

**A GROUNDWATER MONITORING  
STRATEGY  
FOR  
NORTHERN IRELAND**

**SEPTEMBER 2000**



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# GROUNDWATER MONITORING POLICY STATEMENT

**The Environment and Heritage Service (EHS) is committed to monitoring the groundwater resources of Northern Ireland (NI) in line with national and international commitments through a programme of sampling from an identified representative network of boreholes and springs. This network will be used to determine baseline groundwater quantity and quality. Further sampling and analysis may be carried out to detect contaminants depending upon baseline monitoring results and any future risk assessment studies.**

## 1. INTRODUCTION

Groundwater is an integral part of the water cycle. It occurs in permeable rocks, known as aquifers, which are at least partly saturated as a result of the infiltration of rainfall. Groundwater emerges from aquifers at springs or can be pumped from wells or boreholes. Springs drain naturally into rivers and groundwater can provide the entire flow in dry periods (base flow). The discharge from aquifers also helps to conserve wetlands and standing waters, ie lakes.

Groundwater sustains an important component of the water supply of NI. About 8% of the water in the public supply system is drawn directly from boreholes and springs, and additional supplies are taken from private groundwater sources for industrial, agricultural or domestic use. As previously mentioned, groundwater storage contributes baseflow to surface streams, rivers and lakes, abstractions from which, amount to a further 52% of the total public water supply. The remaining 40% is drawn from upland sources such as reservoirs.

Groundwater is therefore an important and valuable resource that requires protection. The risks to groundwater are twofold. One is that over abstraction from an aquifer may reduce the level of the water table and so deplete baseflow to surface

waterways or may cause lower yields for some groundwater users. Such depletion may, in some coastal aquifers, have an adverse effect on groundwater quality by encouraging saline water to come into circulation.

The second risk is that the activities of man on the land surface might pollute the groundwater. Aquifers and the groundwater they contain can be very vulnerable to pollution and they do not have infinite capacity for absorbing and neutralising wastes. The pollution of groundwater can occur slowly and imperceptibly and it may take years for it to become apparent in the water supply. Once an aquifer is polluted, remedial treatment is expensive and may not even be feasible. Contamination of aquifers increases the cost of a water supply because of the need for treatment. We need to be aware of activities that pollute groundwater supplies and to understand the processes that can lead to their contamination. The risks can then be assessed and managed to prevent or minimise the probability of a contamination event. Such potentially polluting activities include waste disposal, industry and agriculture. Distribution of the pollutant might be diffuse as in the application of agrochemicals, or it might originate from more discrete sources such as landfill or industrial sites. Even quarrying for road stone or excavation of aggregate material may adversely affect the quality and quantity of groundwater in a particular vicinity.

EHS is finalising its “Policy and Practice for the Protection of Groundwater in Northern Ireland” following public consultation. A monitoring programme is a vital element in this process. It is therefore essential in NI that a strategy for monitoring groundwater quantity and quality is established and this paper seeks to outline a basis for this strategy.

## 2. LEGISLATIVE FRAMEWORK

Environmental policy in NI has evolved over a long period through a series of legislative, institutional and programme developments.

Recent specialised environmental legislation arises from European Community (EC) Directives. There are several types of EC legislation known as Regulations, Directives, Decisions and Recommendations. However the primary instruments are the Directives and those which are driving the requirement to monitor groundwaters are outlined below.

### 2.1 EC Legislation

#### **Council Directive concerning the protection of groundwater against pollution caused by certain dangerous substances - EC Groundwater Directive (80/68/EEC)**

In order to protect exploitable groundwater sources under this Directive, both direct and indirect discharges of dangerous substances are to be prohibited or regulated. A List I and II of families and groups of dangerous substances are given in an Annex of the Directive. [It should be noted that the lists are not quite identical to Lists I and II of the EC Dangerous Substances Directive (76/464/EEC)]. EHS is required through regulation to 'prevent' the introduction into groundwater of List I substances and to 'limit' the introduction of List II substances so as to avoid pollution of this water by these substances. 'Pollution' is described by reference to the effect of a substance rather than by its presence.

All direct discharges into groundwater (ie without percolation through the ground) of List I substances are to be prohibited (except in trace quantities). However, should the groundwater be unsuitable for other uses, such discharges may be authorised. ReInjection into the same aquifer of water used for geothermal purposes, water pumped out of mines and quarries, or water

pumped out for civil engineering works, may be authorised after investigation. All direct discharges of List II substances are to be subjected to investigation before being authorised.

Any disposal on land of either List I or List II substances which might lead to indirect discharges to groundwater must be subject to investigation. Disposal of these substances may then be authorised or prohibited based on the findings of these investigations and provided that all technical precautions necessary to prevent a direct discharge are taken. Any other activity likely to lead to indirect discharges of List I substances is also to be controlled and the control measures in respect of List I substances are to be notified, by EHS, to the Commission of the EC. Artificial recharge for the purpose of groundwater management must be specially authorised on a case by case basis, and only when there is no risk of polluting the groundwater. All the authorisations mentioned above may only be issued if the groundwater quality is undergoing the necessary surveillance. EHS is required to monitor compliance with conditions laid down in authorisations and also the polluting effect of any discharge on groundwater.

The requirements of this Directive have been transposed into local legislation in NI through The Groundwater Regulations (NI) 1998 (SR 1998 NO 401).

#### **Council Directive concerning the protection of waters against pollution caused by nitrates from agricultural sources - EC Nitrates Directive (91/676/EEC)**

This Directive seeks to reduce or prevent the pollution of water caused by the application and storage of inorganic fertiliser and manure on farmland. It is intended both to safeguard drinking water supplies and to prevent wider ecological damage in the form of the

eutrophication of freshwater and marine waters generally.

Member States are to identify waters actually or potentially affected by pollution from nitrates. In the case of groundwaters this would include waters actually or potentially containing more than 50mg/l nitrates. All known areas of land which drain into waters identified in this way and contributing to pollution must be designated by Member States as 'nitrate vulnerable zones' (NVZs). The identification is to be reviewed and revised at least every four years.

Action Programmes relating to NVZs must be established within two years of designation and revised at least every four years. For the purpose of designating and reviewing NVZs, Member States had to undertake before December 1993 a one-year programme to monitor surface waters and groundwaters, which is to be repeated every four to eight years, depending on the level of nitrate pollution. Every four years the eutrophic state of freshwaters, estuaries and coastal waters is also to be reviewed.

The requirements of the Nitrates Directive have been transposed into local legislation in NI through:

- ◆ The Protection of Water against Agricultural Nitrate Pollution Regulations (NI) 1996. (SR 1996 No 217)
- ◆ The Protection of Water against Agricultural Nitrate Pollution (Amendment) Regulations (NI) 1997 and 1999. (SR 1997 No 256 and 1999 No 3)
- ◆ The Action Programme for NVZs Regulations (NI) 1999. (SR 1999 No 156)

### **Council Directive establishing a framework for Community action in the field of Water Policy – EC Water Framework Directive (Joint Text 30 June 2000)**

This Directive will promote an integrated approach to groundwater and surface water protection. The Directive will focus on quality and quantity of groundwater assigned to river basins with River Basin Management Plans being established and subject to regular review. River basins will be managed by competent authorities appointed in each Member State. Member States will have to achieve the objectives of preventing any further deterioration of groundwater status,

restoring bodies of groundwater and achieving a balance between abstraction and recharge. In particular Member States must achieve good groundwater status, at the latest, 15 years after the Directive is published. Member States in doing so must reverse any significant and sustained upward trend in the concentration of any pollutant resulting from the impact of human activity.

Under Article 10, Member States will be required to establish a groundwater monitoring programme to cover chemical and quantity status. The network must be designed so as to provide a coherent and comprehensive overview of groundwater chemical status within each river basin and to detect long term anthropogenically induced upward trends in pollutants. Conductivity and the concentration of pollutants will be the parameters for the determination of good groundwater chemical status.

Good chemical groundwater status is defined as the chemical composition of the groundwater body such that the concentration of pollutants:

- ◆ do not exceed the quality standards applicable under other relevant EC legislation;
- ◆ would not result in, failure to achieve the environmental objectives provided for surface waters, nor any significant diminution of the ecological or chemical quality, nor any significant damage to terrestrial ecosystems which depend directly on the groundwater body; and
- ◆ do not exhibit changes in conductivity indicative of saline or other intrusion into the groundwater body.

A surveillance monitoring plan must be established for the period of each river basin management plan in order to:

- ◆ supplement and validate the impact assessment procedure; and
- ◆ provide information for use in the assessment of long term trends both as a result of changes in natural conditions and through anthropogenic activity.

Sufficient monitoring sites must be selected for bodies identified at risk and for bodies which cross Member State boundaries. The core parameters to be monitored are:

- ◆ oxygen content
- ◆ pH value
- ◆ conductivity
- ◆ nitrate
- ◆ ammonium

In addition bodies which are identified as being at significant risk of failing to achieve good status shall also be monitored for those parameters which are indicative of the impact of those pressures. Transboundary water bodies will also be monitored for those parameters, which are relevant for the protection of all the uses supported by the groundwater flow.

The results of surveillance monitoring should be used to establish an operational monitoring programme to be applied for the remaining period of the River Basin Management Plan in order to:

- ◆ establish the chemical status of all groundwater bodies or groups of bodies determined as being at risk; and
- ◆ establish the presence of any long term anthropogenically induced upward trend in the concentration of any pollutant.

Operational monitoring sites should be selected for all water bodies which on the basis of both the impact assessment and surveillance monitoring are identified as being at risk of failing to meet the objectives given earlier. The selection of monitoring sites will also reflect an assessment of how representative monitoring data from that site is of the quality of the relevant groundwater bodies. Operational monitoring must be carried out for the periods between surveillance monitoring at a frequency sufficient to detect the impacts of relevant pressures but at least once per year.

Data from both types of monitoring described above will be used to identify long term anthropogenically induced trends in pollutant concentrations and trend reversal. The base year/period must be identified and trend reversal must be demonstrated statistically and the level of confidence stated. In assessing status, the results of individual monitoring points within a groundwater body will be aggregated for the body as a whole.

A groundwater level monitoring network must also be established to provide a reliable assessment of the quantitative status of all groundwater bodies including an assessment of the available groundwater resource. The network must provide representative monitoring points measured at a frequency which will be sufficient to estimate the groundwater level and assess the quantitative status of each body taking into account short and long term variations in recharge and in particular:

- ◆ for groundwater bodies identified at risk of failing to meet objectives, sufficient density of monitoring points must be ensured to assess the impact of abstractions and discharges on level; and
- ◆ for groundwater bodies flowing across Member State boundaries, sufficient monitoring points are provided to estimate the direction and rate of groundwater flow across the boundary.

## 2.2 Local Legislation

### Water Act (NI) 1972

Under the Water Act (NI) 1972 direct discharges to underground strata or groundwater are regulated by the Department of the Environment (“the Department”). This legislation makes it unlawful, inter alia, for the Department to grant a consent that would permit a discharge in breach of any EC Directive. The new Water (NI) Order 1999 repeals and re-enacts with amendments the Water Act (NI) 1972. The water quality provisions of the Order come into effect in 2000. The new Order also makes provisions for the control of water abstraction.

The Water Quality Unit of EHS is responsible for the implementation of this legislation.

# 3. MONITORING OF GROUNDWATERS TO DATE

In April 1992 EHS contracted the British Geological Survey (BGS) to undertake a baseline study of the groundwater in NI. A key aim of this work was to provide recommendations on a network of representative boreholes and springs for future water level and water quality monitoring. Initially 759 groundwater sources were measured for a range of physical characteristics (diameter, depth, and static water level). At 351 sites a range of chemical determinands were also tested and 109 of these sites were then selected on the basis of distribution given the constraints of geology and groundwater use and were analysed at 3 monthly intervals from August 1992 until July 1994.

This work produced the following reports and maps:

- (i) Hydrogeochemical Survey of NI with particular regard to major ions;
- (ii) Hydrogeological Survey of NI: hydrogeological units and resource potential;
- (iii) Goundwater Vulnerability map\*;
- (iv) Hydrogeological map\*; and
- (v) Hydrogeology of Northern Ireland\*.

BGS recommended from these initial studies a programme of 3 monthly sampling at a total of 78 groundwater sampling sites analysing 37 physiochemical parameters. The sites were distributed evenly given the constraints of geology and groundwater use, and are, therefore, situated within a wide range of lithological environments, land use and topography.

## Nitrate Monitoring

In 1992 EHS tasked the Industrial Research & Technology Unit (IRTU) to sample and analyse

29 groundwaters and 56 surface waters on a monthly basis for 12 months specifically for nitrate levels. Results from this monitoring programme confirmed elevated nitrate levels ie exceeding the EC Nitrate Directive's 50mg/l standard, at a small number of boreholes. Analysis of the data also showed that while some boreholes did not contain nitrate concentrations in excess of the standard there was an increasing trend towards exceedence of the limit.

Further work was carried out by BGS on the aquifers of concern and BGS prepared a report describing the aquifers and the digital modeling techniques used to define the catchment areas of the boreholes. This determined the catchment areas which should be taken into consideration for designation of NVZs. Further modelling similar to that carried out by the Environment Agency in England and Wales led to the formal designation in January 1999 of three Nitrate Vulnerable Zones under the EC Nitrates Directive; one at Cloughmills, Co Antrim and two at Comber, Co Down.

Formal designation includes the implementation of Action Programmes and the requirement for landowners within NVZs to monitor certain activities and the concentrations of nitrates applied to the land.



**Sampler at Borehole**

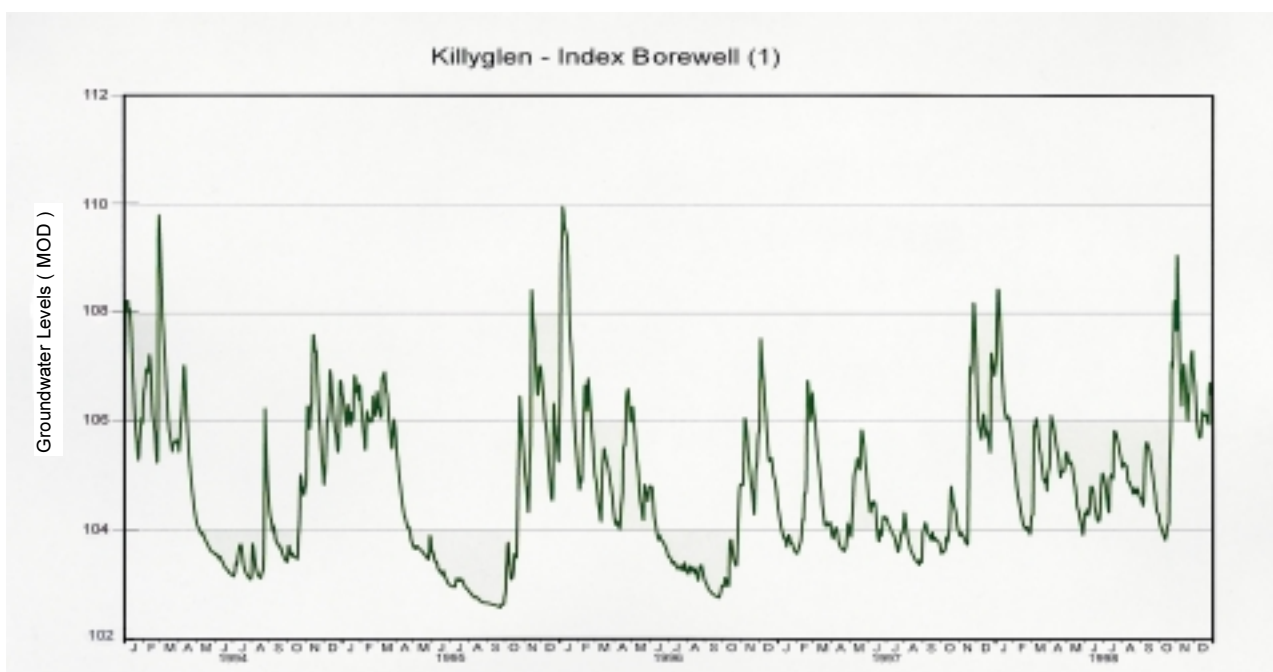
\*Available from the Geological Survey of Northern Ireland

## Other Organisations

Groundwater in NI is monitored for other purposes by a range of other organisations including the Drinking Water Inspectorate (EHS), Water Service (Department of Regional Development), universities and consultants. The Water Quality Unit of EHS will, wherever possible, endeavor to work closely with these other groups in order to make best use of all available information in its decision making processes.

## Index Boreholes

There are currently three boreholes (Appendix 1) monitored under the EHS commitment to the UK Surface Water and Groundwater Archive (SAGA). These index borehole sites are used to assess the national groundwater situation. Information from these sites is reported in national hydrological summaries produced by and available from the Institute of Hydrology. There is a need to review the requirements for similar boreholes throughout NI to provide a more representative view of the NI groundwater resource.



Graph of Water Levels at an Index Borehole



## 4. MONITORING PROGRAMME - 2000

The 2000 NI Groundwater Monitoring Programme is designed to meet the needs of a baseline surveillance monitoring programme for the proposed EC Water Framework Directive.

It is therefore proposed that the 78 sampling sites (Figure 1) recommended by BGS should form the NI groundwater monitoring network. Over time the network will be refined to optimise the value of the data being collected. The sites will be monitored for the physical, chemical and microbiological parameters given in Appendix 2 on a quarterly basis. This will also provide data for monitoring under the EC Nitrates Directive to supplement nitrate levels already being monitored monthly within identified NVZ's.

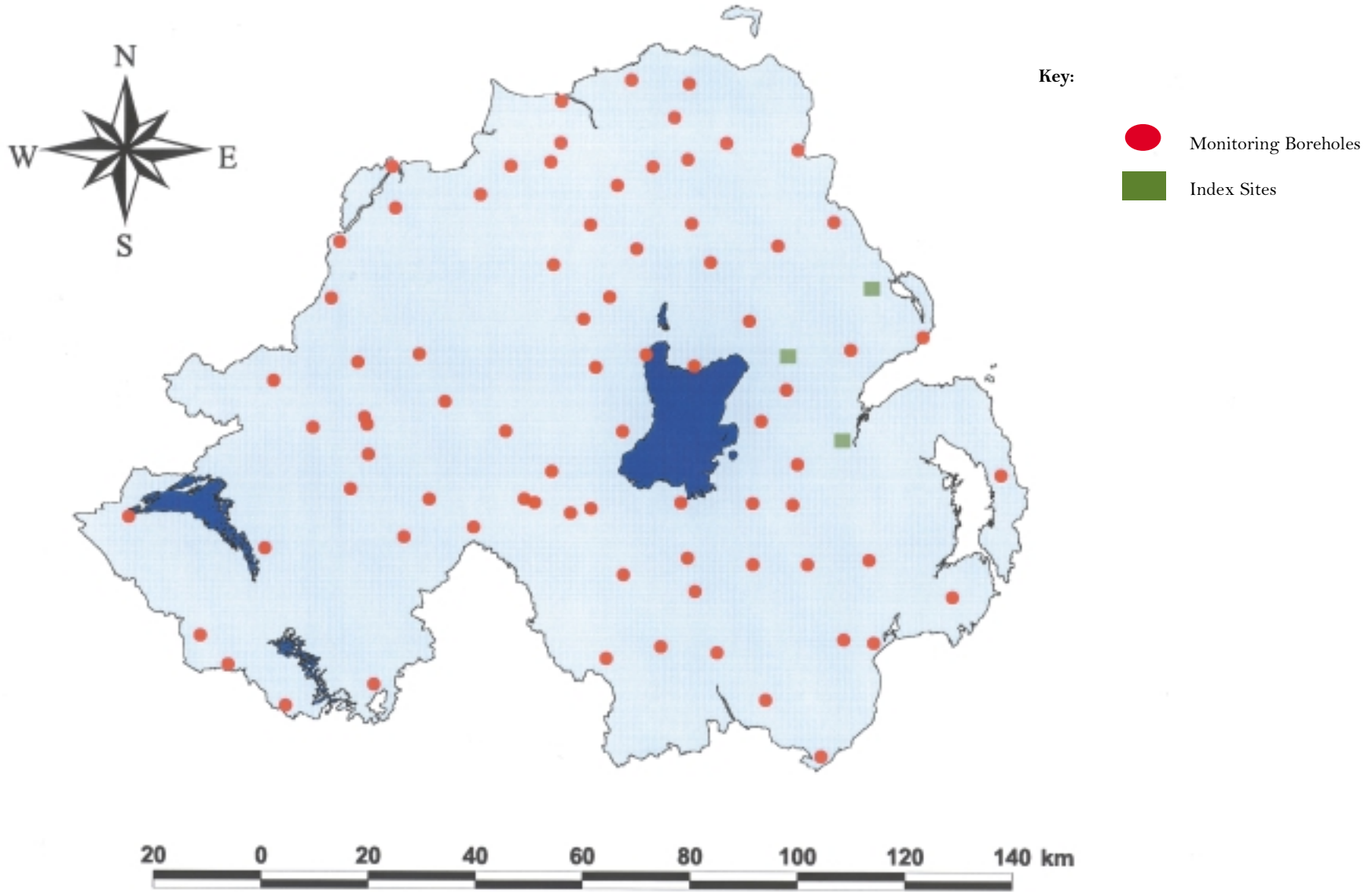
The baseline monitoring of water level at these sites will also be used to provide future recommendations for key sites for continuous water level measurement. EHS will review the resource required to maintain such a network in light of these recommendations and available technology.

An extended suite of chemical parameters to be measured once per year is provided in Appendix 3 and will include a range of List I and II substances to meet the requirements of the EC Groundwater Directive. Any positive results for these pollutants would require further investigation and possibly more frequent monitoring to detect trends. In future years a more risk-based assessment may lead to the targeted monitoring of other potential pollutants. Data provided by the other organisations will also be taken into consideration for targeting this monitoring.

## 5. REVIEW

EHS has initiated the proposed monitoring programme in March 2000 and will review requirements annually. EHS will also set up a suitable database and a system to provide results to interested parties.

# Figure 1: Proposed Groundwater Monitoring Network



## APPENDIX 1

### LOCATION OF INDEX BOREHOLES

Borehole Name	Aquifer Type	Grid Reference
Killyglen	Chalk	D 3660 0297
Templepatrick	Superficial Deposits	J 2249 8621
Dunmurry	Triassic Sandstone	J 2915 6933

## APPENDIX 2

### GROUNDWATER MONITORING – QUARTERLY

Static water level  
Temperature

Alkalinity  
Ammonia  
Dissolved oxygen  
Electrical conductivity  
pH  
Eh –Redox potential

Bicarbonate  
Calcium  
Chloride  
Dissolved iron  
Dissolved manganese  
Magnesium  
Nitrate  
Potassium  
Sodium  
Sulphate  
Total organic carbon

Total coliforms  
Faecal coliforms  
Total viable colony count at 37°C and 22°C.

## GROUNDWATER MONITORING – ANNUALLY

Aluminium  
Antimony  
Arsenic  
Barium  
Benzene  
Beryllium  
Boron  
Cadmium  
Chromium  
Cobalt  
Copper  
Cyanide  
Dissolved hydrocarbons  
Fluoride  
Lead  
Mercury  
Methyl Tertiary Butyl Ether (MTBE)  
Molybdenum  
Nickel  
Nitrite  
Organohalogen compounds – trihalomethanes, tetrachloromethane,  
trichloroethene, tetrachloroethene  
Phenol  
Phosphorus  
Tellurium  
Thallium  
Titanium  
Toluene  
Total Hardness  
Total PAH (Polycyclic Aromatic Hydrocarbons)  
Selenium  
Silica  
Silver  
Uranium  
Vanadium  
Xylene  
Zinc

### GROUNDWATER MONITORING – ANNUALLY

Pesticides:

Aldrin  
Atrazine  
Azinphos-Methyl  
Chlorofenvinphos  
Chlortoluron  
Coumaphos  
pp-DDE  
pp-DDT  
op-DDT  
Diazinon  
Dicamba  
Dichlorbenil  
Dichlorovos  
Dieldrin  
Diquat  
Endosulphan A  
Endosulphan B  
Endrin  
Fenitrothion  
Fenchlorphos  
Flumethrin  
Glyphosate  
Gamma HCH (Lindane)  
Hexachlorobenzene  
Isoproturon  
Malathion  
MCPA  
Mecoprop  
Parathion  
Pentachlorophenol  
Propetamphos  
Simazine  
pp-TDE  
Terbutryne  
Total endosulphan  
Tributyl tin  
Trifluralin  
Total pesticides (sum of the above)

## USEFUL ADDRESSES

Geological Survey of Northern Ireland  
20 College Gardens  
BELFAST  
BT9 6BS

Tel: 028 9066 6595  
Fax: 028 9066 2835  
Email: [gsni@bgs.ac.uk](mailto:gsni@bgs.ac.uk)

CEH - Wallingford Institute of Hydrology  
McLean Building  
Crowmarsh Gifford  
Wallingford  
OXFORDSHIRE  
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