13.0 HYDROGEOLOGY

INTRODUCTION

13.1 This section assesses the potential impact of the proposed landfill development at Meenaboll on groundwater quality downgradient of the proposed landfill. The impact on surface waters is considered in Section 12.0. The assessment was based on the specific geological conditions prevailing at the site (as outlined in Section 11.0) and the proposed design of the landfill as an engineered containment facility (as outlined in Section 6.0).

13.2 The protection of surface and groundwater resources is a determining factor in the assessment of the acceptability of a site for landfill development. The potential impact on surface and groundwater resources generally depends on the prevailing geological and hydrogeological setting of the landfill and the nature and volume of any leachate leakage from the site.

13.3 The potential environmental impacts on groundwater and surface waters that may arise from landfilling of wastes principally relate to the generation of leachate within the landfill and its leakage into the environment. Leachate is generated by the infiltration of rainfall into the waste and its combination with the solutes produced by decomposing organic waste and liquid waste inputs. Historically, many of the problems associated with landfills occurred as a result of their operation as non-engineered 'dilute and disperse' facilities which permitted the uncontrolled migration of leachate into the environment. Under current legislation, however the primary objective of landfill design is to provide effective control measures to prevent or reduce as far as possible leachate emissions from a site to ensure potential impacts on the environment are reduced to an acceptable level.

13.4 Landfill sites are subject to a range of legislative controls, which relate to the protection of groundwater resources. These principally include the Waste Management Act of 1996, Waste Management (Licensing) Regulations, 1997 and the Local Government (Water Pollution) Act, 1977. These relate to the EC Groundwater Directive (80/86/EEC), the Landfill Directive (1999/31/EC) and the Water Framework Directive (2000/60/EEC).

13.5 The Environmental Protection Agency (EPA) is responsible as the regulatory body, for the implementation and enforcement of this legislation in relation to the protection of water resources from potential impacts arising from landfill developments.

13.6 The EPA Manual on Landfill Site Design requires that the design and engineering of a landfill should be supported by a comprehensive risk assessment. In particular this should assess the risk of any adverse environmental impacts on both groundwater and surface waters that may arise as a result of the proposed landfill development.

METHODOLOGY

13.7 In accordance with the EPA Licensing Guidelines the following assessments have been carried out for the proposed landfill site at Meenaboll:

- Site Investigation;
- Groundwater Protection Rating;
- LandSim Probalistic Risk Modelling.

13.8 A site investigation, as outlined in Section 11, was undertaken to determine the suitability of the site specific geological and hydrogeological conditions for the proposed landfill development. The initial phase of the investigation was based on a desk study of geological information and a walkover survey of the site. This was followed by a non-intrusive geophysical survey that was undertaken in two stages. Stage 1 was set out on a 50m grid across the study area and used to profile the thickness of the overburden deposits and identify possible fracture zones within the bedrock. The Stage 2 survey comprised four continuous profiles through the proposed landfill area, which were undertaken to further investigate the competence and structure of the rock. Four further survey lines were also undertaken in the downgradient area of the site to trace the continuation of a dyke, identified by the Stage 1 survey beyond the watershed divide that separates the River Finn and Owenbeg River catchments. The Stage 1 geophysical survey was followed by an intrusive ground investigation that comprised of 50Nr MacIntosh probes, 22Nr trial pits and 13Nr rotary drilled boreholes. The boreholes were used to target identified geophysical anomalies and included in situ tests to determine the engineering characteristics and hydraulic properties of the overburden and bedrock deposits. Standpipes were also installed in all the boreholes to monitor the groundwater flow regime beneath the study area and to facilitate the recovery of groundwater samples for chemical analysis.

13.9 The objectives of the investigation were to:

- Develop a conceptual ground model for the site and an understanding of the groundwater flow regime,
- Determine the hydraulic properties of the solid and drift deposits,
- Determine the aquifer potential and vulnerability of groundwater resources,
- Determine the hydraulic gradient of the water table and direction of groundwater flow,
- Identify and trace possible fracture zones and assess their influence on groundwater flow,

- Establish the chemistry of groundwater at locations upgradient, downgradient and beneath the site as a baseline reference for any future monitoring

13.10 The assessment of the sites suitability for development as a landfill was based on the groundwater protection scheme developed by the Geological Survey of Ireland (GSI) for the selection and management of landfill sites.

13.11 The impact of the proposed landfill on groundwater was also examined within the context of a risk management framework, following the source-pathway-target model related to the site specific conditions. This was based on the LandSim2 software, that has been developed as a probabilistic risk assessment tool for quantifying the potential impact of a landfill site on groundwater resources.

13.12 The LandSim2 model allows the environmental performance of landfill liner and leachate collection systems to be evaluated. This enables the engineering design to be optimised to ensure potential impacts on the local groundwater resources are minimised.

ENVIRONMENTAL SETTING

13.13 The environmental impact of a landfill site is examined in the overall context of its setting within the hydrological cycle. This represents a closed system that relates to the water budget of a catchment area, which takes into account climatic conditions, including the amount of rainfall that provides recharge to the surface water and groundwater systems via which water is transmitted back to the oceans. The groundwater and surface water systems downgradient of a landfill represent the principal resources that may be impacted by the leakage of landfill leachate into the environment.

13.14 The proposed landfill site at Meenaboll will enclose approximately 4.5 hectares of coniferous forestry plantation land that extends across the western flank of the Meenaboll Hill between the 220 and 240mOD contour intervals. The site is situated within the catchment of the River Finn, which is confirmed by the course of a minor stream bounding the northeastern margin of the site. This minor stream is connected to the Sruhanpollandoo stream a tributary of the River Finn. The watershed that divides the River Finn catchment from the Ownbeg River catchment is located to the northeast of the site beyond the minor stream, as identified in Section 12 of the EIS.

Meteorology

13.15 The meteorology of the Meenaboll area is typical of upland areas situated on the western seaboard of Ireland, where rainfall is distributed throughout the year, with the months from October to January generally being the wettest. The 30 year standard annual average rainfall map for the area, indicates that an average precipitation of 1500mm/year falls over the site.

13.16 Potential evapotranspiration (PE) data for the Donegal region is measured by Met. Eireann at the synoptic weather station at Malin Head. The standard annual average data for 1968-97 indicates that 577mm/year of the incident rainfall is lost through evapotranspiration per annum.

13.17 On the basis of the above the effective rainfall (incident rainfall minus potential evapotranspiration) for the landfill site would equate to approximately 923mm/year.

Landfill Operation

13.18 The proposed landfill site will comprise of 5 phases of either 1 or 2 cells. To meet Landfill Directive standards the landfill will be engineered as a fully lined containment landfill facility with a full range of leachate management and control systems as outlined in Section 6 of the EIS.

HYDROGEOLOGY

13.19 The movement of contaminants through the groundwater system is governed by the ground conditions and hydrogeological regime specific to a site, which relates to :

- Hydraulic properties of the overburden deposits and bedrock,
- Influence of structural features such as faults,
- Hydraulic gradient of the water table

Ground Conditions

13.20 The ground conditions recorded by the geophysical surveys and exploratory investigations at Meenaboll are described in Section 11 of this environmental statement.

13.21 No exposures of bedrock were recorded across the site, which is mantled by glacial till deposits in turn overlain by peat. Beneath the proposed landfill site the overburden generally comprises 2.5m to 3.0m of glacial till, overlain by a 1.5m mean thickness of peat.

13.22 The bedrock beneath the site is assigned to the Upper Falcarragh Pelite Formation a sequence of schistose metamorphic rocks. In accordance with this the strata recorded in exploratory boreholes predominantly comprised of psammitic (metamorphosed sandstone) schists with sub-ordinate pelite (metamorphosed mudstone) horizons.

13.23 The geophysical survey of the study area indicated the rock was a strong compact material with little weathering or fracturing. This aspect was confirmed by exploratory investigations, where competent rock was recorded in borehole cores beneath a shallow (0.5m to 2m deep) heavily fractured and weathered horizon below the bedrock surface.

13.24 The geophysical survey of the study area also identified a possible fracture zone, running southeast to northwest along the line of a minor stream that parallels the northeastern boundary of the proposed landfill. This feature was investigated by exploratory boreholes (BH1, 2 and 6), where solid cores of the rock were recovered to determine the frequency of fractures and to characterise the geophysical anomaly. The cores recorded a 3.4m thick metadolerite intrusion of igneous rock into the metamorphic rock at Borehole 1 and fracturing healed by quartz veining in Boreholes 2 and 6. The feature was therefore interpreted as a minor fault or fracture zone, that had been intruded by a dyke of igneous rock and healed by quartz veining, possibly associated with hydrothermal mineralisation during the igneous intrusion.

13.25 The dyke represents a potential hydraulic boundary that may locally influence the groundwater flow regime, by acting as a barrier to transverse groundwater movement towards the watershed of the Gartan catchment. The trend of the dyke was traced during the Stage 2 geophysical survey to determine whether it extended into the River Finn or Owenbeg River catchment. It was found that the dyke continues in northwest direction and extends across the head of the Sruhanpollandoo stream that lies in the River Finn catchment.

Hydraulic Properties

13.26 The hydraulic characteristics of the overburden, bedrock materials and the identified minor fault/dyke were determined by in situ variable head tests undertaken in boreholes during the exploratory investigations for the proposed landfill. The range of permeability results determined are listed in Table 13.1

Table 13.1 Summary of Permeability Test Results

Stratum Description	Permeability (m/sec)
Drift Geology	
Glacial Till	$3.4x10^{-4}$ to $2.5x10^{-7}$
Solid Geology	
Psammitic Schist	$6.1x10^{-4}$ to $7.4x10^{-7}$
Minor Fault/ Dyke	$4.1x10^{-5}$ to $6.4x10^{-7}$

13.27 The results indicate that the permeability of the glacial till varies by up to 3 orders of magnitude being comparable with the typical range (10^{-5} to 10^{-7} m/sec) of silty fine sands and silts. The range of values reflects localised variations in the grading of the ill-sorted material. The higher permeability values (10^{-4} m/sec) relate to the sand and gravel horizons, while the low values (10^{-7} m/sec) relate to fine grained silt and clay horizons. The ground investigation records indicate that the sand horizons are laterally discontinuous.

13.28 The rocks underlying the study area are fine grained crystalline materials which lack significant intergranular porosity. Groundwater movement through the bedrock is therefore principally confined to fractures or other discontinuities within the rock mass, including cleavage and joint planes. In accordance with this the range in permeability values recorded for the bedrock may be related to the frequency of fractures. The higher values (10^{-4} m/sec) generally relate to the more permeable heavily fractured and weathered horizons near surface, while the low values of (10^{-7} m/sec) relate to the more competent bedrock at depth. Logs of the rock cores recovered within the proposed landfill site recorded a 0.5m to 2m deep heavily fractured and weathered horizon near surface. Below this weathered horizon the cores recorded the rock mass is generally dissected by medium spaced tight fractures, conditions represented by the mean permeability value of 10^{-5} m/sec.

13.29 The in situ tests undertaken in boreholes put down on the minor fault/dyke, recorded permeability values equivalent or slightly lower than that of the surrounding psammitic schist. This situation possibly reflects the healing of the fractures by the intrusion of the metadolerite dyke and quartz veins. On this basis it is anticipated that the fault/dyke plane would not have a significant influence on the local groundwater flow regime. The Stage 2 geophysical survey recorded that this feature continues in a northwest direction and extends across the Sruhanpollandoo stream, which lies within the River Finn catchment.

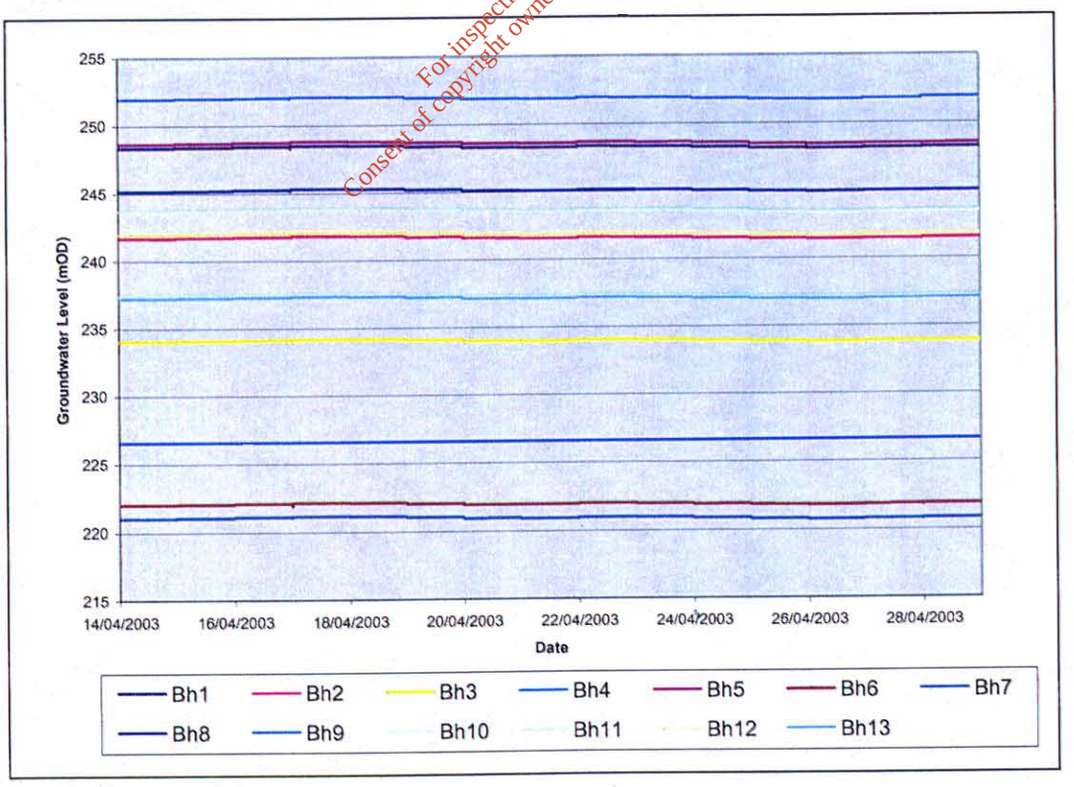
Groundwater Movement

13.30 In accordance with the surface water drainage system, groundwater flow is confined to independent sub-catchments. The proposed landfill lies within the River Finn catchment, being bounded by a minor stream that flows into the Sruhanpollandoo stream, a tributary of the River Finn.

13.31 The hydraulic gradient of the water table typically mirrors the surface contours of the terrain. The western flank of Meenaboll Hill represents the main area for rainfall recharge to the groundwater system upgradient of the landfill site. The area to the northwest of the proposed landfill represents the downgradient area with regard to groundwater movement from the site, flow being directed toward the Sruhanpollandoo stream.

13.32 To facilitate groundwater monitoring, boreholes put down within the study area were installed with standpipe piezometers sealed into the bedrock. The standpipes were fitted with digital water level loggers to facilitate remote continuous monitoring of groundwater levels, the data being downloaded for analysis on a periodic basis. The results of the groundwater level monitoring for each borehole between April and May 2003 are presented as hydrographs in Graph 13.1.

Graph 13.1 Borehole Hydrographs



13.33 The borehole hydrographs indicate that the groundwater level within the study area is relatively constant, being encountered at shallow depth. This corresponds with the fully saturated nature of the subsoils and the groundwater observations recorded by trial pit investigations where seepages to slight flows of groundwater were recorded within the permeable drift and fractured rock horizons near the bedrock surface. Such high water table conditions are generally associated with impeded infiltration as indicated by the widespread development of peaty subsoils within the development area.

13.34 The borehole hydrographs were also used to construct hydraulic contours for the water table surface, as indicated by Figure 13.2. The hydraulic contours indicate that groundwater flow is inclined in a northwest direction. The hydraulic gradient broadly corresponds with the slope of the ground surface that is inclined toward the Sruhanpollandoo stream valley. The hydrographs also indicate that the minor fault/dyke which extends along the minor stream does not have a significant influence on groundwater flow. This corresponds with the similar range in hydraulic conductivity values recorded in boreholes for this feature and the psammitic schist that underlies the landfill area.

Baseline Groundwater Quality

13.35 To establish the baseline chemistry of groundwater within the study area and downgradient of the proposed landfill development, water samples were recovered from the borehole standpipe installations for geochemical analysis on 15th April 2003. The water samples were analysed by Alcontrol Laboratories Ireland, an ISO17025 and UKAS accredited laboratory, for a suite of contaminants listed in the EPA manual on Landfill Monitoring. The results of this analysis are presented in Table 13.2.

Table 13.2 Baseline Groundwater Quality Results

Contaminant Parameter	Units	Upgradient		Landfill Area				Downgradient		Drinking Water Standard
		BH1	BH5	BH3	BH7	BH10	BH13	BH6	BH9	
Arsenic	ug/l	<5	<5	<5	<5	<5	<5	<5	<5	50
Barium	mg/l	0.08	0.12	<0.05	<0.05	0.08	0.07	0.05	0.19	1
Boron	mg/l	0.82	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	2
Cadmium	ug/l	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	0.7	<0.4	5
Calcium	mg/l	31.73	40.55	11.89	15.87	43.05	32.82	33.92	27.75	250
Chromium	ug/l	<1	<1	<1	<1	<1	<1	<1	<1	50
Copper	ug/l	<5	<5	9	<5	<5	<5	<5	<5	3000
Iron	ug/l	7	3	1119	2	13	9	3	29	200
Lead	ug/l	<5	<5	<5	<5	<5	<5	<5	<5	50
Magnesium	mg/l	9.40	8.75	3.02	3.53	7.29	6.69	7.78	5.90	50
Manganese	ug/l	787	1672	602	383	618	1116	197	411	50
Mercury	ug/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	1
Nickel	ug/l	<10	<10	<10	<10	<10	<10	<10	<10	50
Phosphorous	mg/l	<0.05	<0.05	0.06	0.07	<0.05	0.10	0.07	<0.05	2.2
Potassium	mg/l	5.2	4.6	1.8	1.0	3.6	2.8	3.8	3.4	12
Selenium	ug/l	<5	<5	<5	<5	<5	<5	<5	<5	10
Silver	ug/l	<10	<10	<10	<10	<10	<10	<10	<10	10
Sodium	mg/l	13.6	14.8	13.6	13.8	12.0	11.2	18.0	27.5	150
Zinc	ug/l	5051	9012	59	424	5310	133	4989	15	5000
Ammoniacal Nitrogen	mg/l	<0.2	<0.2	1.7	0.3	<0.2	0.3	<0.02	<0.2	0.5
Chloride	mg/l	1	38	<1	<1	17	2	<1	3	400
Electrical Conductivity	mS/cm	0.332	0.358	0.186	0.184	0.373	0.314	0.321	0.320	1.5
Fluoride	mg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.5
pH	pH units	6.97	6.85	6.79	6.68	6.93	6.86	7.47	7.26	5.5-9.5
Sulphate	mg/l	6	<3	45	<3	16	7	6	11	250
Total Alkalinity as $CaCO^3$	mg/l	140	320	60	80	170	130	40	130	>30
Total Cyanide	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Total Organic Carbon	mg/l	95	6	21	4	7	11	5	8	
Total Oxidised Nitrogen	mg/l	<0.3	<0.3	<0.3	<0.3	0.3	<0.3	<0.3	<0.3	
Total Phenols	mg/l	<0.01	<0.01	<0.01	<0.01	0.04	0.02	0.55	<0.01	0.5
Dissolved Oxygen	mg/l	5.3	5.9	6.1	5.9	6.1	5.9	6.4	6.0	
Total Solids	mg/l	265	231	97	129	259	179	211	192	

13.36 The chemical test results indicate that the groundwaters of the study area are calcium bi-carbonate type, being weakly mineralised and slightly acidic. The concentration of the majority of ions analysed was found to be low and well below the maximum allowable concentration set by the EEC Drinking Water Standards. However concentrations of manganese, and locally iron and zinc were recorded at levels exceeding the maximum permissible drinking water standard. This situation relates to the mineralogy of the bedrock.

13.37 In addition to the above total organic carbon and total oxidised nitrogen levels were low while dissolved oxygen levels were good. This situation reflects the absence of sources of agricultural pollution in the area. Ammonia and chloride levels as key indicators of agricultural contamination and landfill leachate are also low.

13.38 On the basis of the above the groundwater beneath the site would be considered good quality, and suitable for sustaining a freshwater ecosystem. It should also be suitable for human consumption though possibly requiring preliminary treatment to reduce the naturally occurring manganese and iron concentrations that affect taste.

GROUNDWATER AND SURFACE WATER ABSTRACTIONS.

13.39 A principal consideration that controlled the siting of the proposed landfill within the study area was that it should lie outside the Lough Gartan catchment area, which is used as a public water supply. Investigation and modelling of the surface water and groundwater regimes in the area have established that the watershed that divides the Finn catchment from the Lough Gartan catchment is located across the slope some 300m beyond the proposed landfill boundary. The investigations demonstrated that the groundwater and surface water that drains through the study area is directed toward the Finn catchment. Therefore there will be no impact on surface water and groundwater abstractions with the Lough Gartan catchment.

13.40 The groundwater and surface water abstractions identified in the vicinity downgradient of the proposed landfill are shown in Figure 13.1. The groundwater abstractions were identified by a search of the GSI borehole database for a 5km area around the proposed landfill.

13.41 The nearest recorded groundwater abstraction points within the Finn catchment comprise a number of bored wells that are used as private supplies around the village of Glendowan, which is situated 5km to the northwest in the Ownbeg River catchment. An unlisted well used for domestic supplies to a rural community, is also reported 3km to the southwest of the site. It is located on the western flank of the Meenatinny Hill below the confluence of the Sruhanpollandoo stream with the Cummirk River, where it lies in a sub-catchment of the River Finn that is separate from that enclosing the landfill.

13.42 The River Finn and its tributary the Sruhanpollandoo stream are not used as surface water drinking supplies for human consumption.

13.43 The principal surface water body that is used as a potable watersource in the area is Lough Gartan that is fed by the Owenbeg River. As the Owenbeg River drains the adjacent but separate surface water catchment to the site, it will not be affected by the landfill development. The watershed divide between the Finn and Owenbeg catchments is marked by a subtle change in the orientation of the topographic contours beyond the minor stream bounding the northeast margins of the proposed landfill development. Groundwater flow beneath the proposed landfill site is also directed toward the River Finn catchment.

GROUNDWATER PROTECTION RATING

Methodology

13.44 Groundwater protection policy for the development of landfills in Ireland has been developed by the Geological Survey of Ireland (GSI) as a Groundwater Protection Matrix. This provides a determination of the acceptability of the proposed site for development as a landfill, based on the prevailing geological conditions at the site. Application of the matrix incorporates two main elements, namely:

- Groundwater Vulnerability Rating: This is based on the geological and hydrogeological setting of the site. The rating ranges from Extreme (E) where bedrock is at or near surface to Low (L) where bedrock is overlain by in excess of 10 m of low permeability overburden;
- Resource Protection Rating: This is based on the value and importance of the groundwater aquifer underlying and downgradient of the site. Aquifers are classified by a prefix code according to their importance as a resource. Major aquifers are designated to be of Regional Importance (R), minor aquifers to be of Local Importance (L) whilst unproductive aquifers are described as Poor (P). These codes are further qualified by a suffix, which reflects the productivity and nature of the aquifer zone. The suffix (k) reflects conduit flow, (f) reflects fracture flow, (g) reflects intergranular flow, (m) reflects moderate productivity, and (u) reflects poor productivity, whilst (l) reflects localised zones of productivity.

13.45 These factors are incorporated into a groundwater protection matrix, presented in Table 13.3. The matrix yields a code of acceptability for sites proposed for landfill development. This ranges from *Acceptable* (R1 and $R2^{1-2}$) to *Not Acceptable* (R4), with ($R3^{1-2}$) designated as being *Generally Not Acceptable*. Landfills taking domestic/municipal waste should ideally plot in the bottom right hand corner of the matrix.

Table 13.3 Groundwater Protection Scheme Matrix for Landfills (after Daly, 1995)

Vulnerability Rating	Resource Protection					
	Regionally Important		Locally Important		Poor Aquifers	
	Rk	Rf/Rg	Lm/Lg	Ll	Pl	Pu
Extreme (E)	R4	R4	R3[2]	R2[2]	R2[2]	**R2[1]**
High (H)	R4	R4	R3[1]	R2[1]	R2[1]	R1
Moderate (M)	R4	R3[1]	R2[2]	R2[1]	R2[1]	R1
Low (L)	R3[1]	R3[1]	R1	R1	R1	R1

Groundwater Vulnerability Rating

13.46 In accordance with the engineered design of the proposed landfill development, the overburden cover will be removed and formation levels reduced below rockhead levels over the base area of the site. On this basis the groundwater vulnerability rating (after Daly & Warren, 1994) is classified as Extreme (E) as no natural protection would be afforded following removal of the overburden.

Resource Protection Rating

13.47 The potential of a bedrock aquifer to yield water in significant quantities depends on the capacity of the strata to store and transmit water through intergranular pores or fissures. Aquifers are therefore classified according to their potential yield, which relates to their importance as either a regional, local or poor groundwater resource. The resource potential of bedrock aquifers underlying the South Donegal region has been provisionally determined by the Geological Survey of Ireland (GSI), based on local well information and hydrogeological investigations.

13.48 In accordance with the GSI classification rocks are subdivided into Regionally Important (R), Locally Important (L) or Poor (P) aquifers. Regionally important aquifers represent rocks with a large capacity to store and yield significant quantities of groundwater sufficient for public supply purposes. Locally important aquifers are capable of yielding sufficient water for group schemes or villages. Poor aquifers represent low permeability rocks that are generally unproductive, with yields only sufficient for domestic supply purposes.

13.49 The Geological Survey of Ireland (GSI) classify the metamorphic strata of the Upper Falcarragh Pelite Formation as a '*Poor and generally unproductive aquifer*'. On this basis the strata are provisionally assigned the code "Pu" by the GSI.

13.50 In accordance with the GSI classification in situ testing undertaken during the exploratory ground investigation indicates the metamorphic rock underlying the site has a low permeability, and by association a limited transmissivity and storage potential. On this basis the potential yield from the rocks would be limited. No evidence of high density fracture zones that would increase the permeability of the strata was recorded during the site investigation and the rock underlying the landfill was recorded by the geophysical survey as a strong competent material without significant fracturing. This aspect was verified by intact cores recovered in exploratory boreholes.

13.51 The minor fault/dyke that runs along the minor stream on the northern boundary of the site represents a hydraulic boundary to transverse groundwater movement. It has a similar or slightly lower permeability than the rock underlying the site. Groundwater monitoring indicates it does not have a significant influence on groundwater flow or act as a potential pathway for accelerated groundwater movement.

Assessment of Groundwater Protection Rating

13.52 The combination of the groundwater vulnerability and resource protection ratings for the site give the rating code **R2**[1] (Table 13.3), which is defined as follows:

R2[1] Acceptable Subject to Guidance in the EPA Landfill Design Manual or conditions of a waste licence.

- Special attention should be given to:

1. Checking for high permeability zones
2. Wells downgradient
3. Projected future development of the aquifer

13.53 The geophysical survey and targeted ground investigation identified no significant fracture zones within the site, and the interpretative geophysical report considers that it is highly unlikely that there are any unknown minor fault or fracture zones under the site. In addition in situ permeability tests and groundwater monitoring indicate that the identified minor fault/dyke does not have a significant influence on groundwater flow. On this basis the site would be considered acceptable.

13.54 The nearest groundwater abstraction to the proposed landfill is located 3km to the southwest, on the western flank of the Meenatinny Hill, which lies in a sub-catchment of the River Finn, separate from the landfill sub-catchment. The proposed landfill development will not impact on this supply.

13.55 No significant future development of the aquifer is considered likely, based on the poor yield, the remoteness of the site and the dispersed nature of the rural community.

13.56 In accordance with the EPA Landfill Design Manual the design proposals for the protection of groundwater resources have included the phased development of the site in bunded cells, with progressive capping and restoration of the completed areas. The engineered containment systems included in the design for the site will minimise leachate leakage from the site, while operational practices and leachate management systems will also control leachate generation and build up within the site.

LANDSIM PROBABILISTIC RISK ASSESSMENT MODELLING

13.57 The impact of a landfill site on groundwater resources is examined within the context of a risk management framework following the source-pathway-target model for all potential exposure linkages. This is related to the hydrological setting of the site and the prevailing geological and hydrogeological conditions determined by the geophysical survey and exploratory ground investigations.

13.58 The source of contamination at any landfill site relates to the leachate generated by rainfall infiltration into the landfill. The principal migration pathway relates to the leakage of leachate through defects in the basal lining of the engineered containment system. The secondary migration pathway relates to the migration of contaminants under a hydraulic gradient through the bedrock aquifer toward a specified compliance point.

13.59 The nearest recorded groundwater abstraction points to the site is an unlisted well used for domestic supplies to a rural community, 3km to the southwest of the site. Therefore as there are no groundwater abstraction points in the immediate vicinity of the proposed development, the impact on groundwater quality was examined at an assumed compliance point. This point is represented by site investigation borehole BH9 that is located 50m downgradient of the edge of the proposed landfill. Full details of the LandSim analysis carried out are included in Appendix E.

Assessment of LandSim Results

13.60 The LandSim modelling indicates that the volume of leachate leakage from the proposed landfill will be minimal following its development as an engineered containment landfill, operated in accordance with current best practices with phased capping and restoration.

13.61 The results indicate that no significant contaminant loading on groundwater quality arises from the leakage from the engineered containment phases. The model indicates that containment levels should remain below current Interim Guideline Values (IGV) for groundwater quality, with the exception of possible minor elevations for at the compliance point. This is unlikely to persist over the long-term or extend significantly beyond the compliance point. On this basis the proposed development of a fully engineered containment landfill site at Meenaboll would meet the requirements of the EC Landfill Directive and Groundwater Directive with respect to off site compliance.

IMPACTS AND MITIGATING MEASURES

Impacts

13.62 The proposed landfill site is underlain by a poor bedrock aquifer that is generally considered to be unproductive. Under the Geological Survey of Ireland groundwater protection scheme, the site is classified as acceptable for development as a landfill site subject to the guidance in the EPA Landfill Design Manual.

13.63 Environmental pollution with respect to surface water and groundwater resources is defined in Section 40(4)(b) of the Waste Management Act, 1996, as:
"the holding, transport, recovery and disposal of waste in a manner which would to a significant extent endanger human health or harm the environment, and in particular:
a) Create a risk to waters, the atmosphere, land, soil, plants and animals".

13.64 Following the above the phased development of the proposed landfill, as a fully engineered lined containment landfill facility with a range of leachate collection and management systems, is designed to minimise leakage from the site and mitigate any further groundwater impacts.

13.65 A probabilistic analysis of the final phase of landfilling operations indicates that no additional impact on groundwater quality arises from the proposed extension as the volume of leakage is minimised by the engineering measures included in the design and by the progressive capping of completed phases.

13.66 On the above basis the proposed development would satisfy the requirements of Section 40(4)(b) of the Waste Management Act, 1996. The risk modelling indicates that the site is suitable for development as an engineered landfill and that ongoing operations are unlikely to cause a significant impact on groundwater quality.

Mitigating Measures

13.67 In accordance with the EPA Landfill Design Manual the proposed landfill will be an engineered lined containment landfill facility with a range of leachate management controls designed to minimise leakage from the site and resultant impacts on groundwater quality.

13.68 The impact of leachate parameters on the basline groundwater quality will also be monitored to ensure compliance with environmental quality standards following development of the proposed landfill. The groundwater control and trigger levels would therefore be reviewed on an annual basis.

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FIGURES

1. KEY

5km RADIAL AREA

STUDY AREA EXTENTS

PROPOSED LANDFILL SITE

GROUNDWATER WELL (GSI REFERENCED)

PRIVATE WELL (NOT UTILISED BY GSI)

N

SCALE: 1:50,000

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Donegal County Council

PROJECT

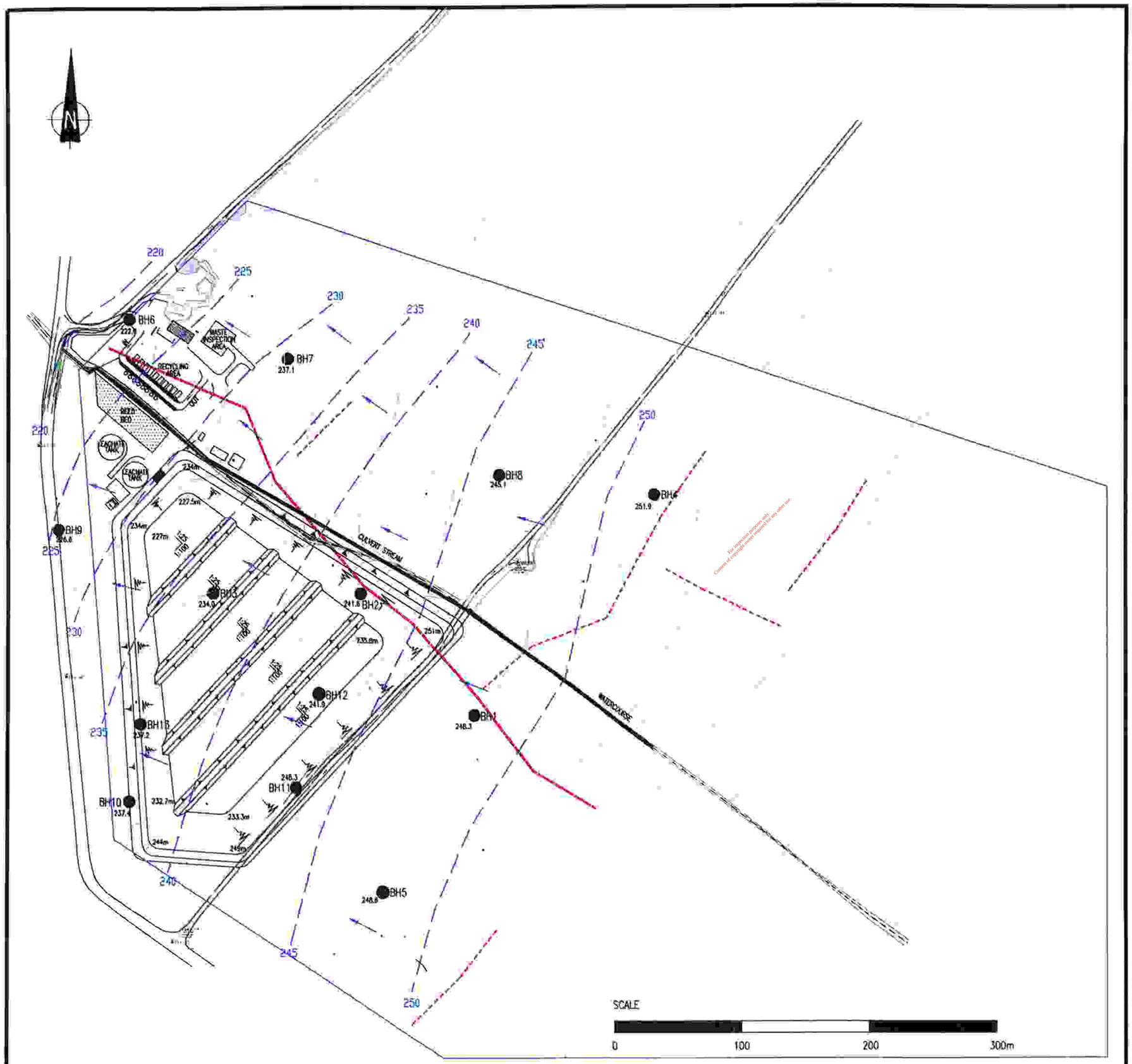
MEENABOLL LANDFILL PROJECT

TITLE

GROUNDWATER AND SURFACE WATER EXTRACTIONS

FIGURE

13.1



1. KEY

- BH 248.8 — BOREHOLE WITH RECORDED GROUNDWATER LEVEL
- 245 — GROUNDWATER CONTOUR IN METRES ABOVE ORDANANCE DATUM
- GROUNDWATER FLOW DIRECTION
- FAULT/DYKE
- MINOR FAULT
- STUDY AREA EXTENTS
- PROPOSED LANDFILL SITE

SCALE: 1:3000

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Donegal County Council

PROJECT

MEENABOLL LANDFILL PROJECT

TITLE

GROUNDWATER CONTOUR PLAN

FIGURE

13.2