-2.R0.BEDROCK AQUIFER MAP.dwg



0 800m 2000

Metres
1:25,000

LEGEND

- ROADSTONE WOOD LTD. LANDHOLDING (c. 211 ha)
- WASTE LICENCE APPLICATI AREA (c. 35.9 ha)
- EXTREME (ROCK AT OR CL TO SURFACE)
- EXTREME
- HIGH
- MODERATE
- LOW

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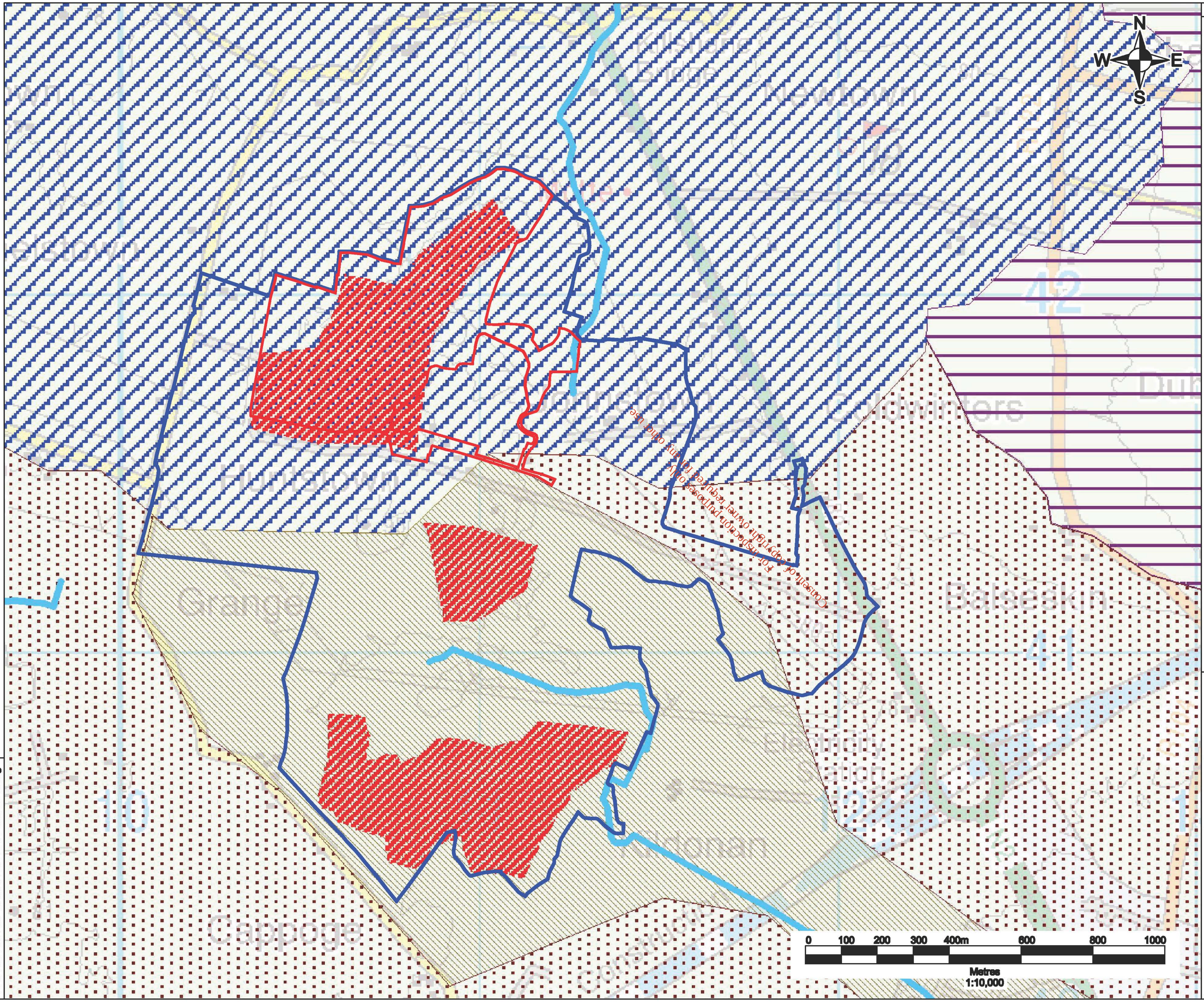
AQUIFER VULNERABILITY MAP

FIGURE 6-3

Scale	Date
1:25,000	FEBRUARY 2011

00160.00016.18.6-3.RO.AQUIFER VULNERABILITY MAP.dwg



LEGEND

ROADSTONE WOOD LTD. LANDHOLDING (c. 201.8 ha)

WASTE LICENCE APPLICAT AREA (c. 35.9 ha)

Active Areas

Catchments

Finglas Stream Subcatchment

Tolka River Catchment

Ward River Catchment

Mayne Stream Catchment

Santry Stream Catchment

Watercourses

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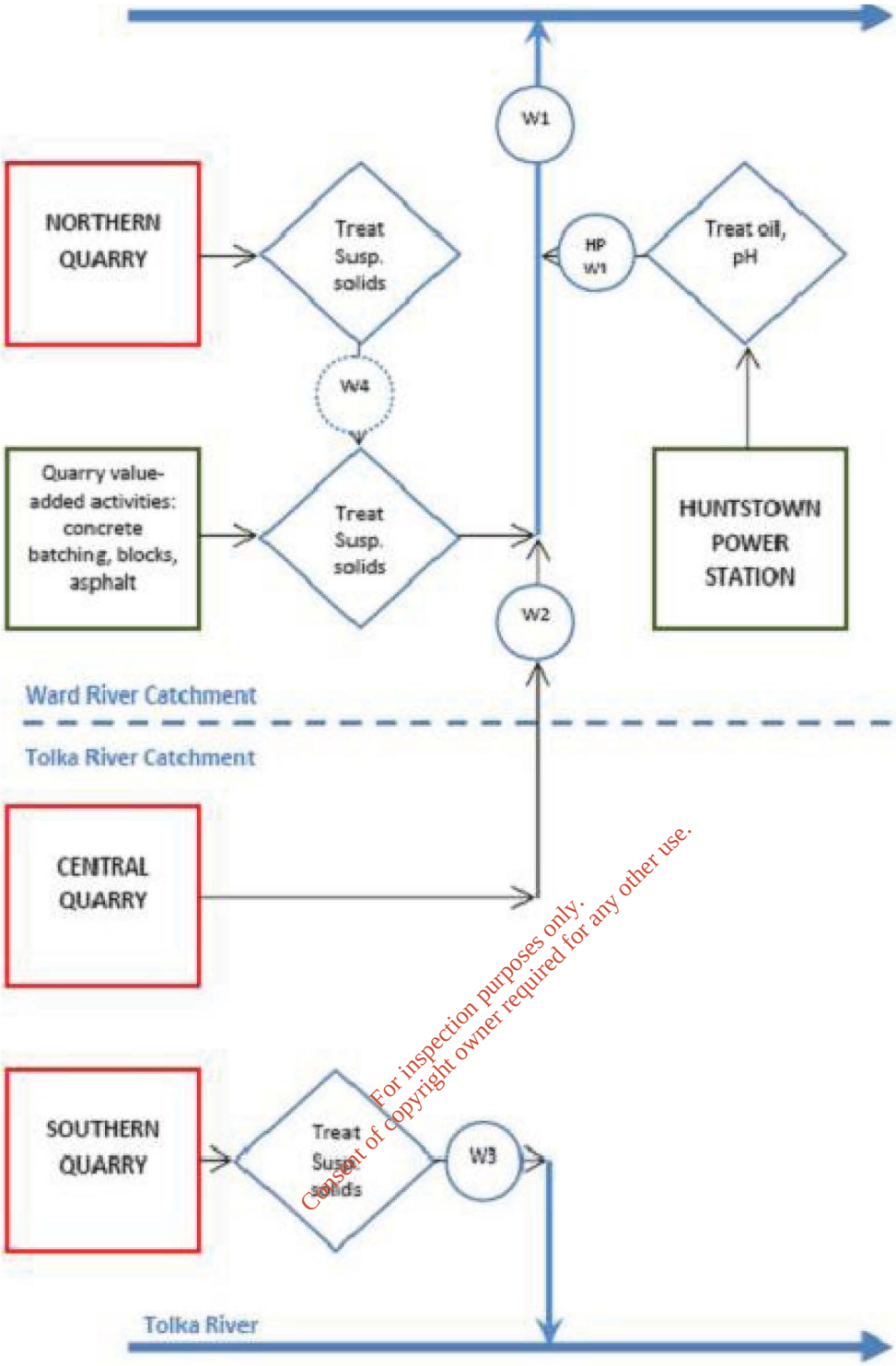
RIVER CATCHMENTS MAP

FIGURE 6-4

Scale 1:10,000 | Date February 2011

00180.00015.18.6-4.R0.RIVER CATCHMENTS.dwg



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ENVIRONMENTAL IMPACT STATEMENT

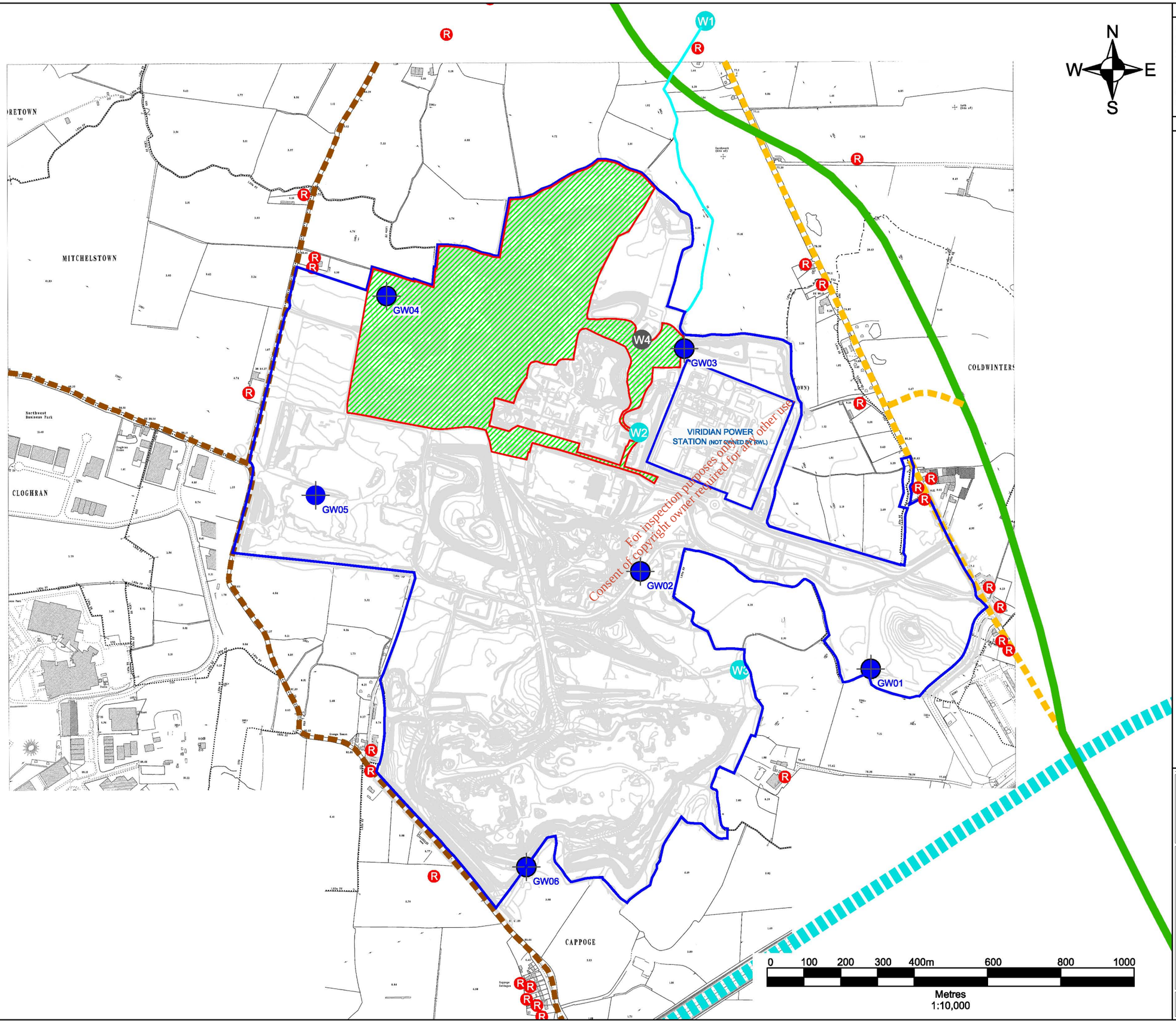
WASTE RECOVERY FACILITY,
HUNTSTOWN QUARRY,
NORTH ROAD, FINGLAS, DUBLIN 11

SURFACE WATER MANAGEMENT SYSTEM

FIGURE 6-5

Scale	Date
NOT TO SCALE	FEBRUARY 2011

00160.00016.18.6-5.R0.SURFACE WATER MANAGEMENT SYSTEM.dwg



NOTES

1. EXTRACT FROM 1:2,500 ORDNANCE SURVEY DIGITAL SHEET NO'S. 3062-A, 3062-B, 3062-C, 3062-D, 3063-A, 3063-C, 3130-A & 3130-B

2. ORDNANCE SURVEY IRELAND LICENCE NO. SU 0000711 (C) ORDNANCE SURVEY & GOVERNMENT OF IRELAND

LEGEND

- ROADSTONE WOOD LTD. LANDHOLDING (c. 201.8 ha)
- WASTE LICENCE APPLICATION AREA (c. 35.9 ha)
- N2 DUAL CARRIAGEWAY
- NORTH ROAD (R135)
- LOCAL ROAD
- M50 MOTORWAY
- LOCATION OF NEAREST RESIDENCES
- GROUNDWATER MONITORING WELL LOCATION
- SURFACE WATER MONITORING LOCATION
- PROPOSED SURFACE WATER MONITORING LOCATION

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ENVIRONMENTAL IMPACT STATEMENT

WASTE RECOVERY FACILITY,
HUNTSTOWN QUARRY,
NORTH ROAD, FINGLAS, DUBLIN 11

WATER MONITORING MAP

FIGURE 6-6

Scale: 1:10,000 @ A3

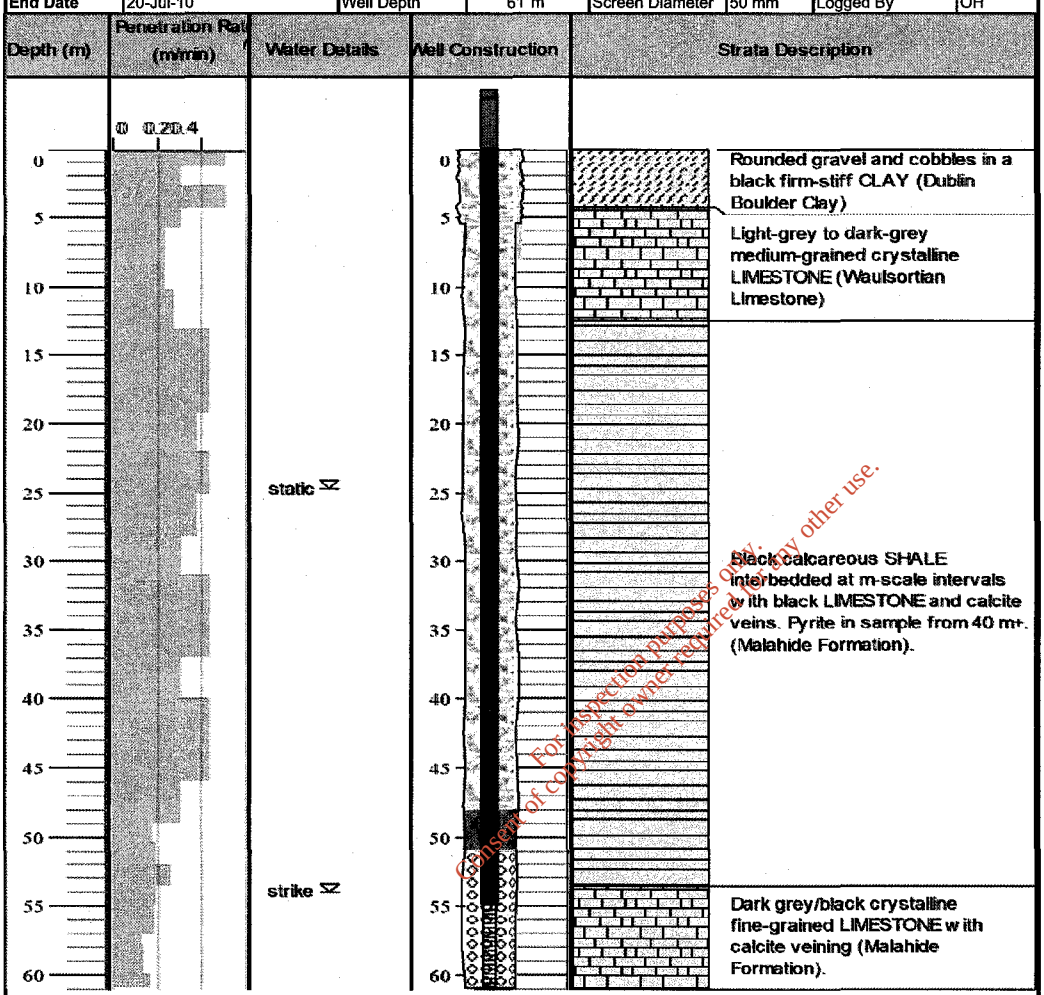
Date: FEBRUARY 2011

00180.00015.18.6-6.R0.WATER MONITORING MAP.dwg

APPENDICES

Appendix 6-1
Groundwater Well Construction Records

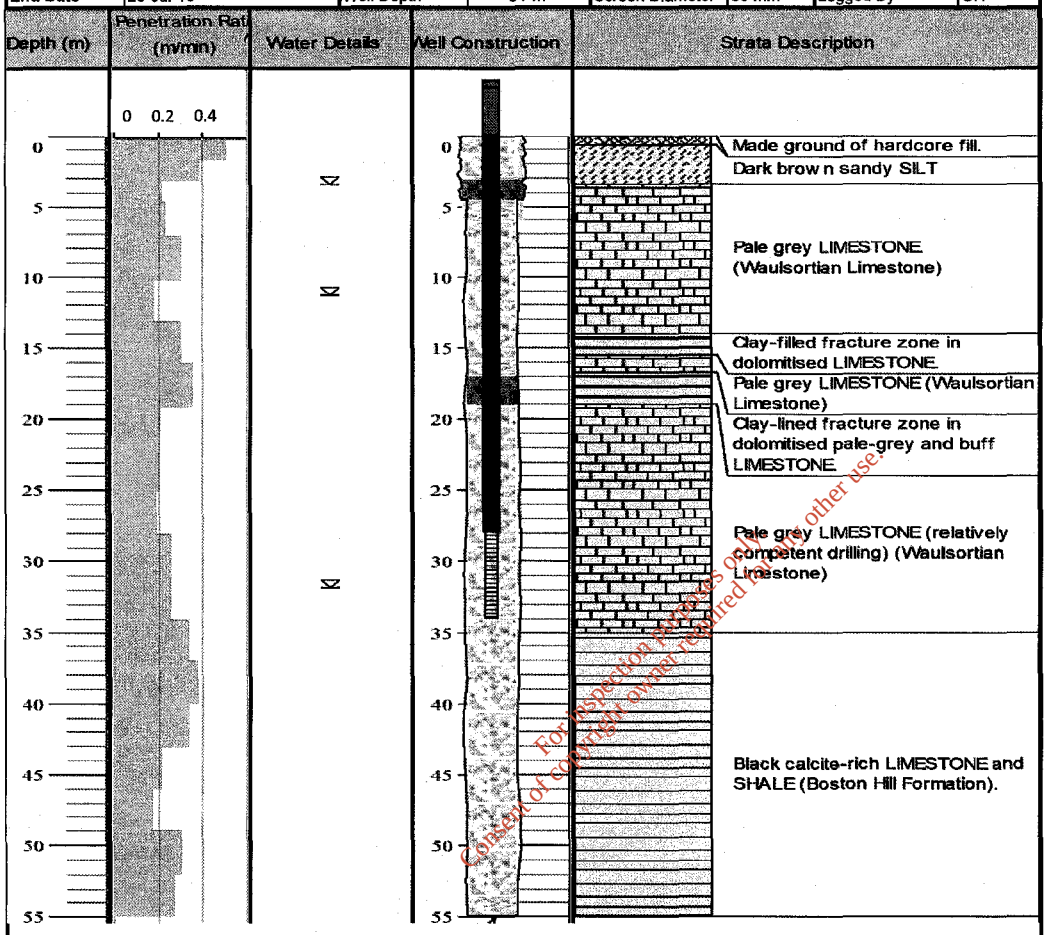
Project Name	Huntstown Quarry PA	**WELL LOG**		SLR Consulting (Ireland) Ltd.			
Client	Roadstone Wood Ltd.	Well Name	GW01	7 Dundrum Business Park			
Project No.	501.0180.00011			Windy Arbour			
Location	Huntstown, County Dublin	Easting	311785.7	Dublin 14			
Contractor	Petersen Drilling Services	Northing	240902.1	T: 01 2964667 F: 01 2964676			
Drill Rig	Knebel	Elevation (gl)	80.98 mOD	Casing Length	55 m	Hole ID	170 mm
Drill Method	Symmetrix and DTH Air	Elevation (TOC)	81.74 mOD	Casing Diameter	50 mm	Static Level	24.7 mbgl
Start Date	17-Jul-10	Boring Depth	61 m	Screen Length	6 m	Depth to Bedrock	4.3 mbgl
End Date	20-Jul-10	Well Depth	61 m	Screen Diameter	50 mm	Logged By	OH



Drilling Diameters			**Steel Support Casings**			Driller Yield Estimate:
Diameter	From	To	Diameter	From	To	Development Time:
0.17	0	5.5				
0.14	5.5	61				

Other Remarks:

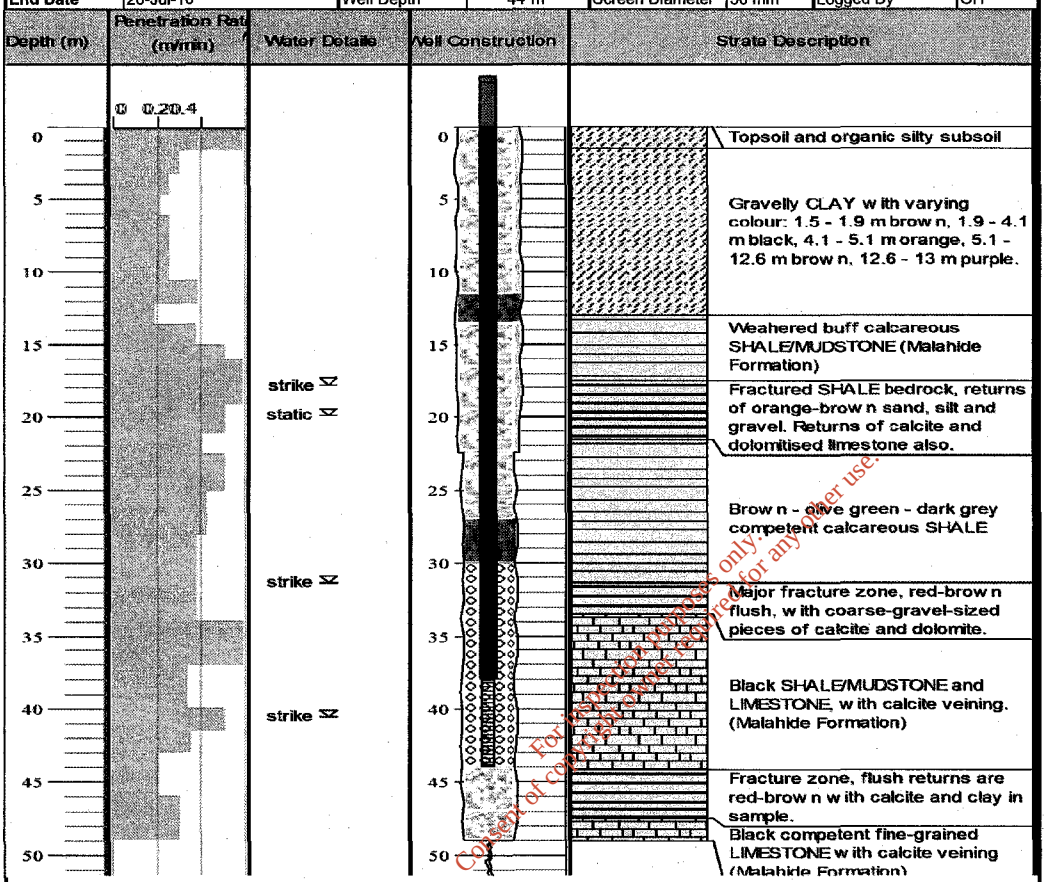
Project Name	Huntstown Quarry PA	**WELL LOG**		SLR Consulting (Ireland) Ltd.			
Client	Roadstone Wood Ltd.	Well Name	GW02	7 Dundrum Business Park			
Project No.	501.0180.00011			Windy Arbour			
Location	Huntstown, County Dublin	Easting	311158.0	Dublin 14			
Contractor	Petersen Drilling Services	Northing	241167.5	T: 01 2964667 F: 01 2964676			
Drill Rig	Knebel	Elevation (gl)	81.51 mOD	Casing Length	28 m	Hole ID	170 mm
Drill Method	Symmetrix and DTH Air	Elevation (TOC)	82.33 mOD	Casing Diameter	50 mm	Static Level	11.2mbgl
Start Date	17-Jul-10	Boring Depth	55 m	Screen Length	6 m	Depth to Bedrock	3.4 mbgl
End Date	20-Jul-10	Well Depth	34 m	Screen Diameter	50 mm	Logged By	OH



Drilling Diameters			**Steel Support Casings**			Driller Yield Estimate:
Diameter	From	To	Diameter	From	To	Development Time:
0.17	0	4.5				
0.14	4.5	55				

Other Remarks:

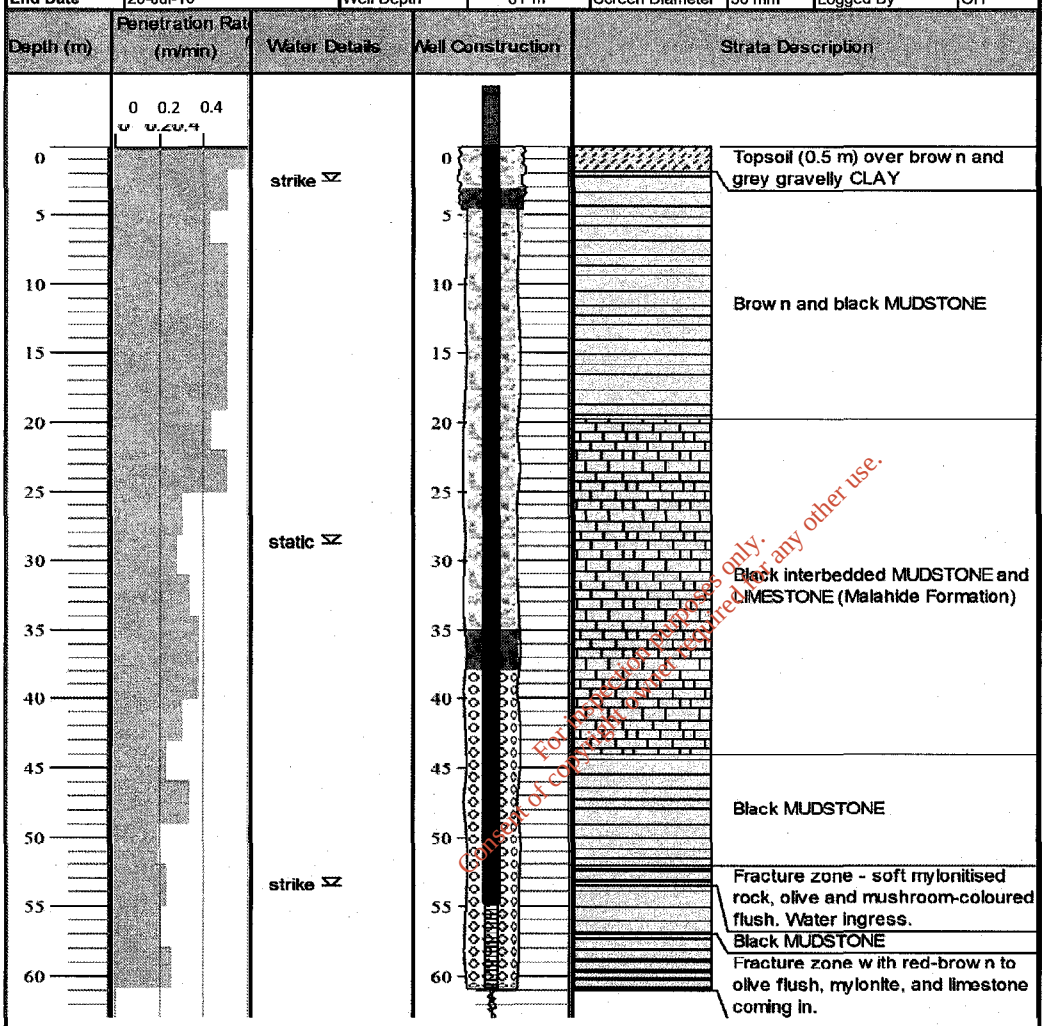
Project Name	Huntstown Quarry PA	**WELL LOG**		SLR Consulting (Ireland) Ltd.			
Client	Roadstone Wood Ltd.	Well Name	GW03	7 Dundrum Business Park			
Project No.	501.0180.00011			Windy Arbour			
Location	Huntstown, County Dublin	Easting	311274.1	Dublin 14			
Contractor	Petersen Drilling Services	Northing	241775.0	T: 01 2964667 F: 01 2964676			
Drill Rig	Knebel	Elevation (gl)	77.94 mOD	Casing Length	38 m	Hole ID	170 mm
Drill Method	Symmetrix and DTH Air	Elevation (TOC)	78.47 mOD	Casing Diameter	50 mm	Static Level	19.9 mbgl
Start Date	17-Jul-10	Boring Depth	49 m	Screen Length	6 m	Depth to Bedrock	13 mbgl
End Date	20-Jul-10	Well Depth	44 m	Screen Diameter	50 mm	Logged By	OH



Drilling Diameters			**Steel Support Casings**			Driller Yield Estimate:
Diameter	From	To	Diameter	From	To	Development Time:
0.17	0	22.5				
0.14	22.5	49				

Other Remarks:

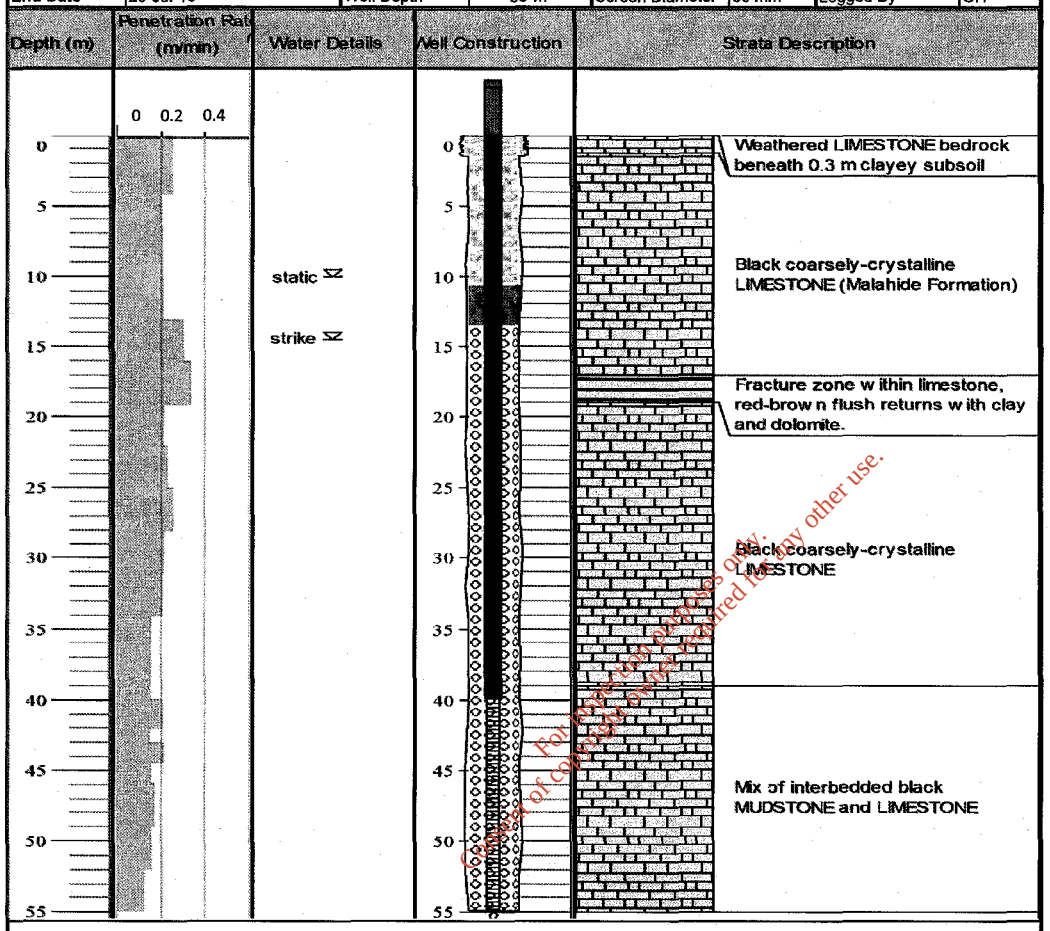
Project Name	Huntstown Quarry PA	**WELL LOG**		SLR Consulting (Ireland) Ltd.			
Client	Roadstone Wood Ltd.	Well Name	GW04	7 Dundrum Business Park			
Project No.	501.0180.00011			Windy Arbour			
Location	Huntstown, County Dublin	Easting	310466.2	Dublin 14			
Contractor	Petersen Drilling Services	Northing	241917.7	T: 01 2964667 F: 01 2964676			
Drill Rig	Knebel	Elevation (gl)	81.21 mOD	Casing Length	55 m	Hole ID	170 mm
Drill Method	Symmetrix and DTH Air	Elevation (TOC)	81.73 mOD	Casing Diameter	50 mm	Static Water Level	28.7 mbgl
Start Date	17-Jul-10	Boring Depth	61 m	Screen Length	6 m	Depth to Bedrock	1.9 mbgl
End Date	20-Jul-10	Well Depth	61 m	Screen Diameter	50 mm	Logged By	OH



Drilling Diameters			**Steel Support Casings**			Driller Yield Estimate:
Diameter	From	To	Diameter	From	To	Development Time:
0.17	0	4.5				
0.14	4.5	61				

Other Remarks:

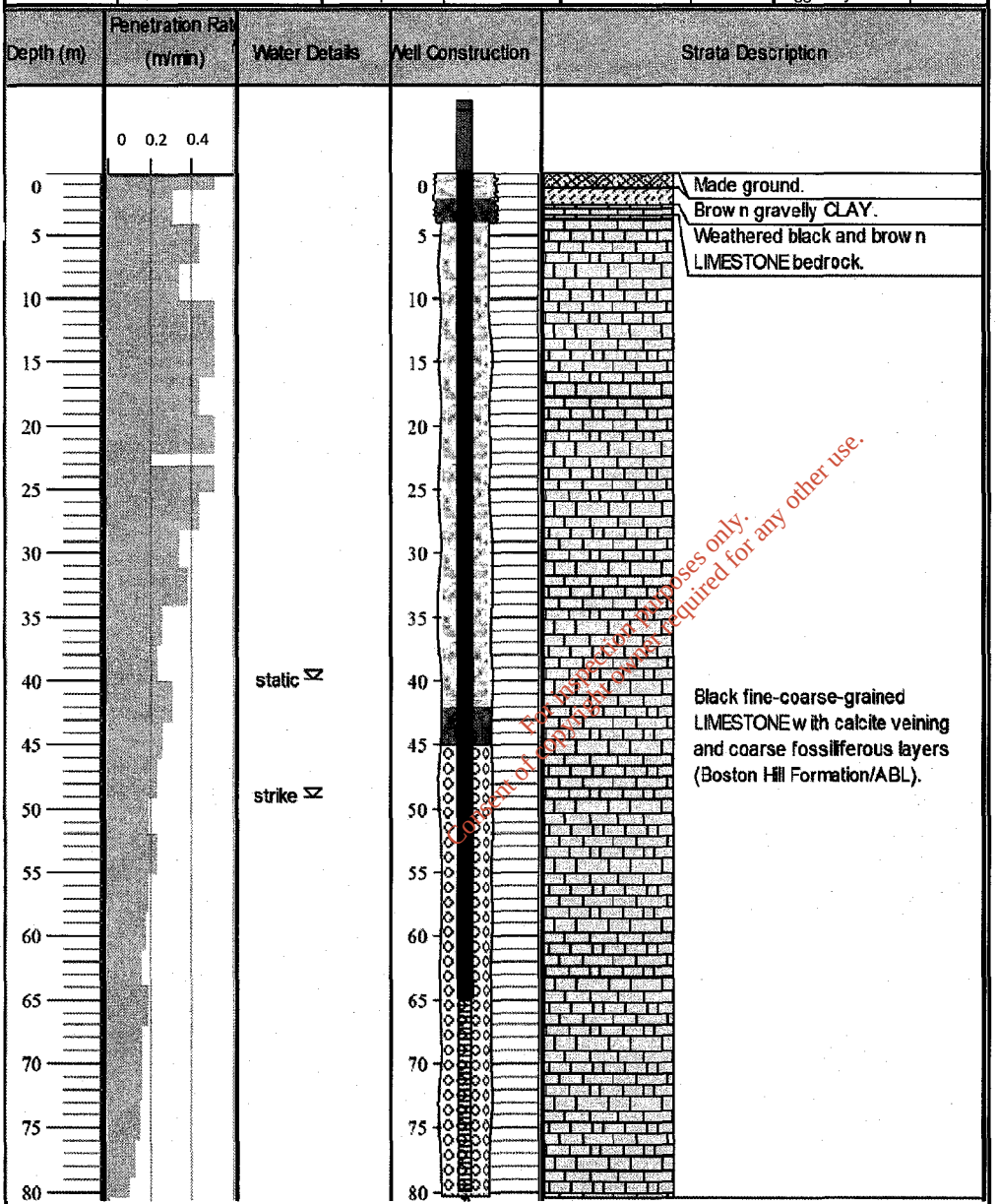
Project Name	Huntstown Quarry PA	**WELL LOG**		SLR Consulting (Ireland) Ltd.			
Client	Roadstone Wood Ltd	Well Name	GW05	7 Dundrum Business Park			
Project No.	501.0180.00011			Windy Arbour			
Location	Huntstown, County Dublin	Easting	310273.0	Dublin 14			
Contractor	Petersen Drilling Services	Northing	241374.9	T: 01 2964667 F: 01 2964676			
Drill Rig	Knebel	Elevation (gl)	84.95 mOD	Casing Length	40 m	Hole ID	170 mm
Drill Method	Symmetrix and DTH Air	Elevation (TOC)	85.33 mOD	Casing Diameter	50 mm	Static Level	10 mbgl
Start Date	17-Jul-10	Boring Depth	55 m	Screen Length	15 m	Depth to Bedrock	0.3 mbgl
End Date	20-Jul-10	Well Depth	55 m	Screen Diameter	50 mm	Logged By	OH



Drilling Diameters			**Steel Support Casings**			Driller Yield Estimate:
Diameter	From	To	Diameter	From	To	Development Time:
0.17	0					
0.14						

Other Remarks:
Approximately 2.5 m of soil and subsoil have been stripped from this area.

Project Name	Huntstown Quarry PA	**WELL LOG**		SLR Consulting (Ireland) Ltd.			
Client	Roadstone Wood Ltd	Well Name	GW06	7 Dundrum Business Park			
Project No.	501.0180.00011			Windy Arbour			
Location	Huntstown, County Dublin	Easting	310847.3	Dublin 14			
Contractor	Petersen Drilling Services	Northing	240902.1	T: 01 2964667 F: 01 2964676			
Drill Rig	Knebel	Elevation (gl)	82.16 mOD	Casing Length	65.5 m	Hole ID	170 mm
Drill Method	Symmetrix and DTH Air	Elevation (TOC)	82.78 mOD	Casing Diameter	50 mm	Static Level	39.8 mbgl
Start Date	17-Jul-10	Boring Depth	80.5 m	Screen Length	15 m	Depth to Bedrock	2.5 mbgl
End Date	20-Jul-10	Well Depth	80.5 m	Screen Diameter	50 mm	Logged By	OH



Drilling Diameters			**Steel Support Casings**			Driller Yield Estimate:
Diameter	From	To	Diameter	From	To	Development Time:
0.17	0	4				
0.14	4	80.5				

Other Remarks:

Appendix 6-2

Water Quality Results

BHP/CL/02C

24 AUG 2010

TEST REPORT

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7 Dundrum Business Park
Windy Arbour
Dublin 14

FTAO: Oliver Higgins

BHP Ref. No.: 94060.1
Order No.:
Date Received: 06/08/10
Date Completed: 20/08/10
Test Specification: Nil
Item :See below

Test	Client Reference	Units	Results	Standard Reference
	Central Sump			
pH		-	7.04	APHA-4500-H^+-B
Electrical Conductivity		μScm^{-1}	227	APHA - 2510 - B
Sodium		mg/l	12.56	APHA - 3120 - B
Potassium		mg/l	1.21	APHA - 3120 - B
Calcium		mg/l	54.3	APHA - 3120 - B
Magnesium		mg/l	0.95	APHA - 3120 - B
Chloride		mg/l	24.7	APHA - 4110 - B
Sulphate (as SO_4)		mg/l	8.16	APHA - 4110 - B
Total Alkalinity (as $CaCO_3$)		mg/l	151	APHA - 2320 -B
Total Hardness (as $CaCO_3$)		mg/l	330	APHA - 2340- B
Nitrate (as NO_3)		mg/l	4.66	APHA - 4110 - B
Nitrite (as NO_2)		mg/l	<0.05	APHA - 4110 - B
BOD		mg/l	2	APHA - 5210 - B
Diesel Range Organics		mg/l	<0.01	GC-FID
Mineral Oils		mg/l	<0.01	GC-FID

Additional information : All methods are from Standard Methods for the Examination of Water and Wastewater 20th Edition.

For and on behalf of BHP laboratories :

P. O Sullivan

Pat O'Sullivan
Issue Date : 20/08/2010

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Dublin 14

FTAO: Oliver Higgins

BHP Ref. No.: 94060.1
Order No.:
Date Received: 06/08/10
Date Completed: 20/08/10
Test Specification: Nil
Item :See below

Test	Client Reference	Units	Results	Standard Reference
	Central Sump			
Ammoniacal Nitrogen (as NH_3-N)		mg/l	0.04	APHA -4500- NH_3-D
Iron		mg/l	<0.001	APHA - 3120 - B
Manganese		mg/l	<0.001	APHA - 3120 - B
OrthoPhosphate (PO_4-P)		mg/l	0.07	APHA - 4110 - B

Additional Information : All methods are from Standard Methods for the Examination of Water and Wastewater 20th Edition.

For and on behalf of BHP laboratories :

Pat O'Sullivan
Issue Date : 20/08/2010

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FTAO: Oliver Higgins

BHP Ref. No.: 94060.2
Order No.:
Date Received: 06/08/10
Date Completed: 20/08/10
Test Specification: Nil
Item :See below

Test	Client Reference	Units	Results	Standard Reference
	Northern Sump			
pH		-	7.11	APHA-4500-H^+-B
Electrical Conductivity		μScm^{-1}	329	APHA - 2510 - B
Sodium		mg/l	20.54	APHA - 3120 - B
Potassium		mg/l	4.89	APHA - 3120 - B
Calcium		mg/l	102.4	APHA - 3120 - B
Magnesium		mg/l	3.25	APHA - 3120 - B
Chloride		mg/l	30.21	APHA - 4110 - B
Sulphate (as SO_4)		mg/l	19.27	APHA - 4110 - B
Total Alkalinity (as $CaCO_3$)		mg/l	209	APHA - 2320 -B
Total Hardness (as $CaCO_3$)		mg/l	430	APHA - 2340- B
Nitrate (as NO_3)		mg/l	3.27	APHA - 4110 - B
Nitrite (as NO_2)		mg/l	<0.05	APHA - 4110 - B
BOD		mg/l	1	APHA - 5210 - B
Diesel Range Organics		mg/l	<0.01	GC-FID
Mineral Oils		mg/l	<0.01	GC-FID

Additional information : All methods are from Standard Methods for the Examination of Water and Wastewater 20th Edition.

For and on behalf of BHP laboratories :

P. O'Sullivan

Pat O'Sullivan
Issue Date : 20/08/2010

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BHP Ref. No.: 94060.2
Order No.:
Date Received: 06/08/10
Date Completed: 20/08/10
Test Specification: Nil
Item :See below

Test	Client Reference	Units	Results	Standard Reference
	Northern Sump			
Ammoniacal Nitrogen (as NH_3-N)		mg/l	0.02	APHA -4500- NH_3-D
Iron		mg/l	0.016	APHA - 3120 - B
Manganese		mg/l	0.002	APHA - 3120 - B
OrthoPhosphate (PO_4-P)		mg/l	0.04	APHA - 4110 - B

Additional information : All methods are from Standard Methods for the Examination of Water and Wastewater 20th Edition.

For and on behalf of BHP laboratories :

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Pat O'Sullivan
Issue Date : 20/08/2010

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FTAO: Oliver Higgins

BHP Ref. No.: 94060.3
Order No.:
Date Received: 06/08/10
Date Completed: 20/08/10
Test Specification: Nil
Item :See below

Test	Client Reference	Units	Results	Standard Reference
	SW01			
pH		-	6.96	APHA-4500-H^+-B
Electrical Conductivity		μScm^{-1}	459	APHA - 2510 - B
Sodium		mg/l	31.2	APHA - 3120 - B
Potassium		mg/l	3.12	APHA - 3120 - B
Calcium		mg/l	80.4	APHA - 3120 - B
Magnesium		mg/l	2.45	APHA - 3120 - B
Chloride		mg/l	56.74	APHA - 4110 - B
Sulphate (as SO_4)		mg/l	20.4	APHA - 4110 - B
Total Alkalinity (as $CaCO_3$)		mg/l	210	APHA - 2320 -B
Total Hardness (as $CaCO_3$)		mg/l	424	APHA - 2340- B
Nitrate (as NO_3)		mg/l	11.24	APHA - 4110 - B
Nitrite (as NO_2)		mg/l	<0.05	APHA - 4110 - B
BOD		mg/l	1	APHA - 5210 - B
Diesel Range Organics		mg/l	<0.01	GC-FID
Mineral Oils		mg/l	<0.01	GC-FID

Additional information : All methods are from Standard Methods for the Examination of Water and Wastewater 20th Edition.

For and on behalf of BHP laboratories :

Pat O'Sullivan
Issue Date : 20/08/2010

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FTAO: Oliver Higgins

BHP Ref. No.: 94060.3
Order No.:
Date Received: 06/08/10
Date Completed: 20/08/10
Test Specification: Nil
Item :See below

Test	Client Reference	Units	Results	Standard Reference
	SW01			
Ammoniacal Nitrogen (as NH_3-N)		mg/l	0.01	APHA -4500- NH_3-D
Iron		mg/l	<0.001	APHA - 3120 - B
Manganese		mg/l	<0.001	APHA - 3120 - B
OrthoPhosphate (PO_4-P)		mg/l	0.08	APHA - 4110 - B

Additional information : All methods are from Standard Methods for the Examination of Water and Wastewater 20th Edition.

For and on behalf of BHP laboratories :

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Pat O'Sullivan
Issue Date : 20/08/2010

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FTAO: Oliver Higgins

BHP Ref. No.: 94060.4
Order No.:
Date Received: 06/08/10
Date Completed: 20/08/10
Test Specification: Nil
Item :See below

Test	Client Reference	Units	Results	Standard Reference
	GW01			
pH		-	7.34	APHA-4500-H^+-B
Electrical Conductivity		μScm^{-1}	114	APHA - 2510 - B
Sodium		mg/l	24.52	APHA - 3120 - B
Potassium		mg/l	3.54	APHA - 3120 - B
Calcium		mg/l	80.7	APHA - 3120 - B
Magnesium		mg/l	17.54	APHA - 3120 - B
Chloride		mg/l	19.23	APHA - 4110 - B
Sulphate (as SO_4)		mg/l	48.96	APHA - 4110 - B
Total Alkalinity (as $CaCO_3$)		mg/l	301	APHA - 2320 -B
Total Hardness (as $CaCO_3$)		mg/l	340	APHA - 2340- B
Nitrate (as NO_3)		mg/l	18.66	APHA - 4110 - B
Nitrite (as NO_2)		mg/l	<0.05	APHA - 4110 - B
Total Organic Carbon		mg/l	4.1	APHA - 5310 - C

Additional information : All methods are from Standard Methods for the Examination of Water and Wastewater 20th Edition.

For and on behalf of BHP laboratories :

Pat O'Sullivan
Issue Date : 20/08/2010

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BHP Ref. No.: 94060.4
Order No.:
Date Received: 06/08/10
Date Completed: 20/08/10
Test Specification: Nil
Item :See below

Test	Client Reference	Units	Results	Standard Reference
	GW01			
Ammoniacal Nitrogen (as NH_3-N)		mg/l	0.02	APHA -4500- NH_3-D
Iron		mg/l	0.006	APHA - 3120 - B
Manganese		mg/l	0.001	APHA - 3120 - B
OrthoPhosphate (PO_4-P)		mg/l	0.1	APHA - 4110 - B

Additional information : All methods are from Standard Methods for the Examination of Water and Wastewater 20th Edition.

For and on behalf of BHP laboratories :

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Issue Date : 20/08/2010

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BHP Ref. No.: 94060.5
Order No.:
Date Received: 06/08/10
Date Completed: 20/08/10
Test Specification: Nil
Item :See below

Test	Client Reference	Units	Results	Standard Reference
	GW02			
pH		-	6.84	APHA-4500-H^+-B
Electrical Conductivity		μScm^{-1}	229	APHA - 2510 - B
Sodium		mg/l	17.89	APHA - 3120 - B
Potassium		mg/l	2.99	APHA - 3120 - B
Calcium		mg/l	75.45	APHA - 3120 - B
Magnesium		mg/l	15.42	APHA - 3120 - B
Chloride		mg/l	24.68	APHA - 4110 - B
Sulphate (as SO_4)		mg/l	12.09	APHA - 4110 - B
Total Alkalinity (as $CaCO_3$)		mg/l	292	APHA - 2320 -B
Total Hardness (as $CaCO_3$)		mg/l	352	APHA - 2340- B
Nitrate (as NO_3)		mg/l	12.45	APHA - 4110 - B
Nitrite (as NO_2)		mg/l	<0.05	APHA - 4110 - B
Total Organic Carbon		mg/l	4.4	APHA - 5310 - C

Additional information : All methods are from Standard Methods for the Examination of Water and Wastewater 20th Edition.

For and on behalf of BHP laboratories :

Pat O'Sullivan
Issue Date : 20/08/2010

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BHP Ref. No.: 94060.5
Order No.:
Date Received: 06/08/10
Date Completed: 20/08/10
Test Specification: Nil
Item :See below

Test	Client Reference	Units	Results	Standard Reference
	GW02			
Ammoniacal Nitrogen (as NH_3-N)		mg/l	0.01	APHA -4500- NH_3-D
Iron		mg/l	<0.001	APHA - 3120 - B
Manganese		mg/l	<0.001	APHA - 3120 - B
OrthoPhosphate (PO_4-P)		mg/l	0.09	APHA - 4110 - B

Additional information : All methods are from Standard Methods for the Examination of Water and Wastewater 20th Edition.

For and on behalf of BHP laboratories :

Pat O'Sullivan
Issue Date : 20/08/2010

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FTAO: Oliver Higgins

BHP Ref. No.: 94060.6
Order No.:
Date Received: 06/08/10
Date Completed: 20/08/10
Test Specification: Nil
Item :See below

Test	Client Reference	Units	Results	Standard Reference
	GW03			
pH		-	7.46	APHA-4500-H^+-B
Electrical Conductivity		μScm^{-1}	376	APHA - 2510 - B
Sodium		mg/l	28.62	APHA - 3120 - B
Potassium		mg/l	4.01	APHA - 3120 - B
Calcium		mg/l	92.52	APHA - 3120 - B
Magnesium		mg/l	20.27	APHA - 3120 - B
Chloride		mg/l	43.11	APHA - 4110 - B
Sulphate (as SO_4)		mg/l	17.24	APHA - 4110 - B
Total Alkalinity (as $CaCO_3$)		mg/l	351	APHA - 2320 -B
Total Hardness (as $CaCO_3$)		mg/l	440	APHA - 2340- B
Nitrate (as NO_3)		mg/l	24.77	APHA - 4110 - B
Nitrite (as NO_2)		mg/l	<0.05	APHA - 4110 - B
Total Organic Carbon		mg/l	1.5	APHA - 5310 - C

Additional information : All methods are from Standard Methods for the Examination of Water and Wastewater 20th Edition.

For and on behalf of BHP laboratories :

Pat O'Sullivan
Issue Date : 20/08/2010

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BHP Ref. No.: 94060.6
Order No.:
Date Received: 06/08/10
Date Completed: 20/08/10
Test Specification: Nil
Item :See below

Test	Client Reference	Units	Results	Standard Reference
	GW03			
Ammoniacal Nitrogen (as NH_3-N)		mg/l	0.04	APHA -4500- NH_3-D
Iron		mg/l	0.052	APHA - 3120 - B
Manganese		mg/l	0.013	APHA - 3120 - B
OrthoPhosphate (PO_4-P)		mg/l	0.06	APHA - 4110 - B

Additional information : All methods are from Standard Methods for the Examination of Water and Wastewater 20th Edition.

For and on behalf of BHP laboratories :

Pat O'Sullivan
Issue Date : 20/08/2010

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BHP Ref. No.: 94060.7
Order No.:
Date Received: 06/08/10
Date Completed: 20/08/10
Test Specification: Nil
Item :See below

Test	Client Reference	Units	Results	Standard Reference
	GW04			
pH		-	7.32	APHA-4500-H^+-B
Electrical Conductivity		μScm^{-1}	512	APHA - 2510 - B
Sodium		mg/l	25.42	APHA - 3120 - B
Potassium		mg/l	3.12	APHA - 3120 - B
Calcium		mg/l	85.42	APHA - 3120 - B
Magnesium		mg/l	19.85	APHA - 3120 - B
Chloride		mg/l	27.49	APHA - 4110 - B
Sulphate (as SO_4)		mg/l	36.11	APHA - 4110 - B
Total Alkalinity (as $CaCO_3$)		mg/l	332	APHA - 2320 -B
Total Hardness (as $CaCO_3$)		mg/l	494	APHA - 2340- B
Nitrate (as NO_3)		mg/l	16.62	APHA - 4110 - B
Nitrite (as NO_2)		mg/l	<0.05	APHA - 4110 - B
Total Organic Carbon		mg/l	0.5	APHA - 5310 - C

Additional information : All methods are from Standard Methods for the Examination of Water and Wastewater 20th Edition.

For and on behalf of BHP laboratories :

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Pat O'Sullivan
Issue Date : 20/08/2010

TEST REPORT

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FTAO: Oliver Higgins

BHP Ref. No.: 94060.7
Order No.:
Date Received: 06/08/10
Date Completed: 20/08/10
Test Specification: Nil
Item :See below

Test	Client Reference	Units	Results	Standard Reference
	GW04			
Ammoniacal Nitrogen (as NH_3-N)		mg/l	0.02	APHA -4500- NH_3-D
Iron		mg/l	<0.001	APHA - 3120 - B
Manganese		mg/l	<0.001	APHA - 3120 - B
OrthoPhosphate (PO_4-P)		mg/l	0.02	APHA - 4110 - B

Additional information : All methods are from Standard Methods for the Examination of Water and Wastewater 20th Edition.

For and on behalf of BHP laboratories :

Pat O'Sullivan
Issue Date : 20/08/2010

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BHP Ref. No.: 94060.8
Order No.:
Date Received: 06/08/10
Date Completed: 20/08/10
Test Specification: Nil
Item :See below

Test	Client Reference	Units	Results	Standard Reference
	GW05			
pH		-	6.86	APHA-4500-H^+-B
Electrical Conductivity		µScm	681	APHA - 2510 - B
Sodium		mg/l	16.89	APHA - 3120 - B
Potassium		mg/l	1.58	APHA - 3120 - B
Calcium		mg/l	68.57	APHA - 3120 - B
Magnesium		mg/l	14.56	APHA - 3120 - B
Chloride		mg/l	19.51	APHA - 4110 - B
Sulphate (as SO_4)		mg/l	24.66	APHA - 4110 - B
Total Alkalinity (as $CaCO_3$)		mg/l	247	APHA - 2320 -B
Total Hardness (as $CaCO_3$)		mg/l	220	APHA - 2340- B
Nitrate (as NO_3)		mg/l	9.32	APHA - 4110 - B
Nitrite (as NO_2)		mg/l	<0.05	APHA - 4110 - B
Total Organic Carbon		mg/l	3.2	APHA - 5310 - C

Additional Information : All methods are from Standard Methods for the Examination of Water and Wastewater 20th Edition.

For and on behalf of BHP laboratories :

P. o Sul

Pat O'Sullivan
Issue Date : 20/08/2010

TEST REPORT

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FTAO: Oliver Higgins

BHP Ref. No.: 94060.8
Order No.:
Date Received: 06/08/10
Date Completed: 20/08/10
Test Specification: Nil
Item :See below

Test	Client Reference	Units	Results	Standard Reference
	GW05			
Ammoniacal Nitrogen (as NH_3-N)		mg/l	0.01	APHA -4500- NH_3-D
Iron		mg/l	<0.001	APHA - 3120 - B
Manganese		mg/l	<0.001	APHA - 3120 - B
OrthoPhosphate (PO_4-P)		mg/l	<0.01	APHA - 4110 - B

Additional information : All methods are from Standard Methods for the Examination of Water and Wastewater 20th Edition.

For and on behalf of BHP laboratories :

Pat O'Sullivan
Issue Date : 20/08/2010

BHP/CL/02C

TEST REPORT

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BHP Ref. No.: 94060.9
Order No.:
Date Received: 06/08/10
Date Completed: 20/08/10
Test Specification: Nil
Item :See below

Test	Client Reference	Units	Results	Standard Reference
	GW06			
pH		-	7.12	APHA-4500-H^+-B
Electrical Conductivity		µScm^{-1}	354	APHA - 2510 - B
Sodium		mg/l	18.45	APHA - 3120 - B
Potassium		mg/l	2.57	APHA - 3120 - B
Calcium		mg/l	78.45	APHA - 3120 - B
Magnesium		mg/l	20.12	APHA - 3120 - B
Chloride		mg/l	34.16	APHA - 4110 - B
Sulphate (as SO_4)		mg/l	18.71	APHA - 4110 - B
Total Alkalinity (as $CaCO_3$)		mg/l	313	APHA - 2320 -B
Total Hardness (as $CaCO_3$)		mg/l	252	APHA - 2340- B
Nitrate (as NO_3)		mg/l	6.44	APHA - 4110 - B
Nitrite (as NO_2)		mg/l	<0.05	APHA - 4110 - B
Total Organic Carbon		mg/l	9.9	APHA - 5310 - C

Additional information : All methods are from Standard Methods for the Examination of Water and Wastewater 20th Edition.

For and on behalf of BHP laboratories :

Pat O'Sullivan
Issue Date : 20/08/2010

TEST REPORT

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BHP Ref. No.: 94060.9
Order No.:
Date Received: 06/08/10
Date Completed: 20/08/10
Test Specification: Nil
Item :See below

Test	Client Reference	Units	Results	Standard Reference
	GW06			
Ammoniacal Nitrogen (as NH_3-N)		mg/l	<0.01	APHA -4500- NH_3-D
Iron		mg/l	0.067	APHA - 3120 - B
Manganese		mg/l	0.021	APHA - 3120 - B
OrthoPhosphate (PO_4-P)		mg/l	0.01	APHA - 4110 - B

Additional information : All methods are from Standard Methods for the Examination of Water and Wastewater 20th Edition.

For and on behalf of BHP laboratories :

Pat O'Sullivan
Issue Date : 20/08/2010

Appendix 6-3
Spill Kit Details

Safety Storage Systems Ltd.
- Spill Kit Details

Emergency Spill Response Kits designed to tackle chemical spills which occur outside bunded areas. Contents include Absorbent Socks, Mats, Pads, Instructions, Disposal Bags and PPE.

Supplied in highly visible mobile wheeled Bins.

Spill Kit type: General Purpos.

250 Litre Spill Kit
1 250 Litre Wheeled Bin
4 Socks (3m x 8cm)
20 Cushions
140 Pads (Double Weight)
1 Plug Rug (61cm X 40cm)
1 5Kg Plugging Granules
1 Caution Tape
4 Disposal Bags and Tie
1 Instruction Sheet