SECTION 6: WATER

6.1 INTRODUCTION

SLR Consulting Limited (SLR) has been retained by Roadstone Dublin to undertake a hydrogeological and hydrological impact assessment for the continued operation of an existing construction and demolition (C+D) waste recovery facility at Fassaroe, Co. Wicklow and proposed restoration of an adjoining worked-out quarry at the same location using inert waste, principally soil and stone.

This EIS 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 existing and proposed waste recovery facilities.

Unmitigated potential impacts, assuming that no mitigation measures are in place, are considered for the initial assessment. Thereafter, a number of appropriate mitigation measures are identified and the potential impacts are reassessed assuming the proposed measures are implemented. The assessment is based on a detailed baseline description and evaluation of the existing local hydrogeological and hydrological regimes.

6.1.1 Background

Roadstone Dublin's landholding at Fassaroe is currently used for the screening and washing of sand and gravel imported from other quarries and for the recovery (processing) of imported inert C&D waste. The proposal to backfill and restore the existing quarry void using imported soils and stones generated by construction and demolition activities 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 waste recovery activities at the site on the hydrogeological and hydrological environment. Further information on the waste types and proposed schedule of works is detailed in Section 2 of this EIS.

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 proposed backfilling of the sand and gravel quarry using imported inert backfill materials. The assessment considers the proposed phasing of the infilling, the waste types and 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 website (www.epa.ie) for maps and environmental information;
- Geological Survey of Ireland website (www.gsi.ie);
- Geology of Kildare-Wicklow, Sheet 16, 1:100,000 scale, Geological Survey of Ireland, 1995;
- 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; and

6.1.4 Contributors

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

Les Brown, B.Sc., M.Sc. Ph.D., Senior Hydrogeologist, SLR Consulting Ireland

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 and the Forest Service. These maps indicate that, prior to development, the majority of the application site was originally underlain by shallow well drained mineral soils, which are classified as grey brown podzolics. These soils were derived from glaciofluvial subsoils parent material which underlies the site (refer to Figure 5.2 in Chapter 5 of this EIS).

The subsoils (Quaternary drift deposits) occurring across and beneath the entire site comprise glaciofluvial sand and gravels derived (mainly) from Carboniferous Limestones. From a review of published topographic and geological maps it is expected that the sands and gravels are laterally extensive to the north and west and will have a thickness in excess of 20m thick. Due to the relatively steep topography it is also expected that the sand and gravel will have a thick unsaturated zone.

Solid Geology
The superficial deposits under the entire site and surrounding area are underlain by bedrock of the Maulin Formation and the Glencullen River Formation (refer to Figure 5.2 in Section 5). The published geological map of the area shows that these formations are part of the Ribband Group and are of Lower Ordovician age. The Maulin Formation comprises of slates, phyllites and schists whilst the Glencullen River Formation comprises tuffs and greywacke.

Local Geology
Three groundwater monitoring wells (designated BH1, BH2 and BH3) were installed across the application site in December 2008. The locations of the monitoring wells are shown in Figure 6.1. The monitoring wells were drilled using rotary techniques, and as a result, it was only possible to obtain general descriptions of the quaternary subsoil deposits encountered during well drilling. In general, the monitoring wells encountered sand and gravel overlying gravelly clay. The boreholes were drilled to depths of 21m (BH1), 24m (BH2) and 30m (BH3). Subsoils encountered during drilling are described as follows:

- MADE GROUND (sandy gravelly clay);
- Fine to medium to coarse brown SAND;
- Stiff brown CLAY; and,
- Slightly sandy, gravelly CLAY.

Stiff clay and gravelly clay was encountered in BH3 but not in BH1 or BH2, which encountered sand and gravel. Monitoring well construction records are presented in the groundwater well installation report, reproduced as Appendix 6A.

6.2.2 Available Information : Hydrogeology

Aquifer Characteristics and Groundwater Vulnerability
The published geological memoir for the region reports that sands and gravels cover a significant part of this region of Ireland and can be developed to provide reasonable water supplies. Well yields in the bedrock are generally only sufficient for domestic or farm supplies and range from 20m^3/d to 50m^3/d, except along faults where they may be in excess of 200m^3/d.

The published geological memoir also indicates that the bedrock hydrogeology in this region of Ireland is dominated by secondary fissure permeability. This is the case for both the Maulin Formation and Glencullen River Formation, which are considered to be aquitards. The bulk permeability of both bedrock formations is low, with groundwater storage and movement constrained to the upper weathered horizons of this unit and fractures / faults.

The Quaternary strata play an important role in the groundwater flow regime of this region. The sands and gravels allow a high level of recharge, provide additional storage to the underlying bedrock aquifers and, where sufficiently thick, can be an aquifer in their own right. Well yields for the sand and gravel deposits are typically between 100m^3/d and 3000m^3/d.

Aquifer maps published on the GSI and EPA websites indicate that the application site is located above a locally important sand and gravel aquifer, which is extensive to the north and west of the site boundary. The subsoil map presented as Figure 5.1 in Chapter 5 shows the extent of the sand and gravel deposit.

Groundwater vulnerability maps indicate that the site is located within an area having High Groundwater Vulnerability status. An extract of the Groundwater Vulnerability map is presented as Figure 6.3. The groundwater vulnerability reflects the high recharge acceptance of the sand and gravel deposits.

Groundwater in the sand and gravel aquifer has not been intercepted by the former quarry workings. Surface water ponding that occurs across the quarry floor is perched above the water table above deposits of silt and clay generated by sand and gravel processing (washing) activities at the site.

Recharge Mechanisms
Published data (including the geological memoir for the area) indicates that rainfall in North Wicklow is of the order of 700mm/yr to 1000mm/yr. Potential recharge to the aquifers ranges from 325mm/yr to 550 mm/yr, depending on the elevation and location. The bulk of this recharge occurs between late October and early March. Although the ground wets after rainfall, it drains rapidly. This, coupled with the lack of surface water features across the area, indicates that the sand and gravel aquifer has a high recharge acceptance and that the unsaturated zone has a high permeability.

Groundwater Levels and Flow
The published geological memoir for the region reports that the groundwater table in elevated sand and gravel deposits can be relatively deep, with the deposit having a thick unsaturated zone.

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

Borehole Name	Surface mOD	Water Strike (mbgl)	Water Strike (approx. mOD)	Deposits recorded at water strike
BH1	79	18.00	61.0	Saturated, brown silty, medium SAND with gravel
BH2	81	20.00	61.0	Saturated, brown sandy CLAY
BH3	87	15.00	72.0	Saturated, brown silty, gravel medium SAND

Table 6.1. Groundwater Strikes Recorded during Drilling

Water levels were also recorded in early January 2009, approximately three weeks after drilling had ceased; groundwater was recorded at the following rest levels:

- BH1 – dry
- BH2 – 61.7m OD (19.29mbgl)
- BH3 – 65.7m OD (21.26mbgl)

Although BH1 intercepted water during drilling and water levels were maintained for some days following drilling, the well dried out some weeks after installation.

Groundwater contours based on the rest levels recorded in the new boreholes have been used to determine groundwater flow contours, and these are presented on Figure 6.4. The groundwater contours show that the indicative groundwater flow direction is eastwards. It is considered that any groundwater movement in the upper weathered horizons of the bedrock formations will be in hydraulic continuity with the overlying sand and gravel unit.

The final floor level across the former quarry is understood to have been approximately 70mOD, and possibly deeper locally at sumps (typically 68mOD). The aerial photograph attached in Plate 6.1 dates from May 1997 and indicates that the floor of the excavation at that time (typically at 70mOD) was dry and therefore clearly above the groundwater table. Inspection of later aerial photography on the Ordnance Survey website indicates that the plan footprint of the pond in both 2000 and 2005 was significantly less that that recorded in September 2008. The relatively high water level in the pond recorded in September 2008 (75.6mOD) is attributed to the high incidence of rainfall over the previous two summers.

From these data it is apparent that:

- The ponds on the quarry floor is rainwater which is perched approximately 5m to 7m above the groundwater table.
- The water table is considered to be steep for a sand and gravel deposit. This suggests that the lower part of the subsoil stratigraphy has a lower permeability.
- The lack of surface water features and high recharge acceptance indicates the upper part the deposit has a higher permeability.

Groundwater Abstractions, Use and Quality
All local residences are understood to be supplied by Local Authority mains. Water for on-site processing and washing of sand and gravel is sourced from the ponds on the abandoned quarry floor.

Groundwater samples were obtained for hydrochemical analysis from monitoring wells BH2 (down-gradient of the quarry floor) and BH3 (up-gradient of the quarry floor) in January 2009. As part of the sampling procedure each well was purged prior to the sample collection. However, in both cases the inflow to each well was minimal causing the well to dry up before the required volume had been removed. Both wells were allowed to recharge prior to groundwater samples being taken. The drying out of both wells confirms that the lower stratigraphy of the subsoil is of a lower permeability than the upper part.

A surface water sample was collected from the ponds perched on the floor of the former quarry. All water samples were sent to an independent accredited laboratory for analysis. A summary of reported water quality is presented as Table 6.2 below:

Parameter	Sampling Locations			EU Drinking Water Standards (98/83/EC)
	BH2 (down gradient)	**BH3 (up gradient)**	**SW1 (quarry floor)**	
Field Tests				
Temperature °C	8.4	10.02	1.33	-
Conductivity µS/cm	457	644	300	2500
pH	8.11	7.58	8.59	2500
Dissolved Oxygen	12.3	7.12	14.94	-
Laboratory Tests				

Table 6.2 Summary of Groundwater Quality

Parameter	Sampling Locations			EU Drinking Water Standards (98/83/EC)
	BH2 (down gradient)	BH3 (up gradient)	SW1 (quarry floor)	
Total Hardness (mg/l)	213	274	100	-
Total Alkalinity (mg/l)	130	210	80	-
TOC (mg/l)	3	<2	-	No ab. ch.
BOD (mg/l)	-	-	<2	-
DRO (µg/l)	-	-	<10	-
PRO (µg/l)	-	-	<10	-
Mineral Oil (µg/l)	-	-	<10	-
Benzene (µg/l)	-	-	<10	-
Toluene (µg/l)	-	-	<10	-
Ethylbenzene (µg/l)	-	-	<10	-
Total Xylene (µg/l)	-	-	<10	-
Dissolved Sodium (mg/l)	15.6	22.7	13.7	200
Dissolved Potassium (mg/l)	2.8	2.3	4.4	-
Dissolved Calcium (mg/l)	67	98	36	-
Dissolved Iron (ug/l)	36	20	9	200
Dissolved Magnesium (mg/l)	11	7	2	-
Dissolved Manganese (ug/l)	261	39	<1	50
Chloride (mg/l)	23	15	17	250
Ammoniacal-N (mg/l)	<0.2	<0.2	<0.2	-
Nitrite (mg/l)	0.12	0.11	0.09	0.5
Nitrate (mg/l)	3.6	13.0	3.6	50
Sulphate (mg/l)	29	38	40	250
Phosphate (ortho) (mg/l)	0.04	0.06	0.08	-

KEY: Shaded = maximum admissible concentration exceeded

Table 6.2 (cont'd) Summary of Groundwater Quality

Groundwater quality is considered to be good. With the exception for high levels of manganese in BH2, all parameters analysed for had ion concentrations lower than the EU Drinking Water Standards. Water quality is also good for the ponded water which lies on the quarry floor. Additional List I analyses for Diesel and Petrol Range Organics, Mineral Oils, Benzene, Toluene, Ethylbenzene and Total Xylene, were undertaken on the sample obtained from the surface water pond on the quarry floor. None of these contaminants were detected in the tested samples.

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 sand and gravel with limestone parent material. Potassium, chloride, ammoniacal nitrogen, nitrite and nitrate are all low and indicate minimal organic contamination. The nitrate level in BH3, although still low, is higher than BH2 and is most likely due to its closer proximity to agricultural land.

There are a small number of hydrochemical variations between up-gradient and down-gradient monitoring wells across the former sand and gravel pit. Most notable of these is the concentration of manganese, which is considerably higher down-gradient than up-gradient. This variation in manganese is most likely to be due to geological factors. The hardness and alkalinity reduce down-gradient of the quarry, which is most likely to be due to mixing caused by rainwater perched on the quarry floor seeping down to the water table and recharging groundwater. The other main constituents show only a slight variation up-gradient and down-gradient of the quarry.

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 has 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 established inert waste recovery facilities such as that at Fassaroe.

Notwithstanding this, review of the Groundwater Vulnerability Map (Figure 6.4) and the Aquifer Map (Figure 6.3) in accordance with the DoELG / EPA / GSI methodology indicates that the Fassaroe site is located within an area of High Vulnerability and a Locally Important Sand/Gravel 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 quarry backfilling / inert soil recovery activities can only be undertaken where previous activities have created void space in the landscape, the additional requirement to identify other sites in lower risk areas does not apply. In any event, the backfilling of existing (perched) groundwater ponds and provision of inert soil cover (predominantly cohesive till) will provide an enhanced degree of protection to the aquifer, 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 existing inert landfills or waste recovery facilities. Further to this, the significance of the impact of the proposed waste recovery activities on groundwater is fully explored in Section 6.3.

6.2.3 Available Information : Hydrology

Local Hydrology and Surface Water Quality

The nearest watercourse to the site is the Cookstown River, which is named as the Glencullen River upstream of Enniskerry (2km west of the site). This watercourse is a tributary of the Dargle River, and is located within the Eastern River Basin District. The Cookstown River lies 200m to the south of the site access road. Ordnance Survey mapping indicates that this watercourse is fed by waters from the Glencullen area.

In 2003 biotic sampling from the Glencullen River, 2km upstream of Enniskerry and 4km upstream of the site was reported to be of a good status (Q value of 4). Biotic sampling undertaken approximately 1km downstream of the site in the Cookstown River, just before it's confluence with the River Dargle also recorded good status (Q value of 4).

Surface Water Flows and Discharge Consents

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. There is currently no information on discharge consents in the immediate vicinity of the site.

Flooding

The Office of Public Works website (www.floodmaps.ie) indicates that there are no records of historic flooding recorded within 1km of the site, and therefore the continued operation and development of waste recovery facilities at the application site is not considered to present any risk of flooding. Surface water runoff and discharges at site will be managed so that they do not increase the risk of flooding in the vicinity of the proposed development area. The proposed restoration profile allows water to be shed to the south and east of the application site, where it can infiltrate into the permeable sand and gravel aquifer.

6.2.4 Field Surveys

Site visits were undertaken by a senior SLR hydrogeologist between the 1st and 12th December 2008. The following observations were noted:

- the majority of the application site was dry underfoot, with no surface water features;
- following rain the site became muddy but soon dried out;
- the quarry floor is covered by silt and clay deposits from historical sand and gravel washing operations;
- the pond on the quarry floor is perched above groundwater in the sand and gravel aquifer, and as such is not representative of the groundwater table;
- although there are areas of the surrounding lands that are moist, no springs or other groundwater features were observed and,
- there is seepage from the quarry floor to the underlying unsaturated aquifer. However, due to the layer of silt and clay, this seepage is minimal. During particularly wet years ponding occurs on the quarry floor. Seepage from the ponds will increase as the water depth increases.

Photographs of the site are presented in Plates 6.2 and 6.3 at the end of this chapter.

6.2.5 Limitations

The assessment provided herein is based on visual observations and measurements from site visits, published information, well drilling information and discussions with site staff and is a qualitative assessment.

6.3 IMPACT OF THE SCHEME

6.3.1 Evaluation Methodology

The impact of the proposed development (as detailed in Chapter 2) is 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 outlined below in Table 6.3.

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 6.3 : Matrix Used to Assess Potential Impacts

The magnitude of potential impacts in relation to hydrogeology and hydrology are detailed in Table 6.4 below :

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 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 run-off well within the drainage system capacity; Minor changes to erosion and sedimentation patterns Minor changes to the water chemistry of surface run-off and groundwater Minor changes to water dependent ecosystems
Moderate	Some fundamental changes to watercourse, hydrology or hydrodynamics; Changes to site resulting in an increase in run-off within system capacity; Moderate changes to erosion and sedimentation patterns Moderate changes to the water chemistry of surface run-off and groundwater. Moderate changes to water dependent ecosystems
Severe	Wholesale changes to watercourse channel, route, hydrology or hydrodynamics; Changes to site resulting in an increase in run-off with flood potential Significant changes to erosion and sedimentation patterns Major changes to the water chemistry of surface run-off and groundwater Major changes to water dependent ecosystems

Table 6.4 : Magnitude of Potential Hydrological and Hydrogeological Impacts

In addition to nature and significance, the potential impacts will also 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 6.3 and 6.4. 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 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
The operation of existing and proposed additional waste recovery facilities will create a risk of groundwater pollution from the following potential sources:

- accidental spillage of fuels and lubricants by traffic and/or construction plant importing or handling the inert fill and during other operational procedures;
- increase in suspended solids and potential for contaminated run-off 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 run-off 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 direct tipping of inert fill high in silt content into groundwater. 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 risk 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 pattern of groundwater recharge through the unsaturated soils. Without mitigation, the probability of occurrence is 'medium' due to the extensive, thick and permeable nature of the unsaturated zone above the aquifer. The magnitude of the impact is assessed as 'low' as the resulting change to recharge will be small and localised to the area immediately around the backfilled quarry. The overall significance is therefore considered to be *'low to medium'*.

Is noted that (a) the regional permeability of the unsaturated zone of the sand and gravel aquifer is 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 side which will maintain aquifer recharge.

6.3.3 Potential Impacts on Surface Water

Given the site setting, it is considered that the potential impact of continued C&D waste recovery activities and backfilling of the former quarry with inert fill will have a negligible effect on surface water in the area for the following reasons:

- there are no surface water features within the site boundary (all water features within the application site are considered to be representative of groundwater and/or perched groundwater);
- run-off from the completed landform will recharge to ground within the Applicant's landholding boundary.

6.3.4 Summary of Potential Impacts

A summary of potential impacts *without mitigation* is presented in Table 6.5 overleaf :

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, Long Term, Direct	Medium to High	Moderate	Medium to High	Yes
Rogue load of contaminated material	Local, Short Term, Direct	Medium	Mild to Moderate	Low to Medium	Yes
Groundwater Flow / Recharge to Aquifer					
Alteration / reduction in recharge to aquifer	Local, Long Term and Direct	Medium	Low	Low to Medium	No
Impermeable barrier to groundwater flow	Local, Long Term, Direct	Low	Moderate	Low	No

Note: it is considered that the potential impacts on the surface water from the development are negligible and as such, these are not detailed in this table.

Table 6.5 Summary of Unmitigated Risk and Magnitude of Potential Impacts at Fassaroe

Review of Table 6.5 indicates that if no mitigation measures are incorporated within the design and backfilling operation for the former sand and gravel quarry, 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. It is therefore recommended that the mitigation measures outlined in the following section are incorporated to reduce the potential impact.

6.3.5 Do Nothing Scenario

Were the proposed backfilling and restoration of the application site not to proceed as proposed, 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. A minor risk of groundwater contamination will exist for as long as the quarry exists. Ongoing vigilance will be required to ensure no potential contaminating activities occur on the quarry floor, especially in the vicinity of, the groundwater ponds.

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 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;
- where possible, refuelling of plant and equipment should be undertaken at the surfaced area in the vicinity of the existing maintenance shed from the existing bunded fuel tank(s) in order to minimise the risk of uncontrolled release of polluting liquids / liquors;
- if necessary, refuelling of plant and equipment at the waste recovery facility should only be undertaken using mobile double skin bowsers;
- maintenance of plant and machinery would be undertaken at the existing maintenance sheds within the application site, as appropriate, to minimise the risk of uncontrolled release of polluting liquids;
- spill kits should be made available on-site to stop migration of spillages, should they occur;
- ponded areas on the quarry floor should be drained prior to the placement of the inert waste in order to minimise the mobilisation of fines,
- consignments of soil and stone forwarded to the facility should be inspected and tested to confirm they are inert prior to deposition at site.

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*'.

In order to minimise potential impact on recharge to the aquifer from backfilling the quarry void with lower permeability soils, it is recommended that an infiltration swale or soakaway be constructed on the down-gradient side. The purpose of the swale / soakaway will be to capture any surface water shed over the restored ground surface and allow it to infiltrate to ground as recharge.

6.4.2 Residual Impacts

A summary of the proposed mitigation methods, together with the predicted effects and residual impacts is presented in Table 6.6 overleaf.

Examination of Table 6.6 confirms that there are no significant residual impacts with respect to groundwater provided the appropriate mitigation measures are undertaken. It is therefore considered that the continued operation of the C&D waste recovery facility and the proposed backfilling of the quarry void using inert soil and stones is acceptable and has no significant impact on groundwater or surface water in the area.

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									
Alteration / reduction in recharge to aquifer	Local, Long Term and Direct	Medium	Low	Low to Medium	Yes	Soakaway and engineering measures	Low	Low	Near Zero
Impermeable barrier to groundwater flow	Local, Long Term, Direct	Low	Moderate	Low	No				

Table 6.6 Summary of Mitigation and Residual Impacts at Fassaroe

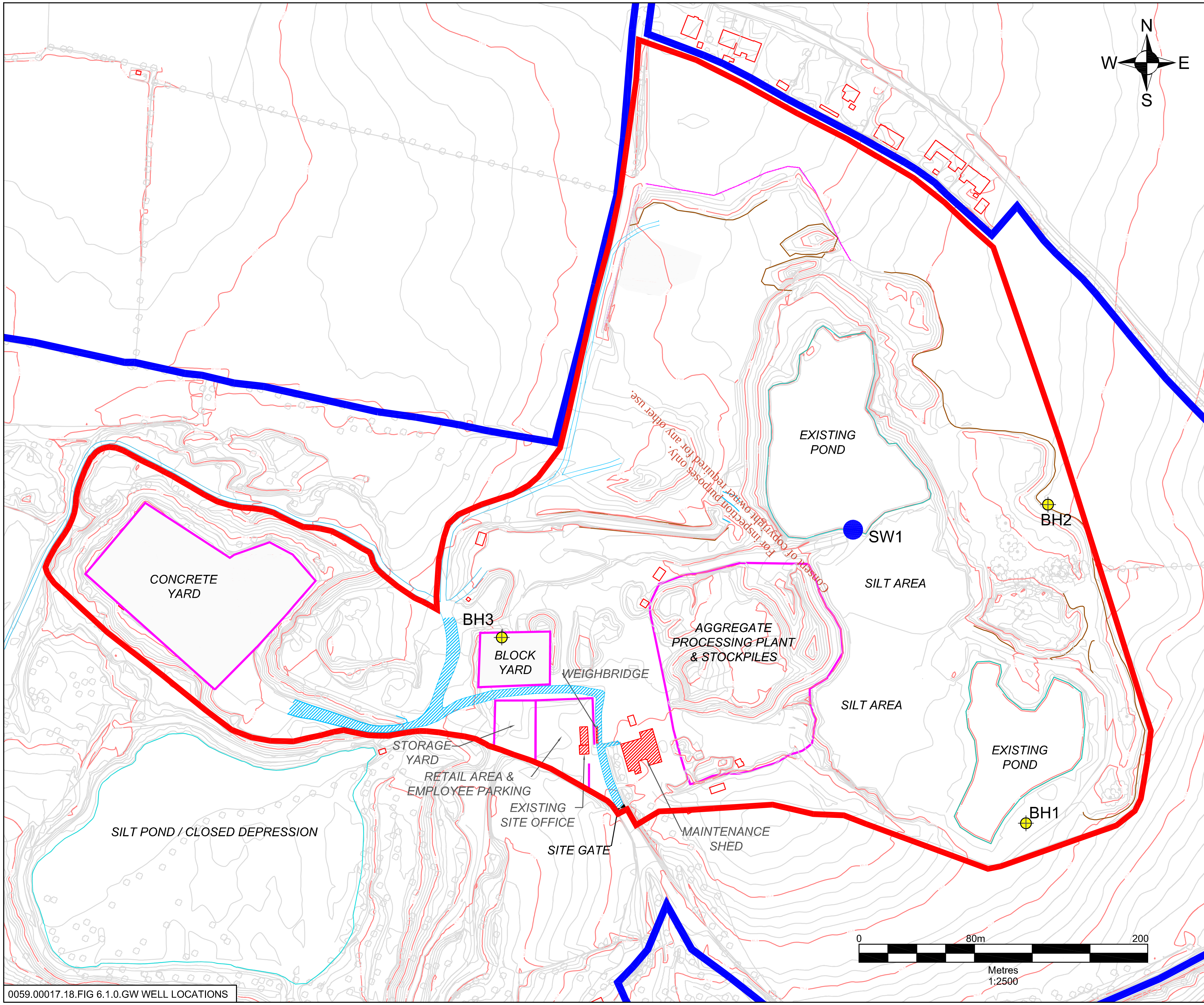
PLATES

PLATE 6.1 Fassaroe Site Complex : Layout in 1997

PLATE 6.2 Standing Water at the Eastern End of the Worked-Out Sand and Gravel Quarry.

PLATE 6.3 Installation of Groundwater Monitoring Well BH1

FIGURES



NOTES

1. Based on OSi 6inch sheet no. 21

2. Ordnance Survey Ireland Licence no. SU 0000709 (c) Ordnance Survey of Ireland & Government of Ireland

LEGEND

- Applicant's Land Interest (c. 65.1 ha)
- Waste Licence Application Area (c. 21.4 ha)
- Borehole Location
- Internal Unpaved Road
- Internal Paved Road
- Building
- SW1 Surface Water Monitoring Location

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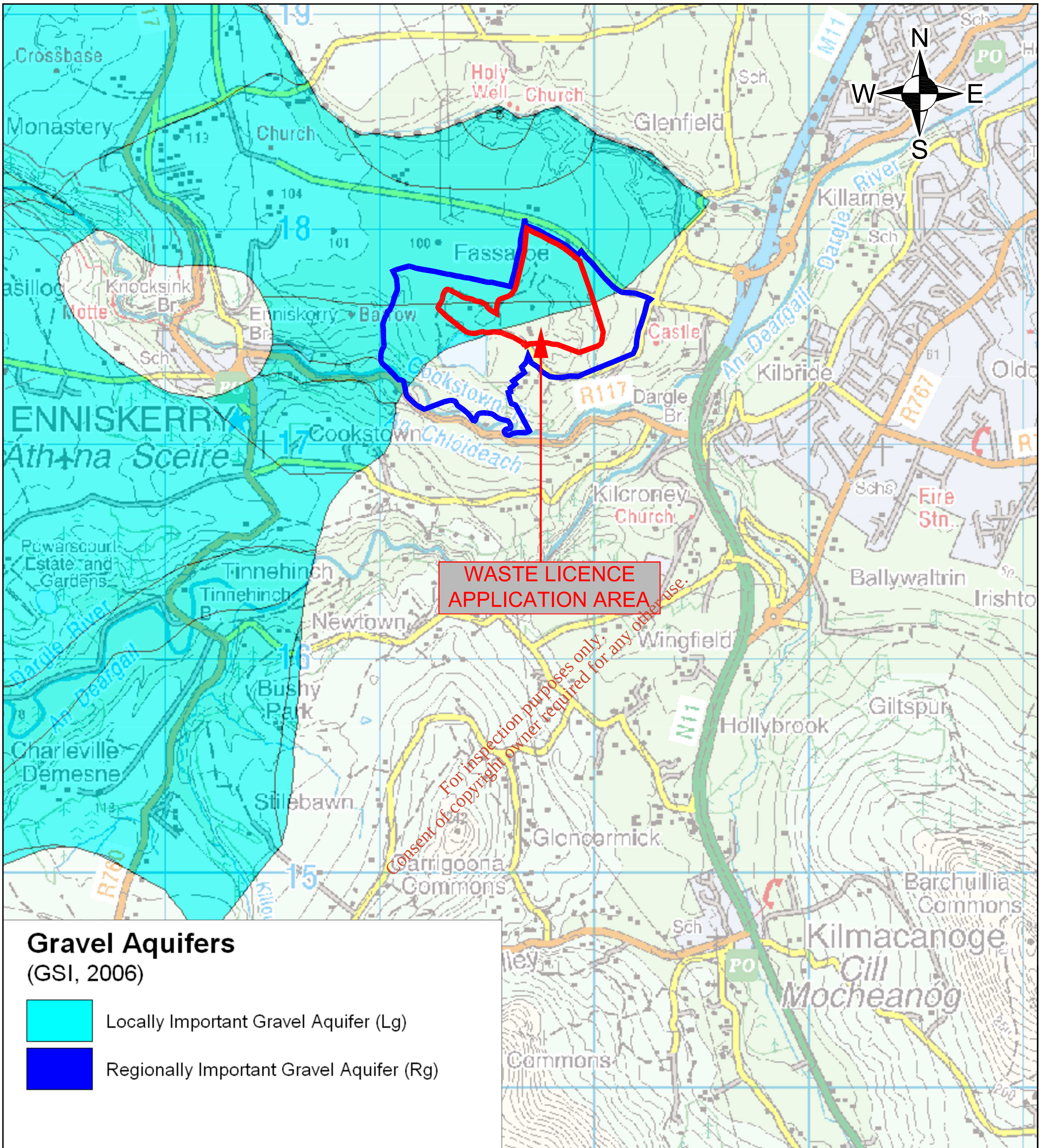
GROUNDWATER WELL LOCATIONS

FIGURE 6.1

Scale: 1:2,500 @ A3
Date: APRIL 2009

0059.00017.18.FIG 6.1.0.GW WELL LOCATIONS



Gravel Aquifers

(GSI, 2006)

- Locally Important Gravel Aquifer (Lg)
- Regionally Important Gravel Aquifer (Rg)

LEGEND

Applicants Land Interest (c. 65.1 ha)

Waste Licence Application Area (c. 21.4 ha)

NOTES

1. Extract from Ordnance Survey Discovery Map No. 50

2. Ordnance Survey Ireland Licence No. SU 0000709 (c) Ordnance Survey Ireland / Government of Ireland

0 800m 2000

Metres

1:25,000

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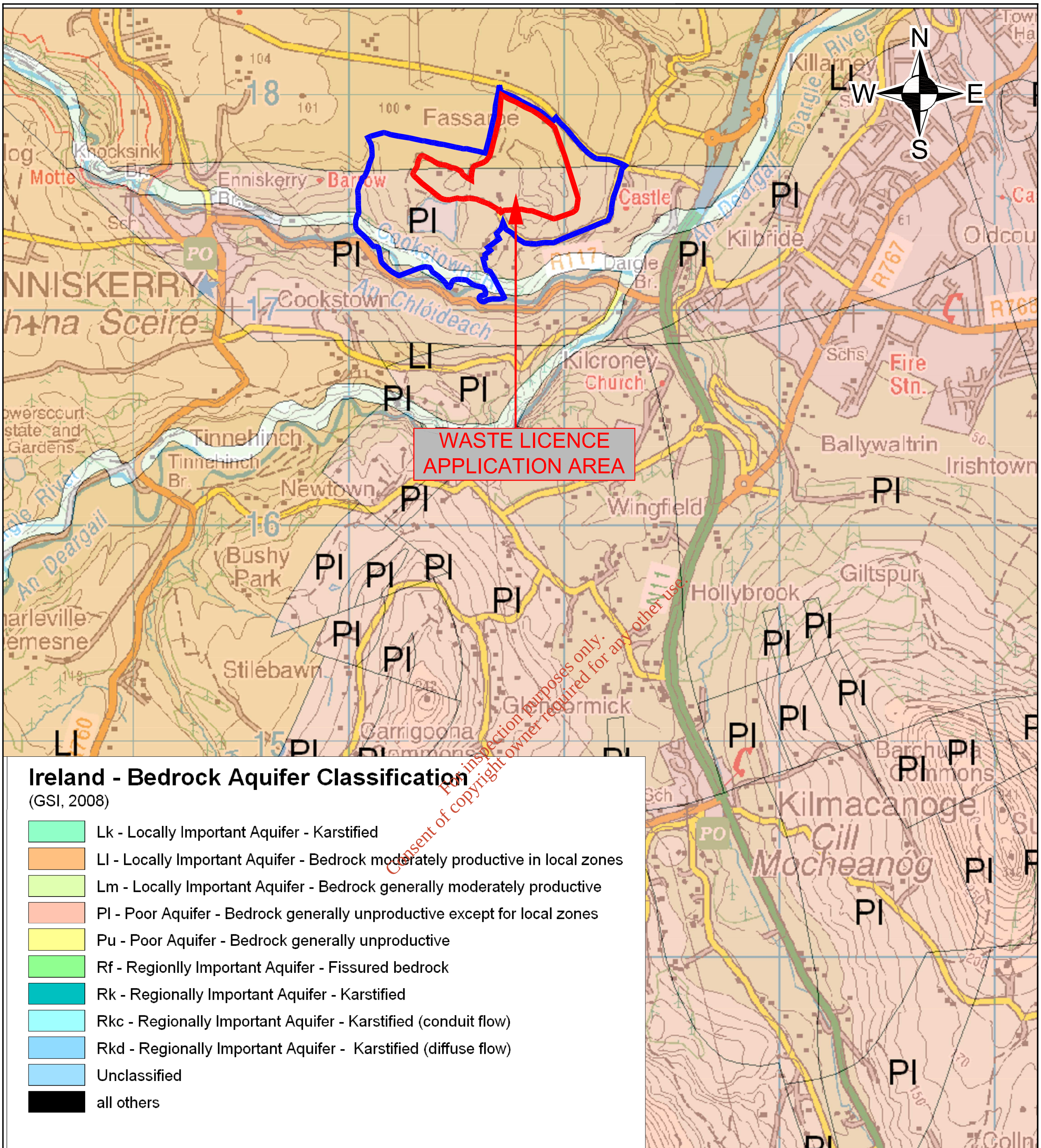
GRAVEL AQUIFER

FIGURE 6.2

Scale	Date
1:25,000 @ A4	APRIL 2009

0059.00017.18.FIG 6.2.0.GRAVEL AQUIFER



LEGEND

Applicants Land Interest (c. 65.1 ha)

Waste Licence Application Area (c. 21.4 ha)

NOTES

1. Extract from Ordnance Survey Discovery Map No. 50

2. Ordnance Survey Ireland Licence No. SU 0000709 (c) Ordnance Survey Ireland / Government of Ireland

0 800m 2000

Metres
1:25,000

0059.00017.18.FIG 6.3.0.BEDROCK AQUIFER

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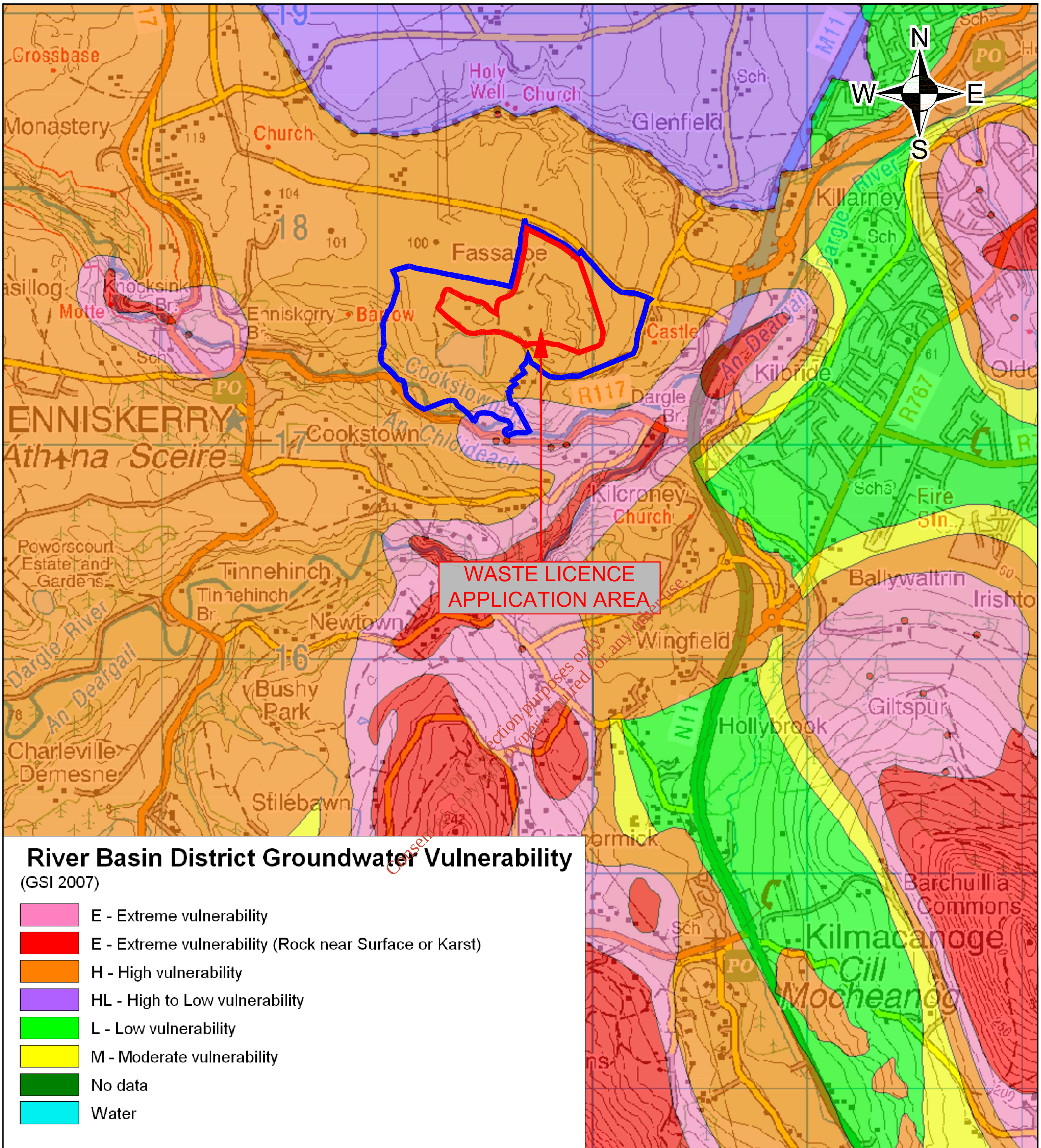
BEDROCK AQUIFER

FIGURE 6.3

Scale	Date
1:25,000 @ A4	APRIL 2009



River Basin District Groundwater Vulnerability

(GSI 2007)

- E - Extreme vulnerability
- E - Extreme vulnerability (Rock near Surface or Karst)
- H - High vulnerability
- HL - High to Low vulnerability
- L - Low vulnerability
- M - Moderate vulnerability
- No data
- Water

LEGEND

- *Applicants Land Interest (c. 65.1 ha)*
- *Waste Licence Application Area (c. 21.4 ha)*

NOTES

1. Extract from Ordnance Survey Discovery Map No. 50

2. Ordnance Survey Ireland Licence No. SU 0000709 (c) Ordnance Survey Ireland / Government of Ireland

0 800m 2000

Metres

1:25,000

0059.00017.18.FIG 6.4.0.GW VULNERABILITY

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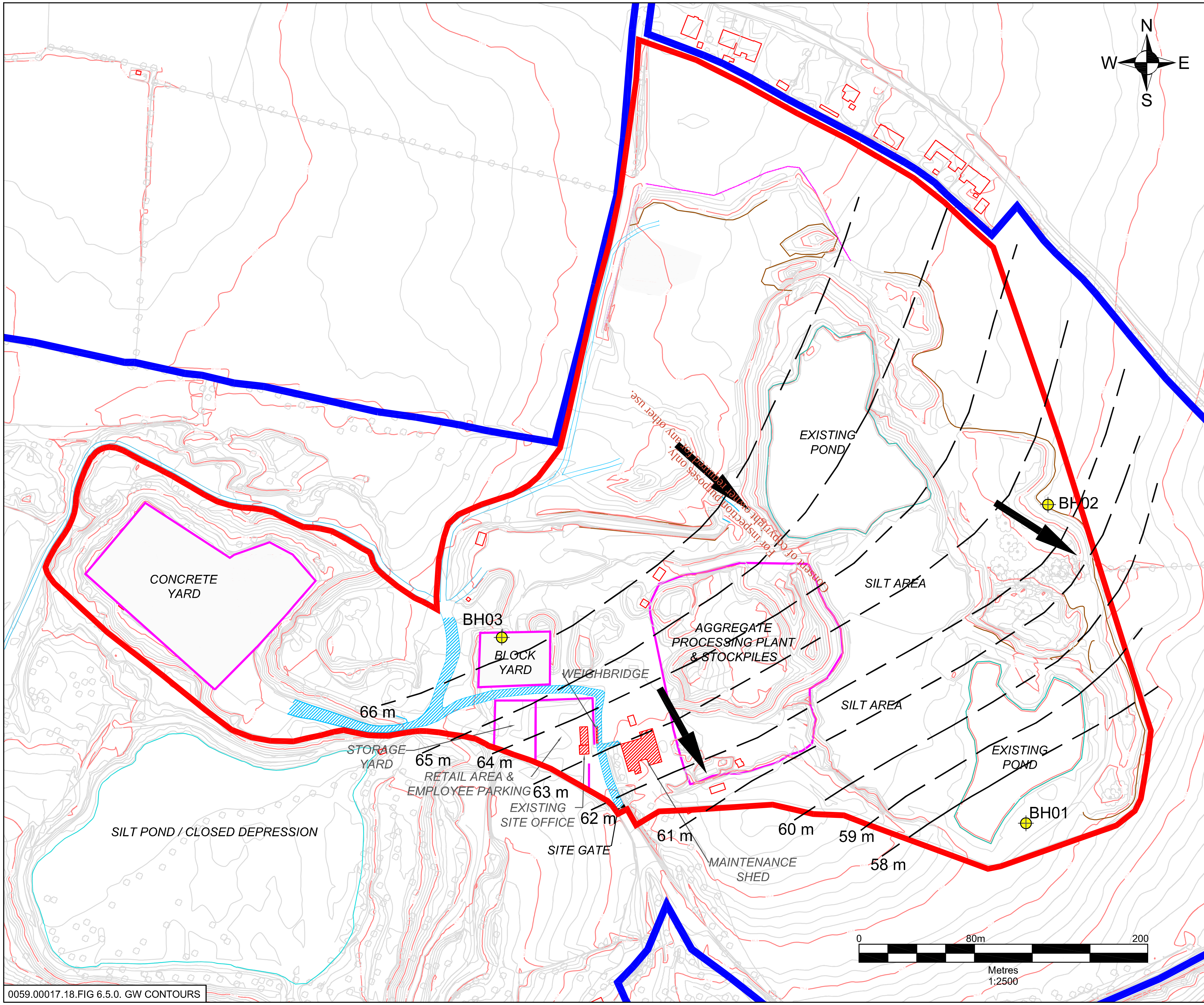
GROUNDWATER VULNERABILITY

FIGURE 6.4

Scale	Date
1:25,000 @ A4	APRIL 2009



NOTES

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2. Ordnance Survey Ireland Licence no. SU 0000709 (c) Ordnance Survey of Ireland & Government of Ireland

LEGEND

- Applicant's Land Interest (c. 65.1 ha)
- Waste Licence Application Area (c. 21.4 ha)
- Borehole Location
- Internal Unpaved Road
- Internal Paved Road
- Building

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GROUNDWATER CONTOURS

FIGURE 6.5

Scale	Date
1:2,500 @ A3	APRIL 2009

0059.00017.18.FIG 6.5.0. GW CONTOURS