

## 10 Curragh Camp Water Supply

### 10.1 Introduction

The objectives of the report are as follows:

- To delineate source protection zones for the Curragh Camp (McDonagh & Hare Park) supply boreholes.
- To outline the principal hydrogeological characteristics of the surrounding area.
- To assist Kildare County Council in protecting the water supply from contamination.

The protection zones are delineated to help prioritise certain areas around the source in terms of pollution risk to the well. This prioritisation is intended to provide a guide in the planning and regulation of development and human activities. The implications of these protection zones are further outlined in 'Groundwater Protection Schemes' (DELG/EPA/GSI, 1999).

The report forms part of the groundwater protection scheme for the county. The maps produced for the scheme are based largely on mapping techniques which use inferences and judgements based on experience at other sites. As such, the maps cannot claim to be definitively accurate across the whole county covered, and should not be used as the sole basis for site-specific decisions, which will usually require the collection of additional site-specific data.

### 10.2 Summary of Borehole Details

	McDonagh Deep Well	Hare Park Deep Well
<b>GSI no.</b>	2621SEW436	2621SEW208
<b>Grid ref. (1:25,000)</b>	278829 216604	277130 211600
<b>Townland</b>	Curragh	Curragh
<b>Source type</b>	Borehole	Borehole
<b>Drilled date</b>	Pre 1940	Pre 1940
<b>Owner</b>	Dept. of Defence	Dept. of Defence
<b>Elevation (ground level)</b>	~110 m O.D.	~110 m O.D.
<b>Depth</b>	Approximately 70 m	Approximately 70 m
<b>Depth of casing</b>	Assumed to be screened to full depth	Assumed to be screened to full depth
<b>Diameter</b>	300 mm (12")	350 mm (14")
<b>Depth to rock</b>	Approximately 70 m	Approximately 70 m
<b>Water level</b>	15.92 m below ground 30/10/02 (not pumping at the time of measurement)	18.45 m below ground 30/10/02 (not pumping at the time of measurement)
<b>Maximum drawdown</b>	Not available	0.66 m (Ball, 1995)
<b>Consumption (Water Works Personnel)</b>	800 m <sup>3</sup> d <sup>-1</sup>	1100 m <sup>3</sup> d <sup>-1</sup>
<b>Yield:</b>	1010 m <sup>3</sup> d <sup>-1</sup>	2765 m <sup>3</sup> d <sup>-1</sup> (Ball, 1995)

	McDonagh Shallow Well	Hare Park Shallow Well
<b>GSI no.</b>	2621SEW028	2621SEW247
<b>Grid ref. (1:25,000)</b>	27850 21160	27702 21160
<b>Townland</b>	Curragh	Curragh
<b>Source type</b>	Dug Well	Dug Well
<b>Drilled</b>	Pre 1940	Pre 1940
<b>Elevation (ground level)</b>	~110 m O.D.	~110 m O.D.
<b>Depth</b>	~33 m	~22 m
<b>Depth of casing</b>	Brick lined	Brick lined
<b>Diameter</b>	4.5 m	4.5 m
<b>Depth to rock</b>	~70 m	~70 m
<b>Static water level</b>	15.67 m below ground 30/10/02	18.45 m below ground 30/10/02
<b>Consumption</b>	Intermittent usage	Intermittent usage

## **10.3 Methodology**

### **10.3.1 Desk Study**

Details about the borehole such as depth, date commissioned and abstraction figures were obtained from the caretaker and County Council personnel; geological and hydrogeological information was taken from GSI records and from Ball (1995).

### **10.3.2 Site visits and fieldwork**

This included the following:

- Preliminary meeting with the Department of Defence on 25/1/02 to gather basic information on the supply.
- Interview with the caretaker 29/10/02.
- Raw Water sampling on 25/6/02.

### **10.3.3 Assessment**

Analysis of the data utilised field studies and previously collected data to delineate protection zones around the source.

## **10.4 Borehole Location & Site Description**

The McDonagh "deep" borehole is situated at the north-eastern side of the Curragh Camp. The borehole is housed in a concrete floored large building named the "McDonagh Waterworks". The well head comprises a 1 m<sup>2</sup> x 7.8 m deep brick lined chamber capped with a galvanised cover. The well casing is completed at the base of this chamber and there is a ladder allowing access to the top of the borehole. The rising main exits the chamber close to the top and goes to a series of small reservoirs that provides water to the camp. The McDonagh "shallow" well is located approximately 150 m to the east of the "deep" borehole, housed inside a red-bricked building. The well head is covered by wooden planks.

The Hare Park supply borehole is situated at the western end of the Curragh Camp. The borehole is located in a modern concrete floored building known as the "Hare Park Waterworks". The borehole is inside a chamber 1 m<sup>2</sup> x 3 m deep and has a galvanised cover. The pump is set at approximately 64 m below ground level. The Hare Park "shallow" well is located approximately 12 m east of the deep borehole housed in the same building. It is covered by galvanised plates. Inside the chamber there are ladders allowing access to inside of the well. The building is fenced off.

## **10.5 Topography, Surface Hydrology and Land Use**

A broad ridge running roughly east-west occupies the area on which the Curragh Camp is located. The highest point on the ridge is 159 m O.D. The general altitude of the Curragh Camp area is 110-120 m O.D.

There are no surface water features in the vicinity of Curragh Camp. The nearest water features are the Tully stream, 3.5 km to the west of the Hare Park supply borehole and the River Liffey, 3.5 km to the east of the McDonagh supply borehole. After heavy rain there is localised ponding.

The land is used by the military and for sheep farming and for exercising horses. The Curragh Camp village and barracks occupies approximately 2 km<sup>2</sup> between the two waterworks. To the north of the Curragh Camp there is the Curragh race course. The rest of the area is predominantly grassland used for sheep farming. Immediately to the north of the Hare Park Waterworks there is a disused landfill filling an old sand/gravel pit. Curragh Camp staff have estimated that tipping had ceased in the mid 1990's. The staff also indicated that the fill mostly comprised builders rubble and that tipping was carried out for at least twenty years. There are two sewerage works in the vicinity of the boreholes.

## 10.6 Geology

### 10.6.1 Introduction

This section briefly describes the relevant characteristics of the geological materials that underlie the supply boreholes. It provides a framework for the assessment of groundwater flow and source protection zones that will follow in later sections.

Geological information was taken from a desk-based survey of available data, which comprised the following:

- Bedrock Geology 1:100,000 Map Series. Geological Survey of Ireland. (Mc Connell *et al*, 1994)
- Information from geological mapping in the nineteenth century (on record at the GSI).
- Report on the drilling and testing of a trial recharge well at the Curragh, Co. Kildare. (Cullen & Co. Ltd, 1982).
- Wright (1988) The Mid-Kildare sand/gravel Aquifer. Geological Survey of Ireland.
- Glanville (1997) The quaternary geology of Co. Kildare, map descriptions for relevant 1:25,000 sheets. GSI report.
- Hayes (2001). Curragh Aquifer - Current Conceptual Understanding and Numerical Modelling.

### 10.6.2 Bedrock Geology

The Rickardstown Limestone Formation occupies the area around the Hare Park source and the Ballysteen Limestone Formation occupies the area around the McDonagh source. These formations are described in more detail in Sections 2 Volume 1 and their distribution is shown on Map 1.

### 10.6.3 Subsoil (Quaternary) Geology

The main subsoil in the vicinity of the sources is sand/gravel (the distribution is shown on Map 2) and is the dominant subsoil around the Curragh. The deposit is one of the most extensive sand/gravel bodies in Ireland. It is classed as a **Regionally Important Sand/gravel aquifer (Rg)** and is discussed in more detail in Section 4 of Volume I. In the vicinity of the supply boreholes the sand/gravel is approximately 65 m thick, consisting primarily of coarse sand and fine sand/gravel. Two till horizons in the order of 2-5 m thick are reported in a geological log of a well drilled close to the two supply boreholes. The tills are generally interspersed with the sand/gravel throughout the thickness of the sand/gravel aquifer. They are not mapped as an aquifer and will serve to impede the flow of groundwater contaminants through the aquifer.

## 10.7 Groundwater Vulnerability

Groundwater vulnerability is dictated by the nature and thickness of the material overlying the uppermost groundwater 'target'. The uppermost aquifer is mapped as a **Regionally Important Sand/gravel aquifer (Rg)**. Therefore the target and considerations of groundwater vulnerability concern the depth to the water table within the sand/gravel and the thickness of the tills overlying the sand/gravel.

The permeability of the till is thought to be moderate to low and the permeability of the sand/gravel is thought to be high. White Young Green (2002) indicate that the thickness of the tills is generally less than 3 m and the static water level is generally greater than 3 m in the vicinity of the supply wells. Consequently, the vulnerability of the groundwater in the sand/gravel is mapped as 'high' (refer to Maps 6 and 8 of Volume I).

The vulnerability mapping provided will not be able to anticipate all the natural variation that occurs in an area. The mapping is intended only as a guide to land use planning and hazard surveys, and is not a substitute for site investigation for specific developments. Classifications may change as a result of investigations such as trial hole assessments for on-site domestic wastewater treatment systems. The potential for discrepancies between large scale vulnerability mapping and site-specific data has been anticipated and addressed in the development of groundwater protection responses (site suitability

guidelines) for specific hazards. More detail can be found in ‘Groundwater Protection Schemes’ (DELG/EPA/GSI, 1999).

## **10.8 Hydrogeology**

### **10.8.1 Introduction**

This section presents our current understanding of groundwater flow in the area of the source.

Hydrogeological and hydrochemical information for this study was obtained from the following sources:

- GSI files and archival Kildare County Council data.
- White Young Green (2002). Curragh Aquifer - Current Conceptual Understanding and Numerical Modelling.
- Hydrogeological work by White Young Green and commissioned by the GSI (2002).
- Report on the drilling and testing of a trial recharge well at the Curragh, Co. Kildare. Cullen, K.T., 1982.
- Wright (1988) The Mid-Kildare sand/gravel Aquifer. Geological Survey of Ireland.
- Kildare County Council drinking water returns (2000, 2002).
- Hydrogeological mapping carried out by GSI on 9<sup>th</sup>, 10<sup>th</sup>, 27<sup>th</sup> & 28<sup>th</sup> May 2002 and 30<sup>th</sup> October 2002.
- A drilling programme carried out by GSI to ascertain depth to bedrock and subsoil permeability (2 holes in the vicinity of the source).

### **10.8.2 Rainfall, Evaporation and Recharge**

The term ‘recharge’ refers to the amount of water replenishing the groundwater flow system. The recharge rate is generally estimated on an annual basis, and generally assumed to consist of an input (i.e. annual rainfall) less water losses prior to entry into the groundwater system (i.e. annual evapotranspiration and runoff). The estimation of a realistic recharge rate is critical in source protection delineation; along with the rate of abstraction at the source it will dictate the size of the zone of contribution to the source.

Detailed recharge estimates have been modelled for the Mid-Kildare Aquifer as part of the hydrogeological investigation for the Kildare bypass and are in the order of 415 mm per year for the area of the Curragh Camp (White Young Green, 2002).

### **10.8.3 Groundwater levels, Flow Directions and Gradients**

Groundwater levels across the Mid-Kildare Aquifer are monitored regularly as part of the work on the Kildare By-pass. Earlier monitoring data is available for two wells situated in the aquifer and these are referred to in section 4 of the report. Hydrographs are presented in Section 4 Volume I. The monitoring data shows that the seasonal variation is in the order of 1.25-2.5 m, with the lowest levels occurring in October and the highest in February (Hayes, 2001). Groundwater levels in the McDonagh and Hare Park wells were approximately 15.7 m and 18.5 m below ground level respectively on the 30/10/02. In June 1995 the water level in Hare Park was 16.8 m below ground level.

Regional groundwater flow directions estimated by Wright (1988) suggest that groundwater in the area of the Curragh Camp flows northwest and north towards Pollardstown Fen. This concurs with the current conceptual understanding of the aquifer developed by White Young Green whom also show that groundwater in the area of the Camp flows toward and discharges at Pollardstown Fen.

Static water gradients are estimated from the water table contours produced by Wright (1988) and from contours produced by White Young Green (2002) to be in the order of 0.002.

#### 10.8.4 Hydrochemistry and Water Quality

Data for the two supply boreholes are summarised graphically in the figures below and the following key points are identified from the data.

- The analyses for hardness indicate a hard to very hard water for both supply boreholes (251-350- $>350$  mg l<sup>-1</sup>).
- Nitrate levels for both supply boreholes is consistently in the order of 20-25 mg l<sup>-1</sup> and there doesn't appear to be a trend in the data.
- From the two raw water samples available at each source there are no reported faecal coliforms and ammonia levels are low at both supply boreholes.
- The most recent sampling at Hare Park reports a chloride level of 53 mg l<sup>-1</sup>, a sodium level of 22.2 mg l<sup>-1</sup> and an iron level of 0.49 mg l<sup>-1</sup> all of which are higher than the GSI threshold levels. The data for Hare Park are sparse and definitive conclusions cannot be drawn. However, the landfill or the sewerage works near the Hare Park supply borehole may be contributing to these apparently anomalous levels (refer to Section 10.12).

**Figure 10-1 Hare Park - Key Indicators of agricultural and domestic groundwater contamination**

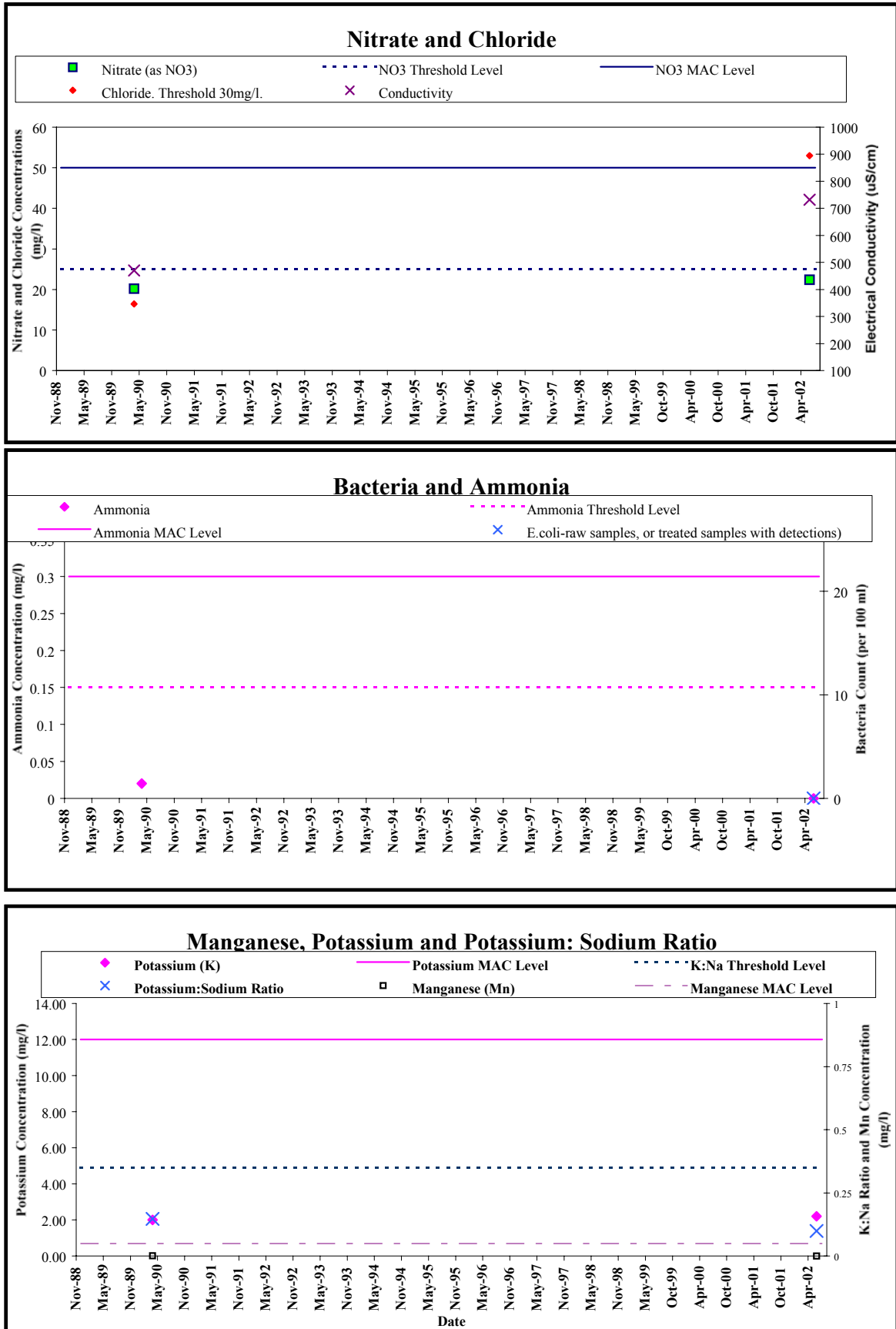
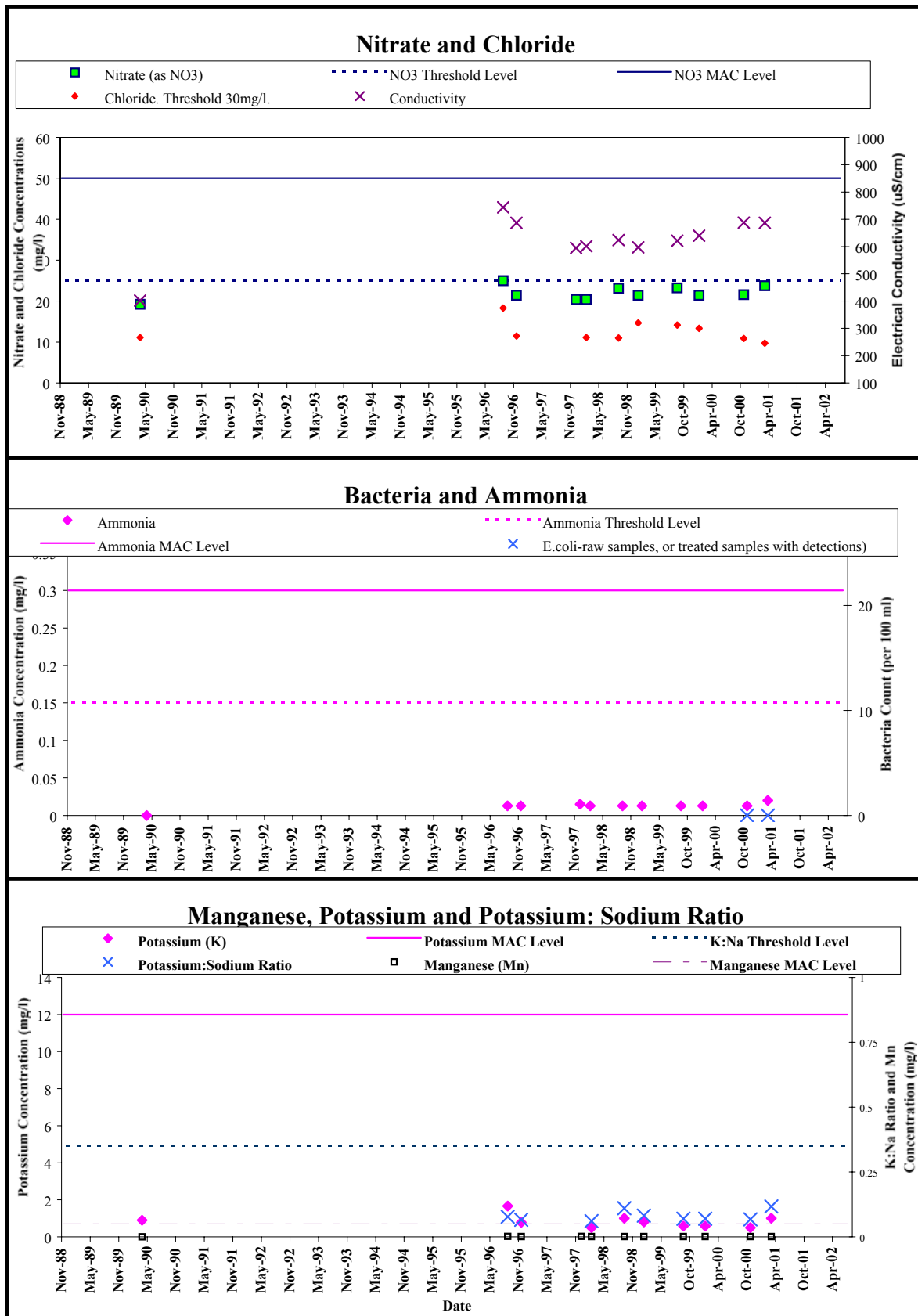


Figure 10-2McDonagh Key Indicators of agricultural and domestic groundwater contamination



### 10.8.5 Aquifer Characteristics

The characteristics of the Mid-Kildare sand/gravel aquifer are discussed in detail in Section 4 of the main report. The supply boreholes are located in the central portion of the aquifer where saturated thicknesses are in the order of 50 m. The aquifer parameters have been modelled for the aquifer as part of the hydrogeological investigations for the Kildare bypass and the figures used are in Table 9 (White Young Green, 2002).

**Table 9 Aquifer parameters for the Mid Kildare sand/gravel Aquifer**

<i>Parameter</i>	<i>Mid Kildare sand/gravel Aquifer</i>
Permeability (m d <sup>-1</sup> )	4-300
Porosity	13%

### 10.9 Conceptual Model

- The Curragh Camp supply boreholes extract up to 2000 m<sup>3</sup> d<sup>-1</sup> from the Mid-Kildare sand/gravel Aquifer which is classed as a **Regionally Important Sand/gravel aquifer (Rg)**.
- The aquifer is considered to be unconfined. Groundwater levels fluctuate 1-3 m annually, and the water table generally lies between 15 and 19 m below ground in the vicinity of the supply boreholes.
- Groundwater from the aquifer in the vicinity of the two supply boreholes discharges to the north at Pollardstown Fen.
- Diffuse recharge occurs over most of the land surface through the permeable sand/gravel & till.

### 10.10 Delineation of Source Protection Areas

#### 10.10.1 Introduction

This section delineates the areas around the source that are believed to contribute groundwater to it, and that therefore require protection. The areas are delineated based on the conceptualisation of the groundwater flow pattern, and are presented in. A groundwater numerical model has been developed by White Young Green and Entec (UK) Ltd. for the Mid-Kildare sand/gravel aquifer to enable an assessment of impacts of proposed road designs on the groundwater regime across the area. White Young Green were commissioned to use the model in the area of the two supply boreholes to predict the extent of the Source Protection Areas.

Two source protection areas are delineated:

- ◆ Inner Protection Area (SI), designed to give protection from microbial pollution;
- ◆ Outer Protection Area (SO), encompassing the zone of contribution (ZOC) to the borehole.

#### 10.10.2 Outer Protection Area

The Outer Protection Area (SO) was bounded by the complete catchment area to the source, i.e. **the zone of contribution (ZOC)**, which is defined as the area required to support an abstraction from long-term recharge. The ZOC is controlled primarily by (a) the pumping rate, (b) the groundwater flow direction and gradient, (c) the subsoil and rock permeability and (d) the recharge in the area.

The ZOC for the Curragh Camp sources was delineated as follows:

- 1) An estimate of the area size was obtained by balancing the average recharge with the abstraction rate.
- 2) The basic boundaries of the ZOC were derived from numerical modelling of the Curragh aquifer. This model had been developed for the Kildare Bypass project (White Young Green, 2002).
- 3) These basic boundaries were expanded by varying the main axis of each ZOC through  $\pm 20^\circ$  to allow for errors in the modelled flow direction.

- 4) The area of the resulting ZOC was compared with the area required to balance the abstraction with diffuse recharge.

The average abstraction is reported by Curragh Camp staff to be 1100 m<sup>3</sup> d<sup>-1</sup> for the Hare Park borehole and 800 m<sup>3</sup> d<sup>-1</sup> for the McDonagh borehole. For the purposes of modelling the sources, the average yields were increased by 50% to 1650 m<sup>3</sup> d<sup>-1</sup> and 1200 m<sup>3</sup> d<sup>-1</sup>. This was to account for increased water demand at certain times of the year or in the future due to possible expansion in the Curragh Camp.

Taking the recharge to be 415 mm, the area required to supply a pumping rate of 2850 m<sup>3</sup> d<sup>-1</sup> was calculated to be approximately 2.5 km<sup>2</sup>. This compares with the ZOC area of 4 km<sup>2</sup> derived from the modelling and subsequent adjustments to the model output.

### 10.10.3 Inner Protection Area

According to “Groundwater Protection Schemes” (DELG/EPA/GSI, 1999), delineation of an Inner Protection Area is required to protect the source from microbial and viral contamination and it is based on the 100-day time of travel (ToT) to the supply. Estimations of the extent of this area cannot be made by hydrogeological mapping and conceptualisation methods alone. The numerical model used to derive the extent of the inner protection zone at both supply wells. A figure of 200 m was derived for both wells. Given the generally deep and flat nature of the water table, and the generally high permeability of the aquifer, it was considered reasonable to extend this distance to the modelled downgradient (as well as the modelled upgradient) side of the sources.

### 10.11 Groundwater Protection Zones

The groundwater protection zones are obtained by integrating the two elements of land surface zoning (source protection areas and vulnerability categories) – a possible total of 8 source protection zones. In practice, the source protection zones are obtained by superimposing the vulnerability map on the source protection area map. Each zone is represented by a code e.g. **SI/H**, which represents an Inner Protection area where the groundwater is highly vulnerable to contamination.

The final groundwater protection zones are shown on Map 8. The matrix of source protection zones is given in Table 10.

**Table 10 Matrix of Source Protection Zones for Curragh Camp.**

VULNERABILITY RATING	SOURCE PROTECTION	
	<i>Inner</i>	<i>Outer</i>
<i>Extreme (E)</i>	Not present	<b>SO/E</b>
<i>High (H)</i>	<b>SI/H</b>	<b>SO/H</b>
<i>Moderate (M)</i>	Not present	Not present
<i>Low (L)</i>	Not present	Not present

### 10.12 Potential Pollution Sources

Leaky sewer pipes, the landfill at Hare Park, the sewerage works and road spillages are the main potential sources of contamination to the boreholes. Sewage after undergoing the first two stages of treatment is spread on irrigation plots which are prone to flooding during heavy rainfall events. Between the samples taken from the Hare Park borehole in 1990 and 2002 (See ) the chloride level has doubled from normal levels to over 50 mg l<sup>-1</sup>. These levels are not high enough to affect human health but they may indicate the presence of other contaminants. Though none of the other contaminant indicators are elevated, it should be remembered that these indicators relate primarily to domestic and agricultural contaminants. If not derived from salt softener, the elevated chloride could indicate that contaminants from the landfill have reached the well. Curragh Camp staff have indicated that tipping mainly comprises builders’ waste which would not normally constitute an groundwater quality hazard. However, there may be a possibility that occasional containers of waste oils, cleaning solvents, pesticides, etc., also occur in the fill. Many of the associated contaminants from these materials have

not been analysed for in available sample results. As such, the available data cannot be used to state that the supply is uncontaminated by materials from the landfill.

### 10.13 Conclusions and Recommendations

- ◆ The source comprises two production boreholes abstracting approximately 2000 m<sup>3</sup> d<sup>-1</sup> which is located in a regionally important sand/gravel aquifer (Rg).
- ◆ The groundwater in the vicinity of the supply boreholes is highly vulnerable to contamination.
- ◆ Leakage from sewerage pipes, the landfill at Hare Park, the sewerage works and runoff/spillages from the roads are the main potential pollution sources. Available data cannot be used to adequately assess the potential impact from the landfill.
- ◆ The protection zones delineated in the report are based on our current understanding of groundwater conditions and on the available data. Additional data obtained in the future may indicate that amendments to the boundaries are necessary.
- ◆ It is recommended that:
  1. Frequent sampling is undertaken at Hare Park of the full list of drinking water parameters including hydrocarbons, pesticides, polyaromatic hydrocarbons, etc., until it can be established that the landfill has not impacted on the well water quality.
  2. A study of the materials within the landfill be carried out. This could range from interviews with Curragh staff to excavations and sampling within the fill. Depending on the findings, the list of parameters analysed in (1) could be expanded or reduced.
  3. Other potential hazards in the ZOC should be located and assessed, particularly in relation to underground structures such as sewers and fuel storage tanks.
  4. A full chemical and bacteriological analysis of the **raw** water of each separate borehole is carried out on a regular basis.
  5. Particular care should be taken when assessing the location of any activities or developments which might cause contamination at the well, particularly in relation to underground structures such as sewers and fuel storage tanks.