Rath Group Water Scheme

Groundwater Source Protection Zones

(July 2009)

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1 Introduction

Rath is the supply for the Rath Group Water Scheme (G.W.S.). This source is at Springfield, and comprises a spring and two boreholes.

The objectives of the report are as follows:

- To delineate source protection zones for Rath G.W.S. (DELG/EPA/GSI, 1999).
- To outline the principle hydrogeological characteristics of the Rath area.
- To assist Offaly 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 source. 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).

2 Location, Site Description and Well Head Protection

The source is located approximately 1 km southwest of Rath village, in the townland of Springfield, 200 m north of the main Rath-Birr road (refer to **Figure 1**).

A pump sump has been excavated at the spring. Bedrock was met at 3 m below ground level (bgl), however, it was possible to excavate further through weathered fractured rock so that the final depth of the sump is 4.9 m bgl. A building has been erected to house the pumping plant (refer to **Figure 2**).

3 Summary of Spring and Well Details

GSI Number	:	2019NWW121	2019NWW127	2019NWW126
Grid ref. (1:25,000)	:	211685 209320	211705 209284	211601 209246
Townland	:	Springfield	Springfield	Springfield
Well type	:	Spring	Borehole	Borehole
Name	:	Spring (PW1)	PW3	TW1*/PW4
Drilled	:	Not applicable	2005	2005
Depth	:	4.9m	~87.78 m	92m
Diameter	:	N/A	0.254 m (10")	0.2m (8")
Owner	:	Offaly Co. Co. and Rath G.W.S.		
Elevation (ground level)	:	60 m OD	60 m OD	60 m OD
Depth to rock	:	3.0 m	~ 4.9 m	6.8m
Static water level	:	Ground level	0.16 mbgl	1.44 mbgl
Pumping water level	:	*N/A*	0.5 mbgl	20.48 mbgl
Present Abstraction	:	*Decommissioned*	341 m^3/d	114 m^3/d
Estimated yield	:	4,500 m^3/d	1,820 m^3/d	120 m^3/d

* TW1 was labelled TW4 in the field as it was the fourth well drilled, thence the pumping well at this location is referred to as PW4.

The borehole logs for the trial wells and production borehole PW3 are contained in **Appendix 1** along with a layout map. The completion details are as for TW1.

Figure 1 Site Location

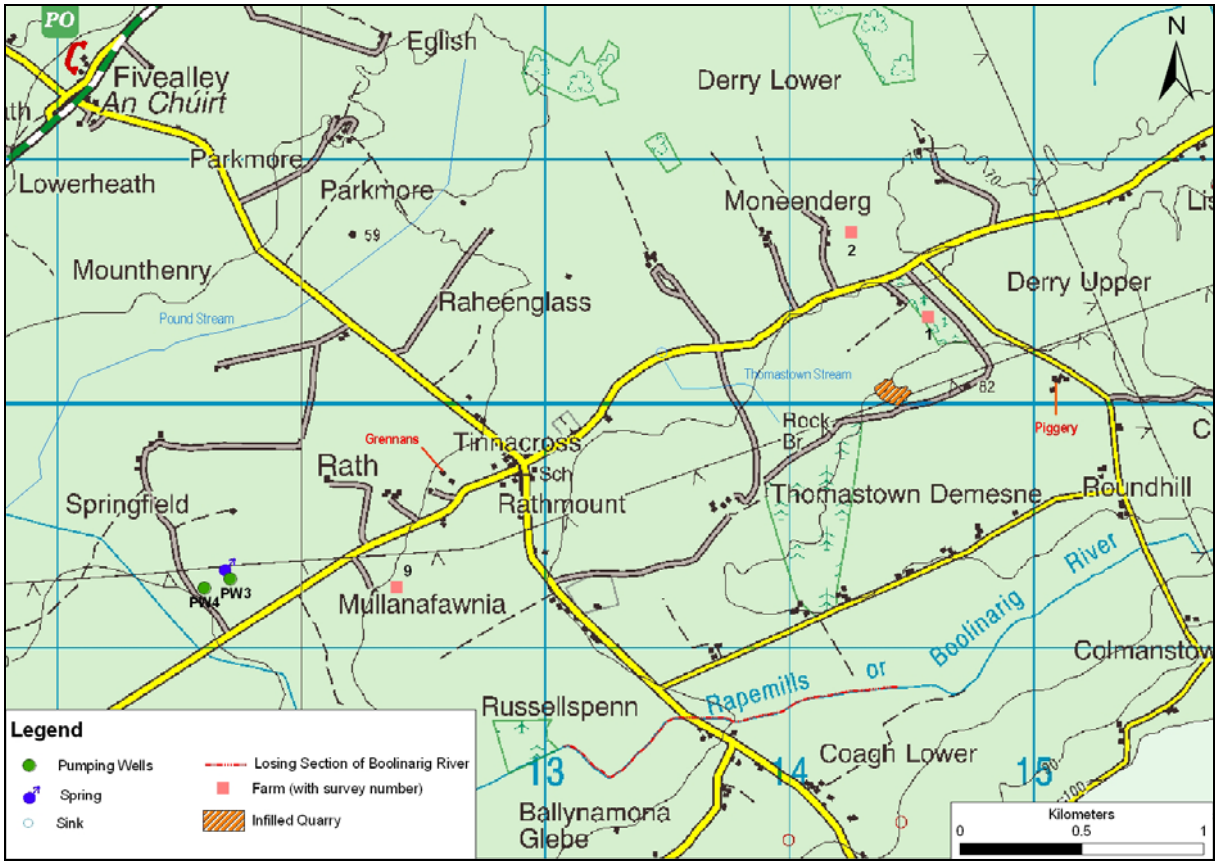


Figure 2 Overflow discharge from Rath Spring

Abstraction from the spring ceased in 2006 due to high nitrate concentrations. Water is currently abstracted from two boreholes (PW3 and PW4); however there is a 'Do Not Drink' notice on the abstracted water as a result of elevated nitrate. The abstracted water is combined in a reservoir before distribution along the mains.

4 Methodology

Details about the spring and boreholes such as depth, date commissioned and abstraction figures were obtained from Group Water Scheme and County Council personnel. Geological and hydrogeological information was provided by the GSI.

The data collection process included the following:

- Drilling of twelve auger holes by GSI September-October 2004.
- Interview and site visit with council staff on 17/08/06.
- Field mapping on 29/08/06 was also carried out to further investigate the subsoil geology, the hydrogeology and vulnerability to contamination.
- A further site visit and walkover was undertaken on 01/07/08.

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

5 Topography, Surface Hydrology and Land Use

The source is situated in a relatively flat, low lying area some 300 m north of the Boolinarig River (also named the Rapemills River) which flows from east to west (**Figure 1**). A 'losing' section has been identified within the Boolinarig River, which is described further in **Section 8.3** below**.** The Boolinarig River is part of the Shannon River catchment. The land in the catchment is gently undulating with the overall slope from northeast to southwest at a gradient of 0.007 (1 in 150).

A tributary of the Boolinarig River, known locally as the Pound Stream, is mapped on the Ordnance Survey ½ Inch to 1 Mile Map Series (Sheet 15: Galway to Offaly, 1990). The Pound Stream flows from northeast to southwest, and is located c.1.5 km north of Rath village, in the vicinity of Eglish townland. This stream joins the Boolinarig River approximately 1 km downstream of the source. This low lying, peaty area is also drained to the north and west by tributaries of the Silver and Little Rivers. The Pound Stream cross-cuts a currently mapped hydrological sub-catchment boundary.

A surface ditch/stream that drains an area, which includes an infilled former limestone quarry, in the Thomastown Demesne, is culverted under the minor road approximately 0.7km northeast of Rath Village (**Figure 1**). This (Thomastown) stream then 'sinks' on the northern side of the road. The sink is shown on the Ordnance Survey 6 Inch to 1 Mile Map Series (Sheet 35, 1912). It is understood that in 1995 the County Council deepened this roadside drain to alleviate local flooding. The deepened drain is believed to tap into larger (approx 1m diameter) underground drainage pipes.

The source is located 1 km down-gradient (southwest) of Rath village. All the houses in the vicinity have their own on-site waste water treatment systems/septic tanks as there is no mains sewage network in the area.

Outside the village, the land use is primarily agricultural with grassland being the dominant type. The level of agricultural activity over 80% of the catchment is moderately intensive (estimated at <120-130 kgs organic nitrogen stocked per ha). The balance of the area is farmed intensively with an estimate >130kgs organic nitrogen stocked per hectare (see **Appendix 4**).

The remaining land use in the area comprises:

- A piggery, located in Derry Upper, approximately 2km east-northeast of Rath Village. Landspreading of slurry arising from the piggery occurs within the catchment.
- A grain importer and feed manufacturer, Grennans, located in the village.
- A former quarry, located in Derry Upper, which has been infilled with unknown material.
- Tillage and forestry that represent minor land use components.

6 Geology

6.1 Introduction

This section briefly describes the relevant characteristics of the geological materials that underlie the source area. 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 review of available data, which comprised the following:

- Gatley, S., Sleeman, A.G., and G. Emo (2003). A Geological Description of Galway – Offaly, and adjacent parts of Westmeath, Tipperary, Laois, Clare and Roscommon to Accompany the Bedrock Geology 1:100,000 Scale Map Series, Sheet 15, Galway – Offaly.
- Information from geological mapping in the nineteenth century (on record at the GSI) and subsequent mapping in the 1970s by the GSI.
- Offaly Groundwater Protection Scheme (Daly *et al*, 1998).
- Subsoil permeability mapping by the GSI (O'Connor, 1998) and soils and subsoil mapping by Teagasc (Meehan, 2007).
- Drilling programme (12 auger holes) carried out by the GSI (2004).
- Borehole logs of the trial/production wells provided by Offaly County Council.

6.2 Bedrock Geology

Limestones occupy the whole area and a brief description of the individual rock units in the vicinity of the source are given in **Table 1**. An extract from the available geology map is given in **Figure 3.**

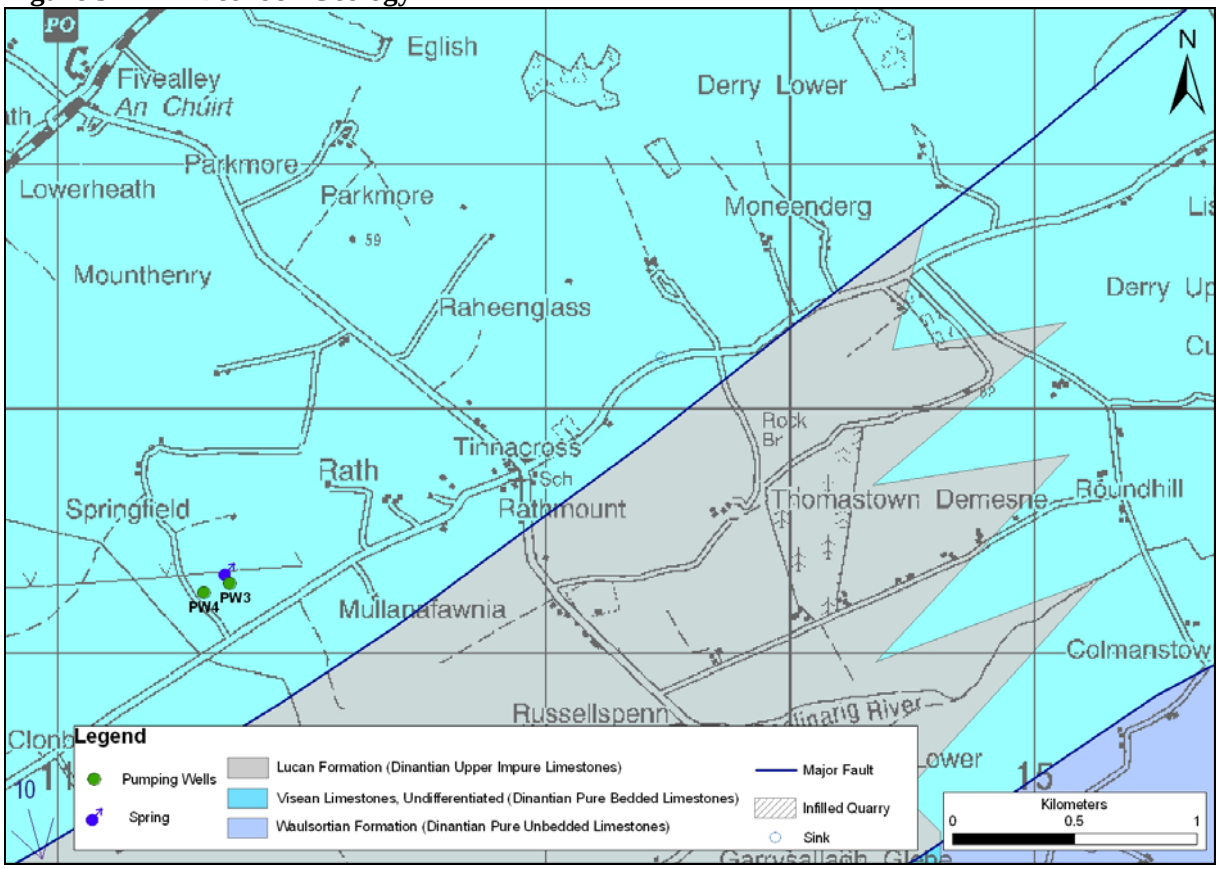
Table 1 Bedrock Geology of the Rath area

Name of Rock Unit	*Rock Material*	*Occurrence*
Dinantian Pure Bedded Limestones (Visean Limestones)	Thick-bedded, coarse grained, pale limestone with some darker fine grained beds and with occasional thin clayey bands	Underlies the village and the source
Dinantian Upper Impure Limestones (Lucan Formation / The 'Calp')	Dark grey, fine grained limestone and shale	Southeast of the source

According to the geology map, the boundary of the Pure Bedded Limestones and the Upper Impure Limestones is approximately 550 m to the southeast of the source.

The rock units have a NE-SW orientation, dipping south-eastwards at 5-20^{o} and are found preserved in the southern limb of the major syncline that trends NE-SW. The rock units have undergone faulting along a similar trend, the source lying approximately 550 m to the northwest of one such major fault.

Figure 3 Bedrock Geology

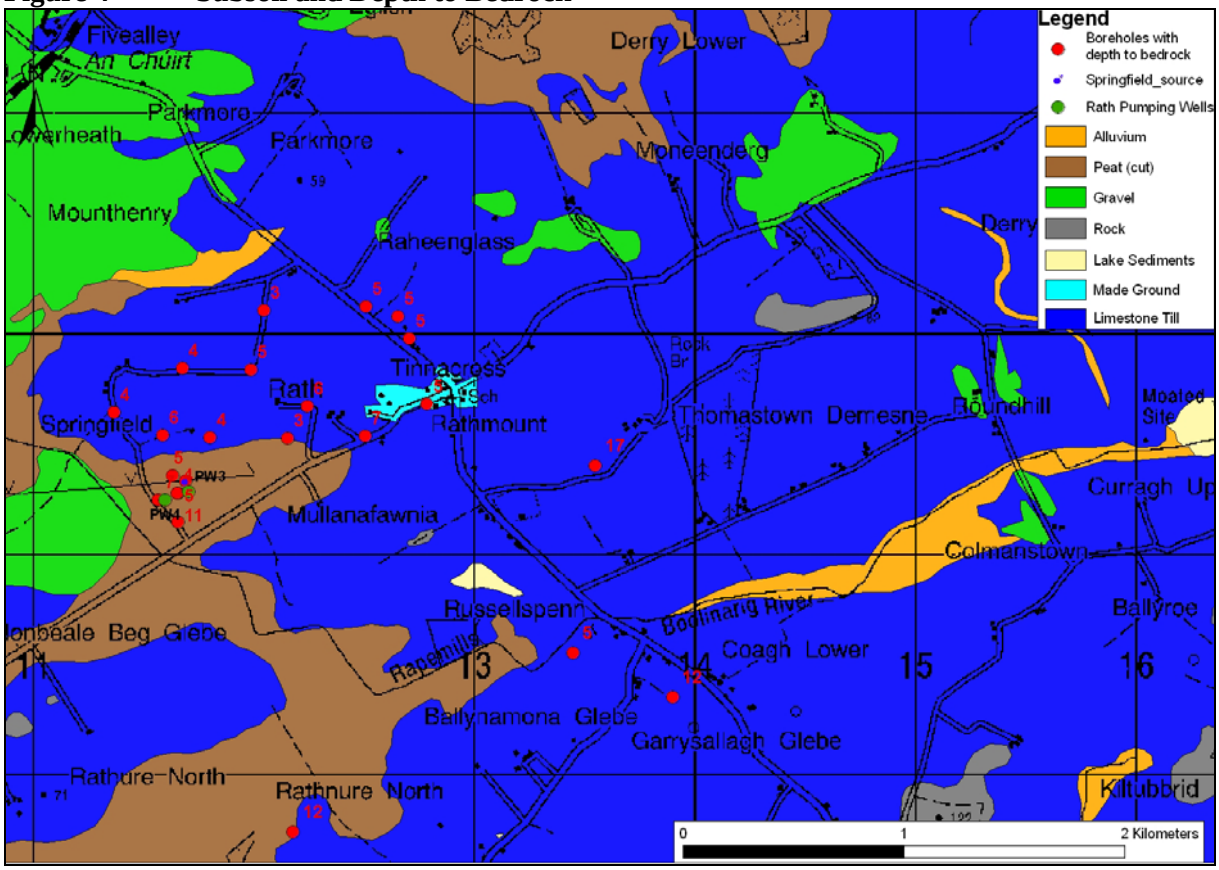


6.3 Subsoil (Quaternary) Geology

Sand/gravel, till and 'cutover' peat are the dominant subsoil types in the area. The characteristics of each category are described briefly below and the occurrence of each is shown in **Figure 4.**

- Cutover peat is mapped in the immediate vicinity of the source and an area 2km to the northeast of the source in Eglish townland.
- Glaciofluvial sand and gravel is present to the west and north of the source.
- Till occupies areas to the east, southeast and north of the source. The till is classified as '**Limestone Till (Carboniferous)**' (Meehan, 2007). 'Till' or 'Boulder clay' is an unsorted mixture of coarse and fine materials deposited by ice.
- Thirteen auger holes were drilled in the vicinity of the source, which are shown in **Figure 5.** Twenty three samples from these auger holes were classified using BS 5930, 1999 (**Appendix 1)**. All of the samples were classified as till, and the majority of the boreholes were dominated by either "silty **GRAVEL**" or "**SAND**".
- Subsoil is absent in areas of outcropping bedrock which occur to the east and northeast. Elsewhere, subsoil thickness is variable, ranging from 3m at the source to 17m in thickness, approximately 2km to the east. Subsoil immediately around the source is generally about 4-6m thick. The location of the auger holes, depth to bedrock, subsoil type and areas of shallow rock are also shown on **Figure 4**.

Figure 4 Subsoil and Depth to Bedrock



7 Groundwater Vulnerability

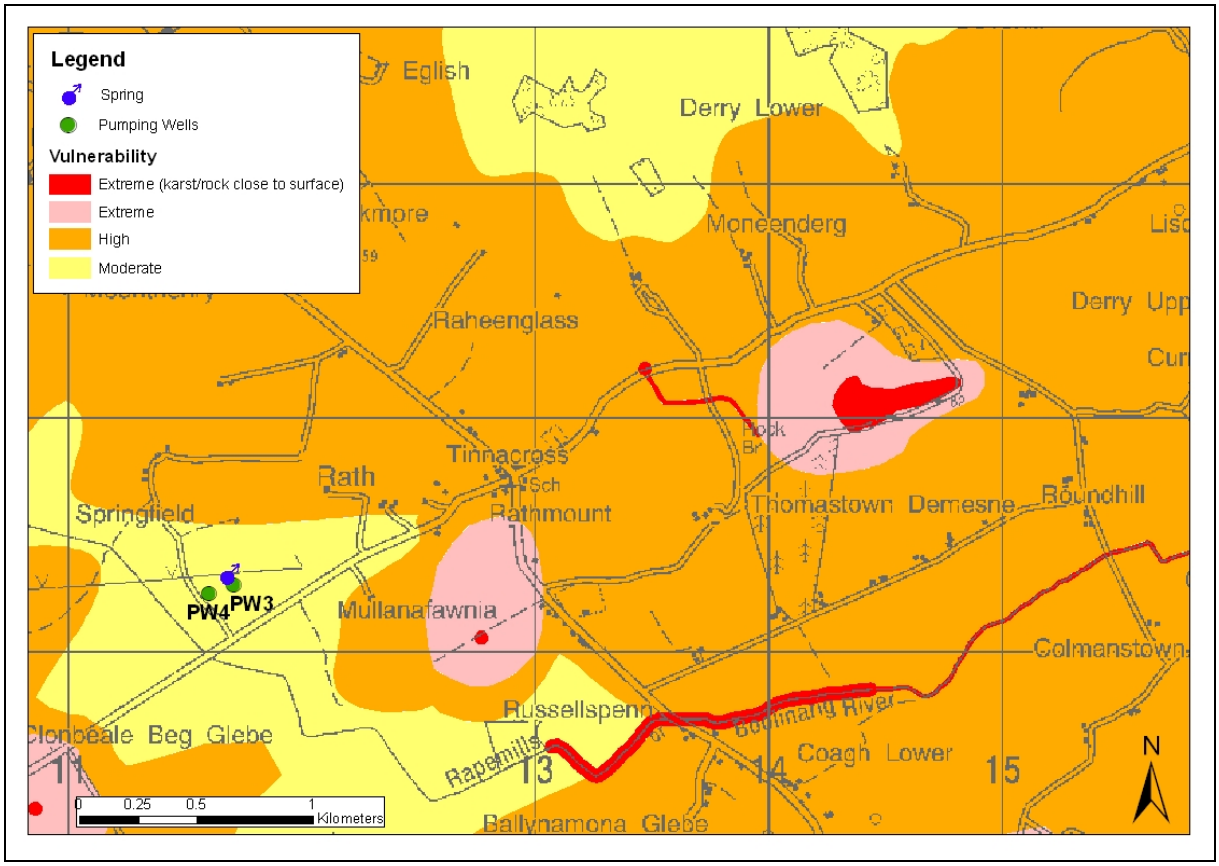
Groundwater vulnerability is dictated by the nature and thickness of the material overlying the uppermost groundwater 'target'. Consequently, vulnerability relates to the thickness of the unsaturated zone in a gravel aquifer, and the permeability and thickness of the subsoil in areas of bedrock aquifer. A description of the vulnerability categories can be found in the Groundwater Protection Schemes document (DELG/EPA/GSI, 1999). The following points relate specifically to the groundwater vulnerability in the area around the Rath supply.

- The source of the groundwater is the bedrock, thus for the purposes of groundwater vulnerability mapping, the "**top of the rock"** is the target.
- The permeability of the till is classed as "**moderate**", and the permeability of the sand & gravel is "**high**".
- Depth to bedrock is variable, as described in Section 6.3 above[1].
- The vulnerability is classified as "**high**" at the source itself, and predominantly "**moderate**"**,** with smaller units of "**high**" and "**extreme**" across the rest of the area. Areas of outcrop and locations of point recharge (e.g. karst features such as the possible sink of the Thomastown Stream and the

[1] Depth to rock interpretations are based on the available data cited here. However, depth to rock varies over short distances. As such, the vulnerability mapping provided will not be able to anticipate all the natural variation that occurs in an area. The mapping is intended 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).

'losing' sections of the Boolinarig River), which includes an arbitrary 30m buffer, represent a sub-category of extreme vulnerability where the groundwater is considered to be at its most vulnerable. The mapped groundwater vulnerability is shown in **Figure 5**.

Figure 5 Groundwater Vulnerability



8 Hydrogeology

8.1 Introduction

This section presents our current understanding of groundwater flow in the vicinity of the Rath boreholes. The interpretations and conceptualisations of flow are used to delineate source protection zones around the source.

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

- Birr Water Supply Scheme (Barry & Partners Ltd. & White Young Green, 2006).
- Offaly Groundwater Protection Scheme (Daly *et al*, 1998).
- An Assessment of the Quality of Public and Group Scheme Groundwater Supplies in County Offaly, (Cronin *et al*, 1999).
- Archival GSI and Offaly County Council data for the years 1977, 1989, 1991. C1–C2 type parameters.
- Offaly County Council drinking water returns 1992 to 2008 inclusive.
- Fieldwork (17/08/06, 29/08/06 and 01/07/08).

8.2 Meteorology and Recharge

The term 'recharge' refers to the amount of water replenishing the groundwater flow system. For the purposes of this report, the recharge rate is estimated on an annual basis, and is taken as the input (i.e. annual rainfall) less water losses prior to entry into the groundwater system (i.e. annual evapotranspiration and runoff). Recharge rate estimation is important in source protection zone delineation, as it determines the size of the zone of contribution to the source that is required to balance out abstraction.

The aquifers predominantly receive recharge from waters percolating diffusely through the overlying soils and subsoils, as well as at specific locations of point recharge (e.g. via certain karst features). The volume of 'point' recharge is thought to be considerably smaller that the diffuse recharge.

The main meteorological parameters involved in recharge rate estimation are rainfall and evapotranspiration. The main hydrogeological factors influencing recharge are subsoil permeability, groundwater vulnerability, soil drainage characteristics and the ability of the aquifer to accept recharge (either as a function of transmissivity and aquifer class, or due to the proximity of the water table to the ground surface). Recharge is likely to be greater in areas dominated by higher permeability subsoils, where subsoils are thinner, and where higher transmissivity aquifers can accept the recharge. The calculations used to estimate recharge are outlined in the following sections.

- **Annual rainfall:** 890 mm.
  Rainfall data for gauging stations around Rath (from Fitzgerald, D., Forrestal, F., 1996) are as follows:

Table 2 Rainfall Data for the Rath Area

Gauging Stations	Grid reference	Elevation OD (m)	Approximate distance & direction from source	Annual precipitation 1961-1990
Birr	N074044	73	7 km southwest	804 mm
Kilcormac G.S.	N182139	64	8 km northeast	860 mm
Kinnity Castle	N203058	143	8 km southeast	1012 mm

The contoured data map for the Offaly Groundwater Protection Scheme (Daly *et al*, 1998) show that the source is located between the 875 mm and the 900 mm average annual rainfall isohyets; therefore 890 mm is taken as an average rainfall value for the area.

- **Annual evapotranspiration losses:** 380 mm.
  Potential evapotranspiration (P.E.) is estimated to be 400 mm/yr [on the basis of the country-wide potential evapotranspiration data presented in the "Agroclimatic Atlas of Ireland" (Collins and Cummins, 1996)]. Actual evapotranspiration (A.E.) is estimated as 95 % of P.E., to allow for seasonal soil moisture deficits.

- **Effective Rainfall:** 510 mm.
  The effective rainfall is calculated by subtracting actual evapotranspiration from rainfall.

- **Recharge coefficient (rc):** 80%.
  The slopes and the nature of the deposits around the source need to be considered in order to give a representative value for the recharge coefficient during rainfall events. A representative value for the recharge coefficient is estimated to be in the order of 80% (WFD Guidance Document GW5, 2004).

These calculations are summarised as follows.

Table 3	Recharge Estimate
Average annual rainfall	890 mm
Estimated P.E.	400 mm
Estimated A.E. (95% of P.E.)	380 mm
Effective rainfall	510 mm
Recharge coefficient	80%
Recharge	**408 mm**

8.3 Groundwater Levels, Flow Directions and Gradients

There are few groundwater level data; however, the water level at the source is at ground level in the spring and between 0-1.5m below ground level in the boreholes and trial wells. The water table is generally assumed to be a subdued reflection of topography. The average topographic gradient around the source is about 0.007.

Water strikes were recorded in the borehole logs at shallow depths (6-15m) in fractures within solid grey limestone as well as within deeper (36-68m) broken limestone with sandy infill and clay filled cavities.

Generally, groundwater flow directions tend toward the Boolinarig River, following the land slope. Hydrogeological mapping of the Boolinarig (29/08/06) revealed that there is a 1.5km 'losing' section between Russellspenn (sinking point; NGR 214505, 208840) and Coagh Lower (emerging point; NGR 213071, 208593). This is also noted on the Ordnance Survey ½ Inch to 1 Mile Map Series (Sheet 15: Galway to Offaly, 1990).

It is thought that all of the surface water that eventually sinks along the 'losing' section of the river re-emerges at the emerging point. However, it is possible that some of this water emerges elsewhere, such as at the GWS spring. Furthermore, following a site walkover, discussions with landowners and a review of information provided by County Council staff, it is possible that the Thomastown Stream 'sink' contributes to the Rath supply. Tracer testing would be required to confirm if this were the case at these two locations.

8.4 Aquifer Characteristics

The Visean Limestones are classed as a **Regionally Important Karstified Aquifer (Rkd) in which diffuse flow predominates,** refer **Figure 6.** Several large supplies draw water from this aquifer in County Offaly (Daly et al, 1998).

The data used in this section are based on the following pumping tests:

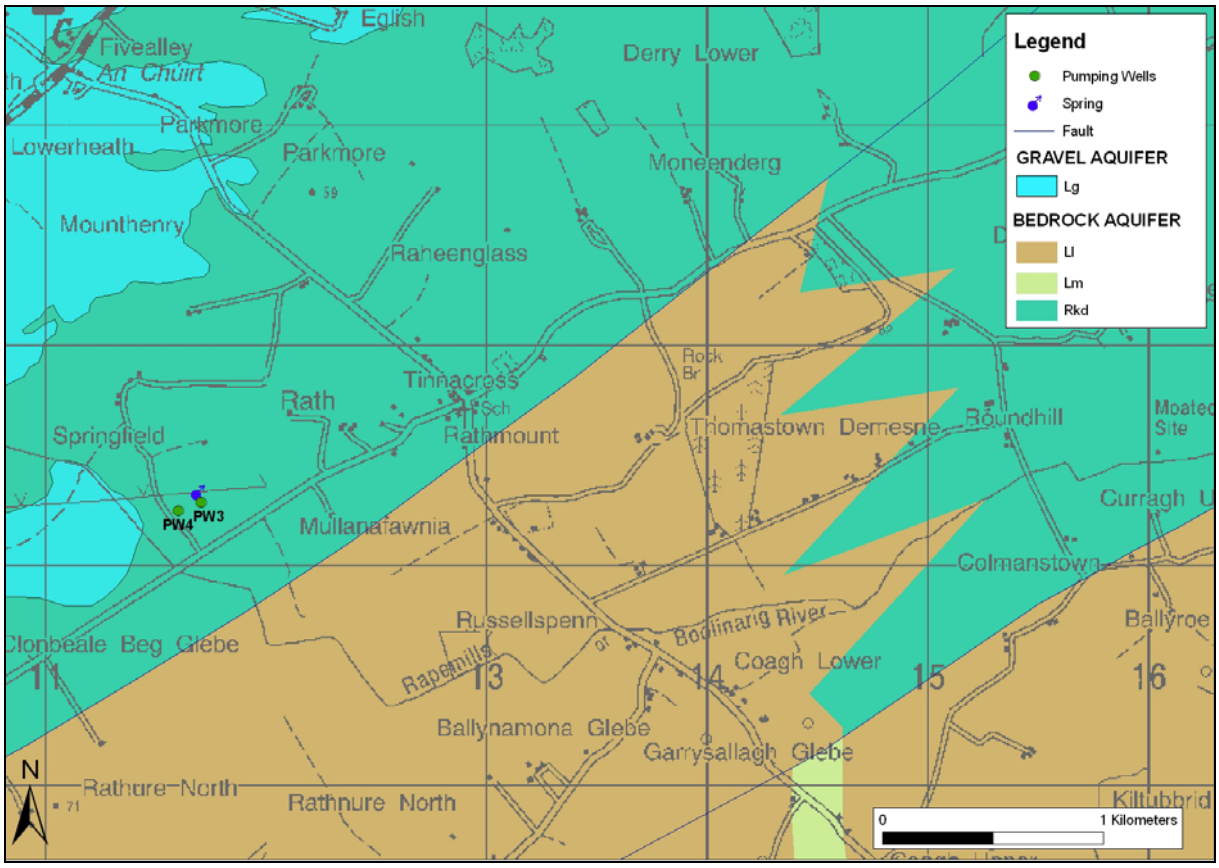
- on the deepened spring in October 1995, at the end of a dry summer (GES, 1995);
- a further test in the deepened spring (PW1) undertaken by the drilling contractors (Kelly's) in 2001;
- trial well pump testing (TW1 to TW4) by White Young Green (WYG) on behalf of Offaly County Council in January 2005; and
- Production Well (PW3) pumping test by White Young Green (WYG) on behalf of Offaly County Council in October 2005.

The pumping test data are given in **Appendix 2.**

The initial pumping test by GES in 1995 on the deepened spring indicates that the aquifer has a transmissivity of 2,700 m^2/day.

The 70 hour pumping test in February 2001 was undertaken in a sump excavated to exploit the spring which, at the time, was 3.8m deep. The final pumping rate was 4,400m^3/day with a drawdown of 1.82m.

Figure 6 Aquifers



In January 2005, pumping tests were carried out on four trial wells (TW1 to TW4, **Appendix 1**) drilled in the vicinity of the source. Each well was pumped individually for 72 hours and the water level response recorded in the adjacent trial wells. The results are summarised in **Table 4**.

Table 4 Summary of Pumping Test Results, January 2005

Trial Hole No.	Pumping Well No.	Static Water Level (mbgl)	Pumping Rate (m^3/day)	Drawdown (m)	Estimated Sustainable Yield (m^3/day)	Specific Capacity (m^3/d/m)	Aquifer Productivity Class
TW1	PW4	1.44	170	20.48	120	8.3	III-IV
TW2	Not in use	0.65	650	2.7	>1,000	233.8	I
TW3	Sealed; PW3 drilled adjacent	0.16	650	0.34	>1,000	1911	I
TW4	Not in use	0.32	650	0.12	>1,000	5,417	I

The most westerly well, TW1, has a significantly lower yield than the other wells. Furthermore, TW2, which is to the southwest, has a lower specific capacity due to the slightly larger drawdown. This may indicate that, in the vicinity of the Rath source, the aquifer productivity reduces towards the west.

From the above results, estimates of transmissivity (Logan Approximation) in TW3 and TW4 are in the same order of magnitude as the spring (2,322 m^2/day and 6608 m^2/day respectively). However, they are significantly less in TW2 (c.300 m^2/day) and TW1 (c.10 m^2/day).

In August 2005, Offaly County Council drilled production well PW3 (adjacent to TW3) to replace the spring source used by Rath Group Water Scheme. The estimated sustainable yield of this well is 1,820m^3/day (WYG, 2006).

The permeability can be calculated by dividing the transmissivity by the saturated thickness of the aquifer. The saturated thickness of a fractured aquifer is difficult to determine. In this instance, the saturated thickness is taken as the depth within which water strikes were recorded within each trial well. This is taken as an approximation of the productive part of aquifer. The permeability (K) ranges from c.0.3 m/d (TW1) to 120 m/d (TW4). The velocity of water moving through this aquifer to the boreholes can be calculated from Darcy's Law:

$$\text{Velocity (V)} = \frac{\text{(K x groundwater gradient (i))}}{\text{porosity (n)}}$$

The groundwater gradient is assumed to be 0.007 (Section 8.3) and a typical effective porosity (n) for this type of rock is considered to be in the order 0.02 (2%). Thus the velocity is estimated as ranging between 0.1 – 42 m/d.

Groundwater flow is through fissures and fractures in the bedrock, and can be very heterogeneous, depending on the distribution of fracturing in the bedrock unit. This situation is likely to result in high permeability zones and may cause local changes in hydraulic gradient (Birr Groundwater Body Description, 2004), and is reflected in the Rath area by the wide range of transmissivity data from each of the trial wells. Transmissivity values from pumping tests in the same Groundwater Body, and therefore the same aquifer, are also in the order of 10-650 m^2/d.

The sand and gravel deposits to the west and north of the source are classified as a Locally Important Sand and Gravel Aquifer (**Figure 6).**

8.5 Hydrochemistry and Water Quality

Water quality data are available for the Rath GWS from 1998 (**Appendix 3)**. Samples have been taken from a variety of sources including the spring itself (the deepened sump known as PW1), the production wells (PW3 and PW4) and the reservoir. Additional samples were also collected from points along the main distribution system, following chlorination. These were collected from the tap in private houses although some of the houses also have their own private well. Therefore, some of these samples may not fully represent the Group Water Scheme supply. Data are lacking for most of 2003 and the first half of 2004.

The data are assessed against EU Drinking Water Standards and against the Interim Guideline Values (IGVs) (EPA, 2003: Towards Setting Guideline Values for the Assessment of Groundwater) as well as GSI recommended threshold values. These values were established to assess the degree of contamination and therefore whether appreciable impact is occurring. Guidelines values set for key parameters are outlined in **Table 5.**

Table 5 Water Quality Assessment Standards

Parameter	Threshold [1] mg/l	EU MAC [2] mg/l
Nitrate	25	50
Potassium	4	12
Chloride	30	250
Ammonia	0.15	0.3
Potassium:Sodium ratio	0.4[3]	-
Faecal bacteria	0	0

[1] Interim Guideline Values (EPA, 2003) unless otherwise indicated

[2] S.I. 278, 2007

[3] Assessing groundwater quality, some useful tips (GSI Groundwater Newsletter, No. 33).

The following key points are identified from the data for the Rath Group Water Scheme.

- The hydrochemical analyses show that the spring water is 'slightly to moderately' hard (115 to 165mg/l $CaCO_3$), which is considerably lower than the concentrations from the production wells (PW3 and PW4 – generally between 400 and 420mg/l $CaCO_3$). The trial well results (January 2005) were similarly 'very hard' (410 to 492mg/l), which is typical of water from a limestone aquifer.

- The electrical conductivity (EC) of the spring water was generally in the range 561-817 µs/cm (average 725µs/cm). Limited results from the production wells (August 2006 to June 2008) indicate EC values between 575-712µs/cm. The trial wells (January 2005) returned similar results.

- Initial pumping tests of the spring in 1995 yielded nitrate results of 33mg/l. Long term nitrate monitoring commenced in 1998 (**Figure 7**). Although initially just above the EU limit for drinking water of 50mg/l, nitrate remained below the limit until January 2002, when it again began to exceed 50mg/l.

  There was a wide range of nitrate levels encountered in October 2004, from 22.1mg/l to 134mg/l. Since then, nitrate in the pumped source has not risen above 72mg/l and is generally significantly below that.

  Nitrate levels in trial wells drilled in January 2005 was below 50mg/l (1.7 to 20.4, but generally greater than 11.6mg/l). However, when production well PW3 was drilled (October 2005), nitrate was above the EU limit (57.9mg/l). 'Grab sampling' from the upper 2-3m of the borehole return nitrate results of 19-20mg/l compared to samples from the pumped level of c.30m where the results were generally greater than 40mg/l. In contrast, nitrate levels were lower in the less productivity well PW4, with results ranging from 5mg/l to 19mg/l.

  In 2008, nitrate data for the Group Water Scheme supply indicate a reduction from 64mg/l NO_3 in January to 34mg/l NO_3 in June. This is possibly because the abstraction is now also coming from PW4, which has lower nitrate.

- Chloride concentrations in the spring for the period May 1998 to May 2005 have been generally in the range of 20 to 29mg/l (average 25mg/l). These values approach the Interim Guideline of 30mg/l, above which significant contamination by organic wastes can be inferred. However, the background level for County Offaly had been quoted as 12-15mg/l in 1998 (Cronin & Furey) and in 1999, the threshold was set at 25mg/l (Cronin & Daly 1999). The latest available data from

December 2005 returned a chloride result of 38.7mg/l, which suggests contamination by organic wastes. Further monitoring results are necessary to confirm the current situation. Chloride in the trial well and production well is generally in the range 25-27mg/l, being lowest in TW1 (16mg/l), the least productive well. In summary, chloride is elevated above background concentrations suggesting contamination by organic waste.

- The Potassium:Sodium (K:Na) ratio for the spring (May 1998 to December 2002) is generally greater than 0.4 which implies contamination from an organic source. In addition, potassium reached over 5mg/l in December 1999 and the overall trend is that the level is rising. A potassium concentration greater than 5 mg/l is also indicative of contamination from an organic source such as slurry. The K:Na ration for the trial wells are also 0.4 and greater, apart from TW1 (K:Na 0.1). Potassium in TW3 was slightly above the IGV of 5mg/l (5.7 mg/l). There are insufficient data to determine a K:Na ratio for PW3.
- While manganese levels were elevated (0.55 to 0.41 mg/l) in the trial wells drilled and tested in January 2005, this was not the case in the Rath spring or PW3 (0.002 mg/l), which both had results below the EU drinking water standard.
- Faecal contamination at the production wells is absent. Faecal contamination ranged from absent to generally <10 cfu with a maximum of 29 cfu when the spring source was being pumped.

Due to the issue of high nitrate in the source, a survey of agricultural activity in the catchment, i.e. the preliminary zone of contribution, was carried out to give an indication of the pollution source. The survey was carried out by Environmental Agricultural Consultants in February 2008. The report is given in **Appendix 4**.

Sixteen farms were surveyed. Two farms (Numbers 1 and 2 on Figure 1, Appendix 4) were identified as having poor storage of farmyard manure and contaminated yard runoff going directly to groundwater. On a third farm (Number 9 on Figure 1, Appendix 4), outwintering of farm animals was found to be causing gross soil degradation.

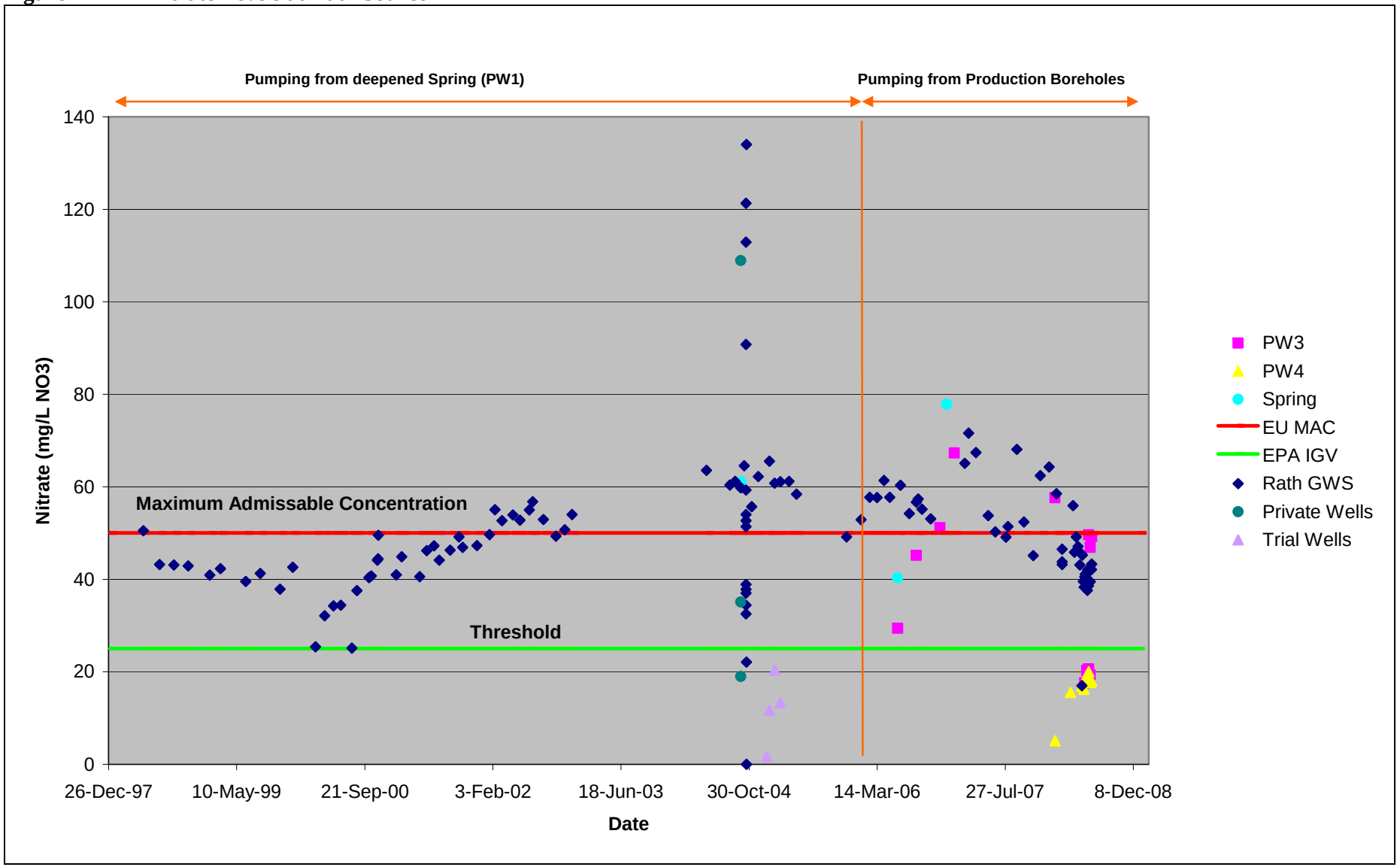
In addition, the application of pig slurry was noted in the area surrounding the infilled quarry. This area is drained to the Thomastown Stream, which was found to have high levels of nitrate (24-30mg/l NO_3). It is thought that the stream eventually sinks, as described in Section 5 above. If there is a connection between the sinking stream and the GWS, this could be a source of contamination. A tracer test could confirm this connection.

A further underground stream was identified in the agricultural survey (Number 2 in Moneenderg, Appendix 4). However an interview with the landowner coupled with an inspection has since confirmed that this is simply a shallow drain excavated as a requirement of the Rural Environmental Protection Scheme (REPS).

The farm survey within the catchment did not include inspection of septic tanks as it was considered that gross output from these sources, regardless of efficiency, was not of a magnitude sufficient to elevate the nitrate to the concentrations found.

In summary, the combined chloride, nitrate and potassium:sodium results, as well as the results of the farm survey, indicate that there is significant human impact on the groundwater quality arising from organic waste.

Figure 7 Nitrate Levels at Rath Source



8.6 Conceptual Model

- The GWS primarily abstracts groundwater from the Dinantian Pure Bedded Limestones which are a **Regionally important karstified aquifer in which diffuse flow predominates (Rkd)**. There is likely to be some input from the Dinantian Upper Impure Limestones, which are a locally important aquifer.

- The permeability in this aquifer system depends on the development of faults, fissures and fractures, which may then be enlarged by karstification. Fissures and fractures are recorded in the borehole logs that indicate zones of higher permeability exist in the bedrock in this area. The presence of a losing section of the Boolinarig River indicates karstification may occur within the underlying bedrock in the area. Similarly the Thomastown Stream 'sink' may also be karst feature. The latter needs establishing through further field investigation and a tracer testing.

- The pumping test results of the most westerly trial well suggest that the aquifer productivity reduces to the west of the source. The possible reduction in aquifer transmissivity in this area may be a contributing factor to the development of spring, with the lower permeability bedrock to the west forcing groundwater to the surface.

- Groundwater flow is probably confined to fractures, fissures, joints, bedding planes as well as the uppermost part of the bedrock.

- The rock unit is largely overlain by moderately permeable till, and the groundwater is considered to be unconfined.

- The regional groundwater flow broadly reflects topography, flowing northeast to southwest, tending toward the Boolinarig (Rapemills) River.

- Recharge to groundwater is estimated to be in the order of 408 mm/yr.
- The water quality results for nitrate, chloride and potassium:sodium ratio indicate that there is a significant human impact on the groundwater quality. It is considered that the source of this impact arises from organic agricultural waste, which is also the conclusion of an independent farm survey.

9 Delineation of Source Protection Areas

9.1 Introduction

This section delineates the areas around the GWS that are likely to be contributing groundwater to the boreholes and that therefore require protection. The areas are delineated based on the conceptualisation of the groundwater flow pattern, as described in the conceptual model and are presented in **Figure 8**. 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) of the well.

9.2 Outer Protection Area

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

The ZOC for the Rath source is delineated as follows:

1) The size of the ZOC area is estimated by using the average recharge and the discharge data from the spring and boreholes.
2) The shape of the area is then derived by hydrogeological mapping techniques.
3) To allow for errors in the estimation of groundwater flow direction and to allow for an increase in the ZOC in dry weather, a safety margin of 50% is incorporated by assuming a higher abstraction rate than the current rate.

Generally, the spring requires a much larger area to sustain its discharge than the boreholes. The delineated ZOC for the spring is thought to include the majority of the estimated ZOCs for PW3 and PW4.

The **southern, northern and eastern boundaries** are those delineated for the spring's ZOC (**Figure 8**) and are derived from hydrogeological mapping. These boundaries are groundwater divides, which are assumed to coincide with the local topographic divides. It is considered that the 'losing' section of the Boolinarig River does not contribute to the Rath GWS because the flow on either side of the losing section appears to be similar in volume i.e. the flow is all re-emerging downstream. As such, this is located outside of the ZOC. However, further tracer testing would help to confirm this.

The **western boundary** is on the down gradient side of the borehole PW4 and it based on analytical modelling. From the aquifer parameters, the extent of the down-gradient influence is estimated using the uniform flow equation for delineating well head protection areas (Todd 1980):

$$\text{Approximate down-gradient extent} = \frac{\text{(discharge rate)}}{2 \times \text{pi} \times \text{(transmissivity)} \times \text{(hydraulic gradient)}}$$

where the pumping rate[2] is 114 m^3/d, the transmissivity[3] is taken as 20 m^2/d and the hydraulic gradient is 0.007. This gives an approximate down-gradient extent of 130 m.

The total discharge from the spring is estimated to be 4,500 m^3/d and a total borehole abstraction rate[4] of 685 m^3/d is also used to help delineated the ZOC. Taking the recharge to be 408mm/yr, the area required to supply the spring, including the boreholes, is approximately 4.5 km^2. This compares favourably with the delineated of ZOC (c.5 km^2).

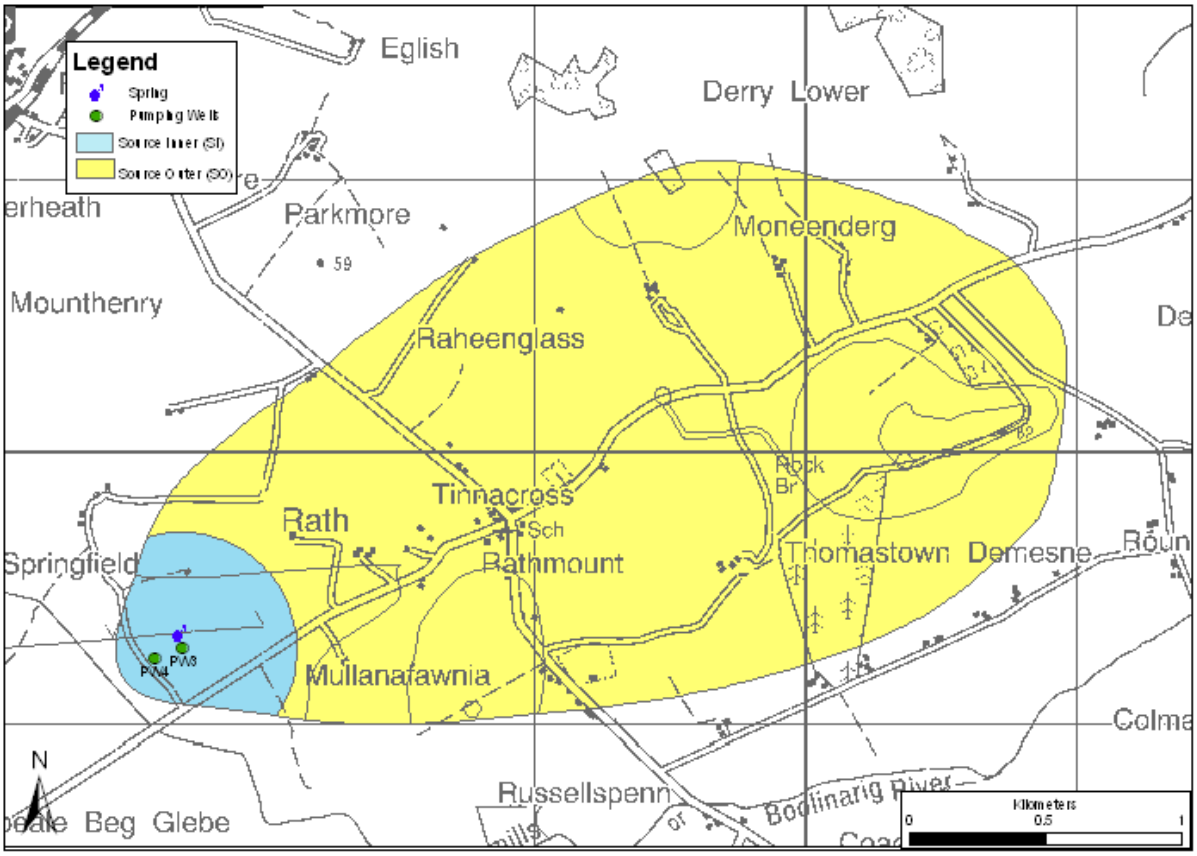
9.3 Inner Protection Area

The Inner Protection Area (SI) is the area defined by a 100-day time of travel (ToT) to the source. It is delineated to protect against the effects of potentially contaminating activities that may have an immediate influence on water quality at the source, in particular microbial contamination.

In Section 8.4 groundwater velocities have been estimated by using the range of aquifer parameters derived from the pumping tests of each of the trial wells. The velocity varies from 0.1-42 m/d. In order provide a conservative estimate of the 100-day ToT, the fastest velocity has been used i.e. 42 m/d. Therefore in 100 days, the groundwater can potentially travel 420 m. The SI is also shown in **Figure 8**.

[2] An additional 50% has not been added to the abstraction rate from PW4 as it is considered that this would give an overly-conservative down-gradient distance, which, given the aquifer properties at this location, are thought to be unrealistic.
[3] Using the Logan Approximation, a transmissivity value of 10 m^2/d has been estimated from the pumping test data. However, the transmissivity is variable in this area and is likely to increase between PW4 and PW3, which has a transmissivity of c.2300 m^2/d. Therefore a harmonic mean of 20 m^2/d has been taken as a more representative value.
[4] The total current abstract is 455 m^3/d. The 685 m^3/d abstraction value used includes the 50% safety margin.

Figure 8 **Rath Outer and Inner Source Protection Areas**



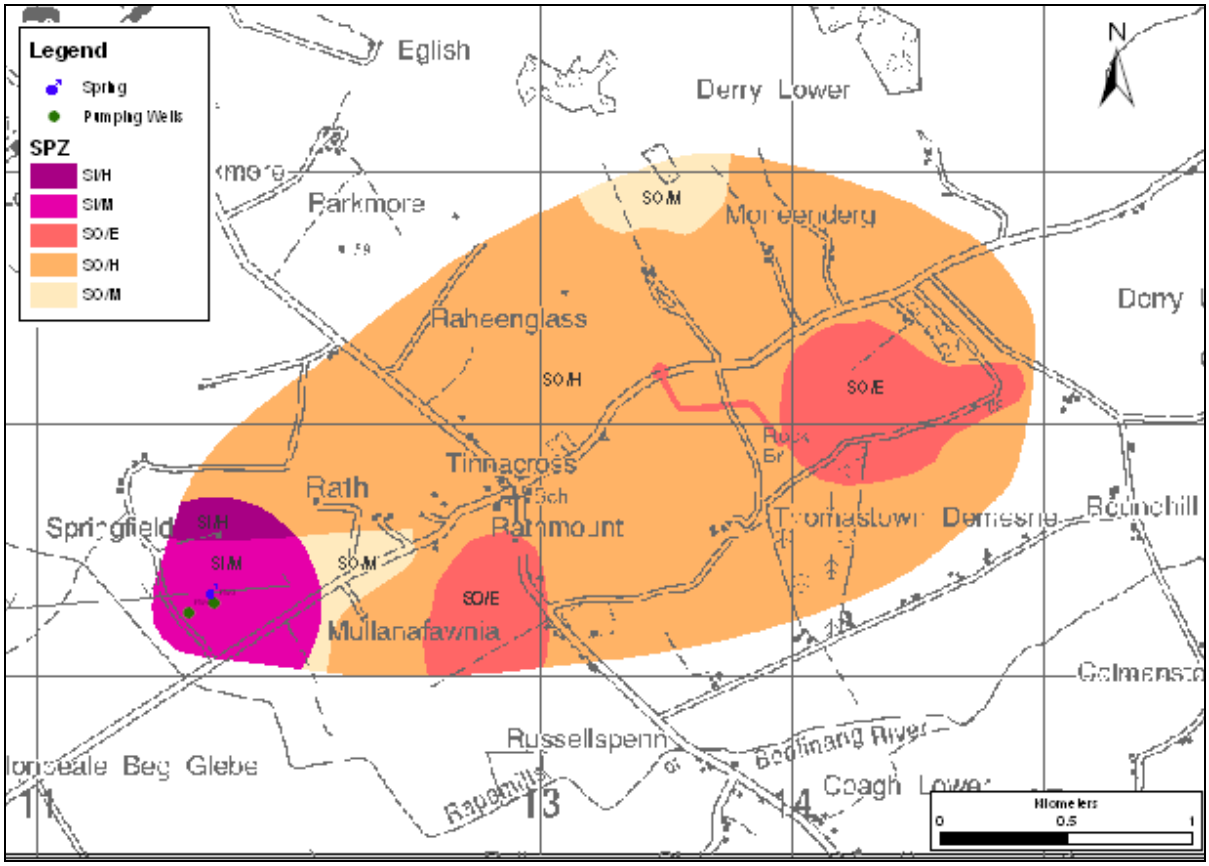
10 Groundwater Protection Zones

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. There are five groundwater protection zones present around the Rath source, as shown on **Table 6** and in **Figure 9**.

Table 6 **Matrix of Source Protection Zones at Rath**

VULNERABILITY RATING	SOURCE PROTECTION	
	Inner	***Outer***
Extreme (E)	Absent	SO/E
High (H)	SI/H	SO/H
Moderate (M)	SI/M	SO/M
Low (L)	Absent	Absent

Figure 9. Rath Source Groundwater Protection Zones



11 Potential Pollution Sources

Land use in the area is discussed in Section 5. The land near the source is largely grassland-dominated and is primarily used for grazing. Agricultural activities are the principal hazards in the area. The main potential sources of pollution within the ZOC are farmyards, runoff from roads, road spillage and landspreading of organic fertilisers. The main potential pollutants are nitrate, faecal bacteria, viruses and cryptosporidium.

12 Conclusions and Recommendations

Based on the results of desk study, site walkover and data analysis and interpretation, the following conclusions are made with respect to the Rath Source:

- The source is located in a highly productive **Regionally Important Karstified Limestone Bedrock Aquifer**.

- The area within the ZOC is predominantly classified as highly vulnerability to groundwater contamination, with small areas of moderate (e.g. around the supply) and extreme vulnerability.

- The spring and the more productive borehole (PW3) have nitrate levels that currently render the water unfit for human consumption. The nitrates are likely to be due to contamination by organic agricultural waste.

- Monitoring on at least a monthly basis since February 2008 indicates that the water quality abstracted from the lower productivity well (PW4) complies with the drinking water standard for nitrate.

- Pumping tests indicate that the limestone bedrock aquifer is generally highly productive; however productivity may be decreasing to the west of the source. This, coupled with the apparent lower nitrate levels, may indicate a different flow system to the rest of the well field.

The following recommendations are made:

- Nitrate levels in groundwater across the ZOC should be ascertained and monitored to further aid determination of the specific sources of nitrates.

- Tracer testing on the 'losing' section of the Boolinarig River and the Thomastown Stream 'sink' could be undertaken to identify if these contribute to the Rath GWS. This would confirm the boundaries of the ZOC and further identify/confirm sources of pollution.

- The zone of contribution to the source should be protected and monitored to preserve the quality of the supply. Chemical and bacteriological analyses of raw water should be carried out on a regular basis. Monitoring should include nitrate. The source of sampling should be clearly identified.

- Ensure the Code of Good Agricultural Practice is being implemented within the Inner and Outer Source Protection Zones including regular inspection and review of Farm Management Plans as necessary, particularly those farms previously identified as being a source of pollution. The groundwater protection responses to the landspreading of organic waste should be adhered to.

- Investigate the former quarry to determine the nature of the infill material.

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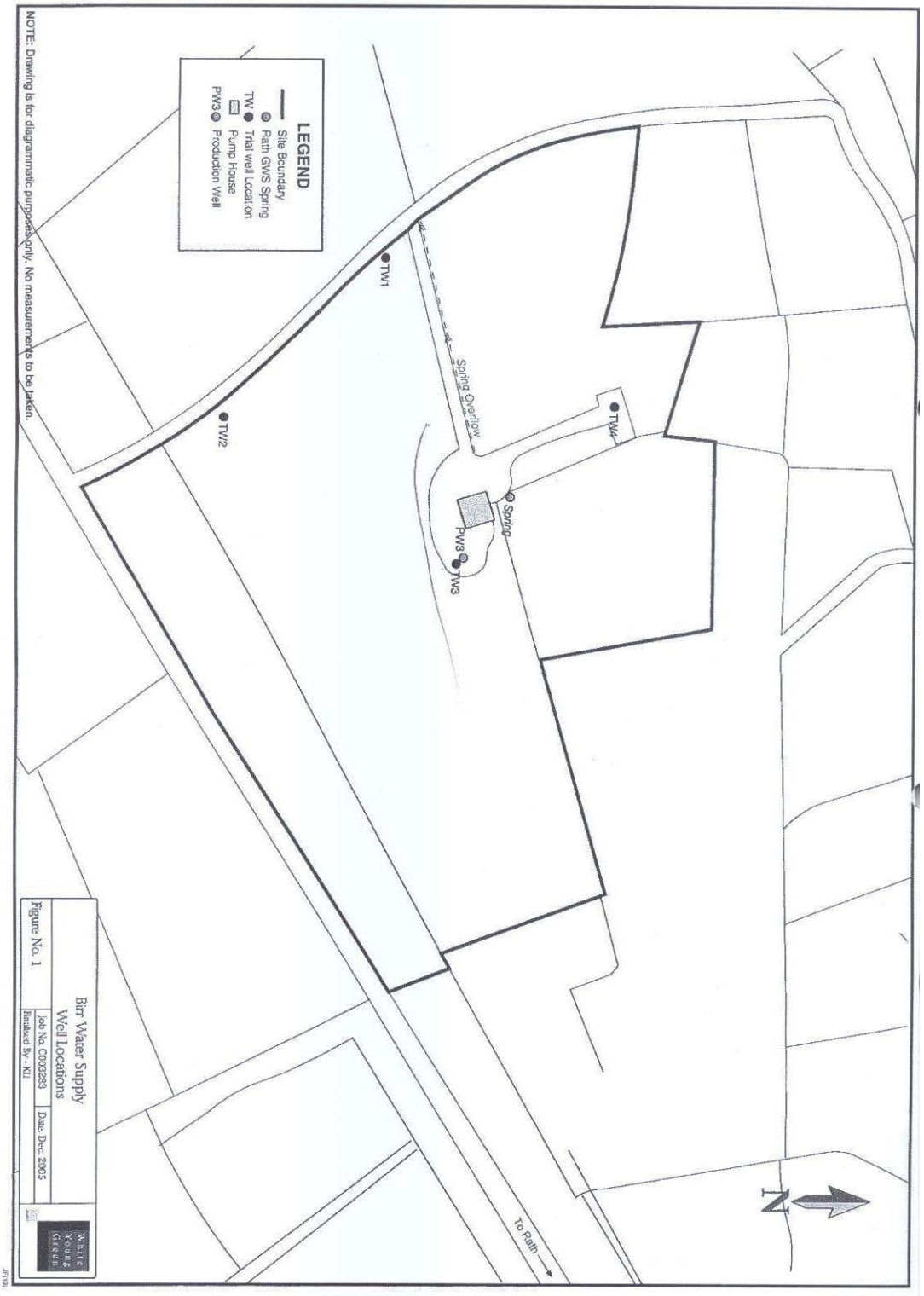
Appendix I
Trial and Production Well Borehole Logs



Well Log PW3

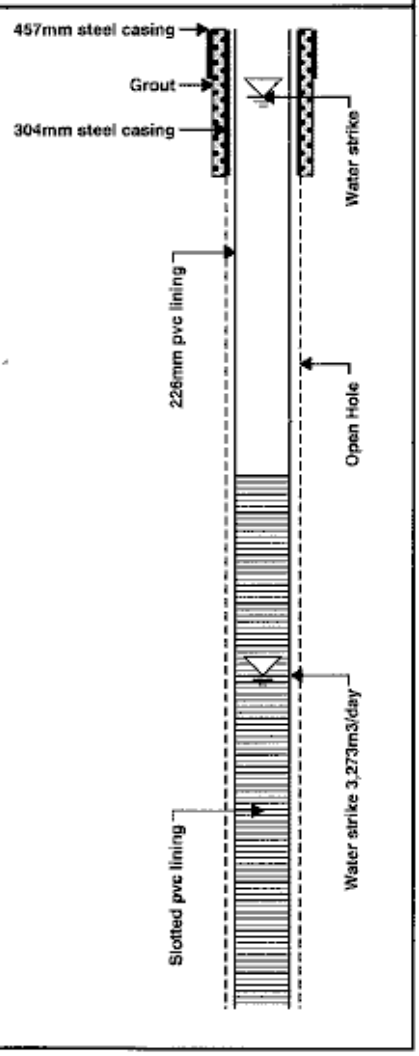
Well No. PW3 **Grid Reference**

Project No. C003283 **Client** Offaly County Council **Drill Date** 25/08/05

Well Type Production Well **Location** Rath, Birr, Offaly **Geologist** based on driller's records

SUBSURFACE PROFILE

Description	Depth (m)	Symbol
Ground Surface		
Interbedded CLAY and GRAVELS		
Grey LIMESTONE		
Solid grey LIMESTONE Water Strike between 6 and 9 metres		
Solid grey LIMESTONE		
Broken LIMESTONE Clay filled cavity. Water strike		
Solid Grey LIMESTONE		
Soft and hard LIMESTONE		
Solid grey LIMESTONE		



Drill Method air rotary **Hole Size (mm)** 457mm

Casing Length (m) 87.8 **TOC (mOD)**

Driller Dunnes Drillers **Static Water Level (bgl)**

Well Log

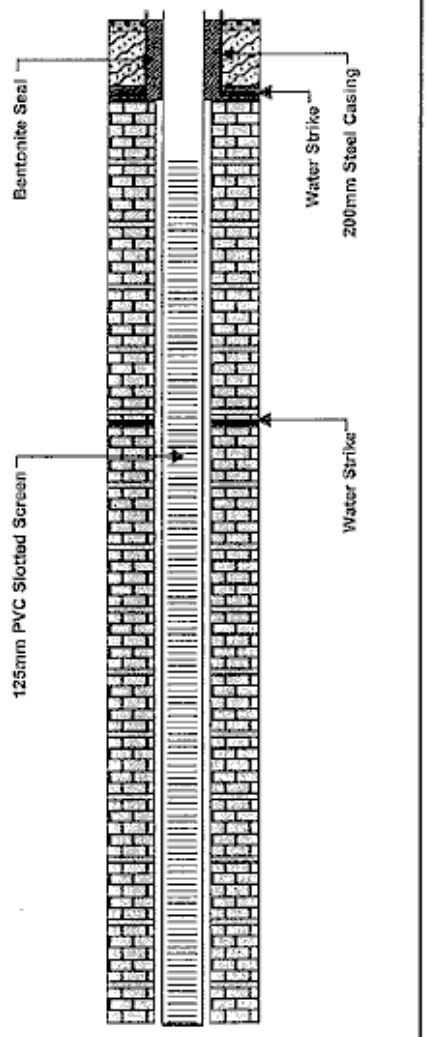
Well No. TW-1 **Grid Reference** 11570 09244

Project No. C003283 **Client** JB Barry **Drill Date** 10/12/2004

Well Type Trial Well **Location** Rath, Birr **Geologist** B. Sexton

SUBSURFACE PROFILE

Description	Depth (m)	Symbol
Ground Surface		
Gravel Large limestone Gravel fill.		
Clay Firm brown grey Clay with some fine gravels.		
Clay Soft light brown sandy Clay.		
Limestone Broken Limestone with sandy infil. Water inflow at this point of approximately 1090m³/day.		
Limestone Solid grey Limestone.		
Fracture Broken Limestone with sandy infill. Water inflow at this point of approximately 327m³/day.		
Limestone Solid grey Limestone.		



White Young Green

Drill Method Air Rotary **Hole Size (mm)** 200

Casing Length (m) 7.3 **TOC (mOD)**

Driller Aidan Briody **Static Water Level (bgl)** 0.63

Well Log

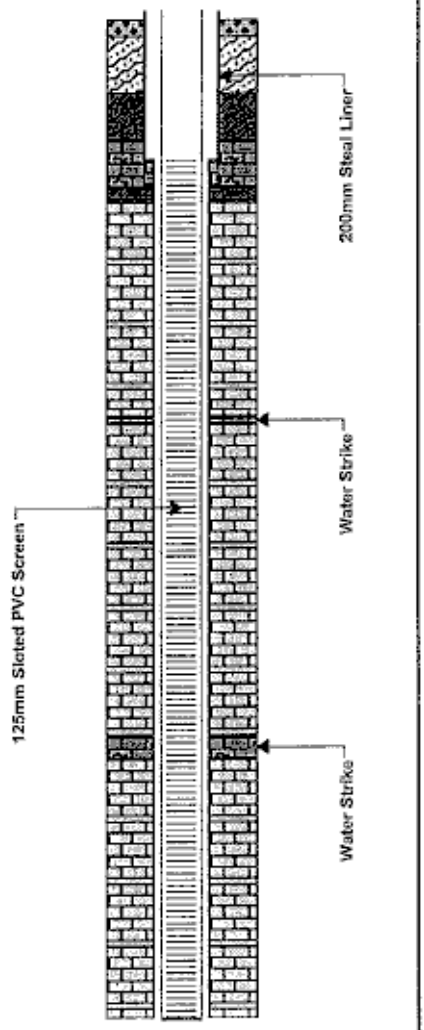
Well No. TW-2 **Grid Reference** 11659 09144

Project No. C003283 **Client** JB Barry **Drill Date** 6/12/2004

Well Type Trial Well **Location** Rath, Birr **Geologist** B. Sexton

SUBSURFACE PROFILE

Description	Depth (m)	Symbol
Ground Surface	0.0	
Gravel Large limestone gravel fill.		
Clay Grey sticky Clay with fine gravels.	10.0	
Clay Light brown gravelly Clay.		
Limestone Soft broken sandy limestone.	20.0	
Limsetone Very fractured Limestone with orange sand infill.		
Limestone Grey solid Limestone.	30.0	
Fracture Very broken Limestone with orange sand infill. Water inflow of approximately 109m³/day.	40.0	
Limestone Grey solid Limestone.	50.0	
	60.0	
Fracture Very broken Limestone with orange sand infill.Water entry at this point of approximately 545-872m³/day.	70.0	
Limestone Grey solid Limestone.	80.0	
	90.0	



White Young Green

Drill Method Air Rotary **Hole Size (mm)** 200

Casing Length (m) 12.8 **TOC (mOD)**

Driller Aidan Briody **Static Water Level (bgl)** 1.095

Well Log

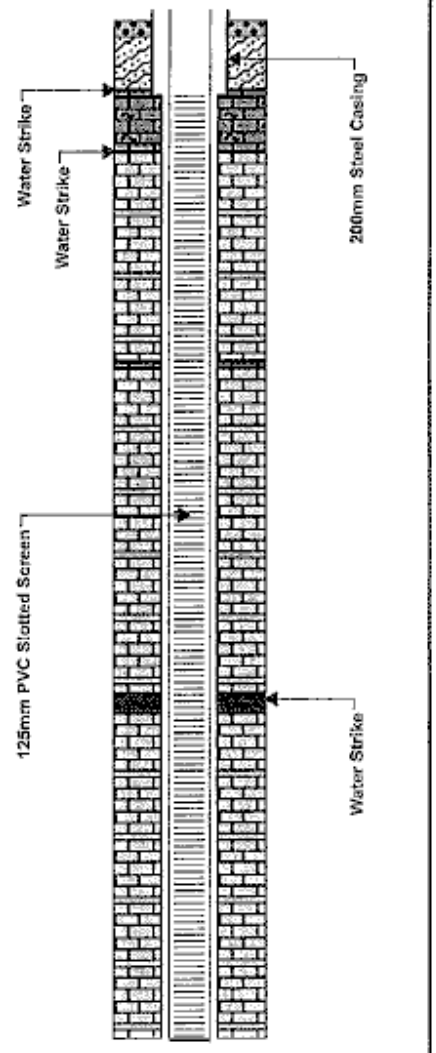
Well No. TW-3 **Grid Reference** 11658 09277

Project No. C003283 **Client** JB Barry **Drill Date** 8/12/2004

Well Type Trial Well **Location** Rath, Birr **Geologist** B. Sexton

SUBSURFACE PROFILE

Description	Depth (m)	Symbol
Ground Surface		
Gravel Large limestone Gravel fill.		
Clay Firm grey gravelly Clay.		
Limestone Solid dark grey Limestone. Water inflow at this point of approximately 327m³/day.		
Limestone Pale grey Limestone. Water inflow at this point of approximately 763m³/day.		
Fracture Very broken limestone with sandy Infill.		
Limestone Solid pale grey Limestone.		
Clay Deep orange soft Clay. Water inflow at this point of approximately 1090m³/day.		
Limestone Solid pale grey Limestone.		



Drill Method Air Rotary **Hole Size (mm)** 200

Casing Length (m) 6 **TOC (mOD)**

Driller Aidan Briody **Static Water Level (bgl)** 0.57

Well Log

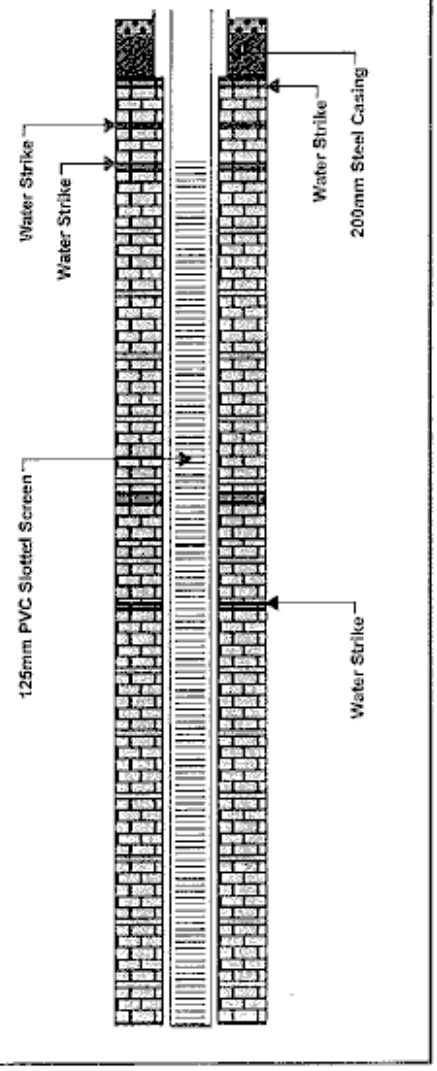
Well No. TW-4 **Grid Reference** 11635 09357

Project No. C003283 **Client** JB Barry **Drill Date** 9/12/2004

Well Type Trial Well **Location** Rath, Birr **Geologist** B. Sexton

SUBSURFACE PROFILE

Description	Depth (m)	Symbol	Well Construction
Ground Surface			
Gravel Large limestone Gravel fill.			
Clay Firm brown gravelly Clay.			
Limestone Broken section of limestone with sandy infill.			
Limestone Solid Limestone. Water inflow at this point of approximately 109m³/day.			
Fracture Fractured Limestone. Water inflow at this point of approximately 327-545m³/day.			
Limestone Solid pale Limestone.			
Fracture Broken limestone.Water inflow at tghis point of approximately 872m³/day.			
Limestone Solid pale grey Limestone.			
Fracture Broken Limestone			
Limestone Pale grey solid Limestone.			
Fracture Broken Limestone. Water inflow at this point of approximately 1090m³/day.			
Limestone Pale grey solid Limestone.			



White Young Green

Drill Method Air Rotary **Hole Size (mm)** 200

Casing Length (m) 5.3 **TOC (mOD)**

Driller Aidan Briody **Static Water Level (bgl)** 0.57

Appendix II

GSI Auger Hole Logs

AUGER HOLE	EASTING	NORTHING	DTB	BS5930 (depth)	BS5930 (depth)	BS5930 (depth)	BS5930 (depth)	SUBSOIL
1	212656	210075	5.0	SILT (3)	GVL (5)			TILL
2	212511	210122	5.0	S/C (1.5)	SAND (3)			TILL
3	212047	210105	3.0	GVL (1.5)				TILL
4	211988	209836	5.0	GVL (1.5)	GVL (3)			TILL
5	212708	209978	5.0	S/C (2)				TILL
6	212246	209670	6.0	S/C (1.5)	GVL (3.5)	GVL (5)		TILL
7	211679	209842	4.0	GVL (2)	GVL (3.5)			TILL
8	211369	209641	4.0	SILT (2)				TILL
9	211590	209539	6.0	GVL (2)	S/C (5)			TILL
10	211805	209527	4.0	SILT (3)				TILL
11	212507	209535	7.0	S/C (2)	GVL (3.5)	S/C (4.5)	CLAY (6)	TILL
12	212785	209679	5.0	SAND (2)				TILL
13	212155	209524	3.0	GVL (3)				TILL

DTB: Depth to bedrock
S/C: Silt/Clay
GVL: Gravel

Appendix III

Rath Group Water Scheme
Water Quality Data

				Colour	Turbidity	Odour	pH	Conductivity	Chloride	Sulphates	Calcium	Magnesium	Sodium	Potassium	Aluminium
ID Code	Date of Sampling	Appearance		Chem-1	Chem-2	Chem-3	Chem-6	Chem-7	Chem-8	Chem-9	Chem-10	Chem-11	Chem-12	Chem-13	Chem-14
	October-95														
	11-May-98								20				8.6	4	
	13-Jul-98								23				8.6	4.5	
	7-Sep-98								24				9.5	3.6	
	2-Nov-98								25				9.2	4.1	
	25-Jan-99								21				9.38	3.71	
	8-Mar-99								26				8.82	3.74	
	14-Jun-99					None			23				9.64	3.76	
	10-Aug-99					None			25				9.64	4.28	
	26-Oct-99					None			24.8				10.01	4.45	
	15-Dec-99					None			25				9.59	5	
565	13-Mar-00	Slightly dull; slight/some suspended particles	50	1	.66	None	7.2	727	27.2				10.48	5.14	<0.01
36	17-Apr-00	Slightly dull; slight/some suspended particles		5	1.18	None	7.1	723	25.1				9.78	4.12	0.18
061	22-May-00	Slightly dull; slight/some suspended particles		1	.39	None	7	738	24.8				9.44	3.8	<0.01
300	19-Jun-00	Slightly dull; slight amount of suspended particles		5	0.37	None	7	739	25.5				9.33	4.57	<0.01
3	2-Aug-00					None			25.8				9.91	5	
830	21-Aug-00	Clear; slight amount of suspended particles		1	1.2	None	6.9	709	24.8				9.94	3.96	0.13
521	7-Oct-00	Dull; large amount of suspended particles		4	(17.6)	None	7	811	24.1				9.79	3.82	(0.72)
343	16-Oct-00	Slightly dull; slight/some suspended particles		1	.56	Slight sta	7	728	25.1				9.56	3.46	<0.01
023	9-Nov-00	Slightly dull; slight to some suspended particles		1	0.72	None	6.9	734	25.3				9.47	4.14	<0.01
854	12-Nov-00	Dull; some /large amount of suspended particles		2	2.22	S.veg.deca	7	724	24.6				8.25	4.34	0.13
576	13-Nov-00	Slightly dull; some suspended particles		1	3.38	Earthy typ	7	754	27.3				4.51	2.13	0.07
4	22-Jan-01	Slightly dull; some suspended particles.		2	2.33	Vegetative	7.0	692	25.3			10	9.11	3.88	0.13
67	12-Feb-01	Slightly dull; slight amount of suspended particles.		1	1.14	None	6.9	724	24.5				8.57	3.94	0.37
17	23-Apr-01	Clear; slight amount of suspended particles		16	0.18	Vegetative	7	696	24.3				9.96	4.92	0.01
159	21-May-01	Slightly dull, some suspended particles.		2	2.74	None	6.9	646	25.5				9.52	4.28	0.15
417	18-Jun-01	Slightly dull; slight to some suspended particles		5	0.38	None	7.1	734	26.2				9.47	4.51	<0.01
602	9-Jul-01	Clear;slight amount of suspended particles		2	0.09	None	6.8	640	26.3				9.10	4.86	<0.01
958	20-Aug-01	Slightly dull;slight amount of suspended particles		2	0.11	None	6.8	763	26.5				9.16	4.24	<0.01
302	24-Sep-01	Clear;slight amount of suspended particles		2	0.09	None	6.9	736	26.1				10.05	4.58	<0.01
397	8-Oct-01	Clear;slight amount of suspended particles		1	0.22	see below	7.1	731	25.8				8.72	4.2	<0.01
2919	3-Dec-01	Clear;slight amount of suspended particles		6	0.11	Sweet	7.0	699	25.9				9.01	4.42	<0.01
0	21-Jan-02	Clear;slight amount of suspended particles		4	0.11	stale	7	817	26.3				9.01	4.98	<0.01
56	11-Feb-02	Clear; slight amount of suspended particles		1	0.16	veg decay	7.1	717	23.8				9.38	5.42	<0.01
95	11-Mar-02	Clear; slight amount of suspended particles		4	0.14	stale	7.1	683	23.3				9.19	4.93	<0.01
22	22-Apr-02	Clear; slight amount of suspended particles		<5	0.09	None	6.9	561	24.7				9.43	4.91	<0.01
187	20-May-02	Clear; slight amount of suspended particles		<5	0.07	None	6.7	744	24.3				9.58	4.95	<0.01
512	25-Jun-02	Clear; slight amount of suspended particles		<5.0	0.16	None	6.8	744	24.2				9.16	5.14	0.01
630	8-Jul-02	Clear;slight amount of suspended particles		<5	0.15	None	6.7	744	25.7				9.02	5.29	<0.01
971	19-Aug-02	Clear;slight amount of suspended particles		<5	0.1	None	6.9	698	25.2				8.8	4.6	<0.01
389	7-Oct-02	Clear;slight amount of suspended particles		6.8	0.12	None	7.3	730	25				9.1	4.6	<0.01
2709	11-Nov-02	Clear; slight amount of suspended particles	50	8	0.13	None	7.0	743	24.9				9.3	4.9	<0.01
	9-Dec-02	Clear; slight amount of suspended particles		7.1	0.16	None	6.8	744	23.7				9.6	5.4	<0.01
	17-May-04	Clear; slight amount of suspended particles		<5.0	0.11	None		670	28.6						
	16-Aug-04	Clear; slight amount of suspended particles		<5.0	0.18	None	6.8	750	26.7						
	5-Sep-04	Clear;slight amount of suspended particles		<5.0	0.16	None	7.1	760							

ID Code	Date of Sampling	Appearance		Chem-1	Chem-2	Chem-3	Chem-6	Chem-7	Chem-8	Chem-9	Chem-10	Chem-11	Chem-12	Chem-13	Chem-14
	28-Sep-04														
	11-Oct-04	Clear;slight amount of suspended particles		<5.0	0.21	None	6.9	752	26.9						
	9-Nov-04	Clear;slight amount of suspended particles		<5.0	0.21	None	6.8	758	27.4						<100
	5-Dec-04	Clear;slight amount of suspended particles		<5.0	0.26	None	6.8	772	27.5						<10
	17-Jan-05	Clear; slight amount of suspended particles		<5	0.4	None	6.9	747	27.9						
	7-Feb-05	Clear;slight amount of suspended particles		<5	0.2	None	6.6	705	27.3						
	1-Mar-05	Clear;slight amount of suspended particles		<5	0.21	None	6.7	679	27.5						
	5-Mar-05														
	4-Apr-05	Clear;slight amount of suspended particles		<5.0	0.33	None	7.1	709	27.4						
	3-May-05	Clear;slight amount of suspended particles		<5.0	0.26	None	6.7	710	25						
	14-Nov-05														
	6-Dec-05	Clear; slight amount of suspended particles		<5.0	0.41	None	6.5	813							
	10-Jan-06			<5	0.51	None	7.1	748							<10
	13-Feb-06	Clear;slight amount of suspended particles		<5	0.51	None	7.1	748							<10
	13-Mar-06														
	10-Apr-06														
	2-May-06														
	2-Jun-06														
	13-Jun-06														
	17-Jul-06	Clear; slight amount of suspended particles		<5	0.5		7.1	729							<10
	14-Aug-06														
	21-Aug-06														
	5-Sep-06														
	9-Oct-06	Clear; slight amount of suspended particles		<5	0.45	None	7	749							<10
	11-Dec-06														
	7-Aug-07	Clear; slight amount of suspended particles		<5	0.29	none	7.1	710							<25
	9-Oct-07	Clear;slight amount of suspended particles		<5	0.36	none	7.1								<25
	11-Dec-07	Clear;slight amount of suspended particles		<5	0.42	none	7.1	771							<25
	12-Feb-08	Clear;slight amount of suspended particles		<5	0.15	none		356							<25
	5-Mar-08														
	16-Apr-08														
	21-Apr-08														
	29-Apr-08														
	23-Apr-08														
	7-May-08														
	14-May-08														
	20-May-08														
	27-May-08														
	11-Jun-08														
	16-Jun-08														

		Nitrates	Nitrites	Ammonium	Oxidisability	Iron	Manganese	Copper	Zinc	Fluoride	Cadmium	Lead	Total Harness	Alkalinity
Date of Sampling	Appearance	Chem-16	Chem-17	Chem-18	Chem-20	Chem-28	Chem-29	Chem-30	Chem-31	Chem-33	Chem-38	Chem-43	Chem-61	Chem-62
October-95		33.00												
11-May-98		50.50												
13-Jul-98		43.20	<0.1											
7-Sep-98		43.09	<0.1											
2-Nov-98		42.89	<0.1											
25-Jan-99		40.92	0.01											
8-Mar-99		42.28	0.01											
14-Jun-99		39.52	<.007											
10-Aug-99		41.26	<.007											
26-Oct-99		37.87	<.007											
15-Dec-99		42.60	<.007											
13-Mar-00	Slightly dull; slight/some suspended particles	25.40	0.014	0.06		80	<10	<20	13			<10	172	
17-Apr-00	Slightly dull; slight/some suspended particles	32.12	<0.007	0.04		151	20	<20	32			<10	162	
22-May-00	Slightly dull; slight/some suspended particles	34.26	0.007	0.04		64	<10	<20	22			<10	169	
19-Jun-00	Slightly dull; slight amount of suspended particles	34.38	0.009	0.07		<45	10	<20	11			<10	165	
2-Aug-00		25.12	<0.007											
21-Aug-00	Clear; slight amount of suspended particles	37.54	<0.007	0.04		58	<10	<20	24			<10	169	
7-Oct-00	Dull; large amount of suspended particles	40.39	<0.007	0.03		(486)	22	<20	30			<10	164	
16-Oct-00	Slightly dull; slight/some suspended particles	40.74	<0.007	0.05		<45	<10	<20	<10			<10	169	
9-Nov-00	Slightly dull; slight to some suspended particles	44.11	<0.007	0.04		<45	<10	<20	<10			<10	169	
12-Nov-00	Dull; some /large amount of suspended particles	44.45	<0.007	<0.03		122	17	<20	23			<10	179	
13-Nov-00	Slightly dull; some suspended particles	49.53	<0.007	0.3		123	10	<20	24			<10	165	
22-Jan-01	Slightly dull; some suspended particles.	40.95	<0.007	<0.03		89	10	<20	24			<10	159	
12-Feb-01	Slightly dull; slight amount of suspended particles.	44.85	<0.007	0.05		75	<10	<20	26			<10	164	
23-Apr-01	Clear; slight amount of suspended particles	40.58	<0.007	0.04		<45	<10	<20	<10			<10	158	
21-May-01	Slightly dull, some suspended particles.	46.23	0.009	0.04		118	<10	<20	31			<10	141	
18-Jun-01	Slightly dull; slight to some suspended particles	47.23	0.014	0.04		<45	<10	<20	14			<10	164	
9-Jul-01	Clear;slight amount of suspended particles	44.11	0.009	0.05		<45	<10	<20	13			<10	158	
20-Aug-01	Slightly dull;slight amount of suspended particles	46.30	0.009	0.06		<45	<10	<20	10			<10	149	
24-Sep-01	Clear;slight amount of suspended particles	49.15	<0.007	0.03		61	<10	,20	<10			<10	148	
8-Oct-01	Clear;slight amount of suspended particles	46.90	<0.007	0.04		<45	<10	<20	10			<10	149	
3-Dec-01	Clear;slight amount of suspended particles	47.30	<0.007	<0.03		<45	<10	<20	10			<10	163	
21-Jan-02	Clear;slight amount of suspended particles	49.66	<0.007	<0.03		<45	<10	<20	12			<10	123	
11-Feb-02	Clear; slight amount of suspended particles	55.06	<0.007	<0.03		<45	<10	<20	10			<10	159	
11-Mar-02	Clear; slight amount of suspended particles	52.70	<0.018	<0.08		<100	<25	<50	<50			<10	148	
22-Apr-02	Clear; slight amount of suspended particles	53.90	<0.018	<0.08		<100	<25	<50	<50			<10	168	
20-May-02	Clear; slight amount of suspended particles	52.76	<0.018	<0.08		<100	<25	<50	<50			<5	162	
25-Jun-02	Clear; slight amount of suspended particles	55.00	<0.018	<0.08		<100	<25	<50	<50			<5	164	
8-Jul-02	Clear;slight amount of suspended particles	56.78	<0.018	<0.08		<100	<25	<50	<50			<5	162.8	
19-Aug-02	Clear;slight amount of suspended particles	52.92	<0.01	<0.08		<100	<25	<50	<50			<5	161.4	
7-Oct-02	Clear;slight amount of suspended particles	49.34	<0.018	<0.08		<100	<25	<50	<50			<5	161.8	
11-Nov-02	Clear; slight amount of suspended particles	50.72	<0.018	<0.08		<100	<25	<50	<50			<5	167.8	
9-Dec-02	Clear; slight amount of suspended particles	54.00	<0.018	<0.08		<100	<25	<50	<50			<5		
17-May-04	Clear; slight amount of suspended particles	63.56	0.079	0.15		<100	<25	<0.05				<5		
16-Aug-04	Clear; slight amount of suspended particles	60.40	0.034	0.15		<100	<25	<0.05				<5	161	
5-Sep-04	Clear;slight amount of suspended particles	61.18	0.053	0.11		<100	<25	<0.05				<5	163	

Date of Sampling	Appearance	Chem-16	Chem-17	Chem-18	Chem-20	Chem-28	Chem-29	Chem-30	Chem-31	Chem-33	Chem-38	Chem-43	Chem-61	Chem-62
28-Sep-04		61.10												
11-Oct-04	Clear;slight amount of suspended particles	64.52	0.054	0.13		<100	<25	<0.05				<5	159.6	
9-Nov-04	Clear;slight amount of suspended particles	55.70	0.021	0.08		<100	<25	<0.05				<5	124	
5-Dec-04	Clear;slight amount of suspended particles	62.20	0.019	0.11		<100	<25	<0.05				<5	115	
17-Jan-05	Clear; slight amount of suspended particles	65.54	<0.018	<0.08		<100	<25	<0.05				<5	120	
7-Feb-05	Clear;slight amount of suspended particles	60.78	<0.018	<0.08		<100	<25	<0.05				<5	159.2	
1-Mar-05	Clear;slight amount of suspended particles	61.10	<0.018	<0.08		<100	<25	<0.05				<5	160.4	
5-Mar-05														
4-Apr-05	Clear;slight amount of suspended particles	61.16	<0.018	<0.08		<100	<25	<0.05				<5	160.4	
3-May-05	Clear;slight amount of suspended particles	58.40	<0.018	<0.08		<100	<25	<0.05				<5	155	
14-Nov-05		49.19	<0.018											
6-Dec-05	Clear; slight amount of suspended particles	<2.21	<0.018	0.32		<100	<25	<0.05				>5	165	
10-Jan-06		52.90	<0.018	<0.08		<100								
13-Feb-06	Clear;slight amount of suspended particles	57.72	<0.018	<0.08		<100								
13-Mar-06		57.66	<0.018											
10-Apr-06		61.38	<0.018											
2-May-06		57.74	<0.018											
2-Jun-06		40.30												
13-Jun-06		60.33	<0.018											
17-Jul-06	Clear; slight amount of suspended particles	54.21	<0.018	<0.08		<100								
14-Aug-06		56.66	<0.018											
21-Aug-06		57.37	<0.018											
5-Sep-06		55.14	<0.018											
9-Oct-06	Clear; slight amount of suspended particles	53.05	<0.018	<0.08		<100								
11-Dec-06		77.84	<0.018											
7-Aug-07	Clear; slight amount of suspended particles	51.37	<0.018			<100								
9-Oct-07	Clear;slight amount of suspended particles	52.40	<0.018	<0.08		<100								
11-Dec-07	Clear;slight amount of suspended particles	62.43	<0.018	<0.08		<100								
12-Feb-08	Clear;slight amount of suspended particles	58.49	<0.018			<100								
5-Mar-08		43.19	<0.018											
16-Apr-08		55.93	<0.018											
21-Apr-08														
29-Apr-08		49.16	<0.018											
23-Apr-08		45.84	<0.018											
7-May-08		47.1	<0.018											
14-May-08		43.09	<0.018											
20-May-08		45.45	<0.018											
27-May-08		39.55	<0.018											
11-Jun-08		37.62	<0.018											
16-Jun-08		38.6	<0.018											

		Chlorine		
Date of Sampling	Appearance	Chem-63	Comment	k:na
October-95				
11-May-98				0.5
13-Jul-98				0.5
7-Sep-98				0.4
2-Nov-98				0.4
25-Jan-99				0.4
8-Mar-99				0.4
14-Jun-99				0.4
10-Aug-99				0.4
26-Oct-99				0.4
15-Dec-99				0.5
13-Mar-00	Slightly dull; slight/some suspended particles			0.5
17-Apr-00	Slightly dull; slight/some suspended particles			0.4
22-May-00	Slightly dull; slight/some suspended particles			0.4
19-Jun-00	Slightly dull; slight amount of suspended particles			0.5
2-Aug-00				0.5
21-Aug-00	Clear; slight amount of suspended particles			0.4
7-Oct-00	Dull; large amount of suspended particles			0.4
16-Oct-00	Slightly dull; slight/some suspended particles			0.4
9-Nov-00	Slightly dull; slight to some suspended particles			0.4
12-Nov-00	Dull; some /large amount of suspended particles			0.5
13-Nov-00	Slightly dull; some suspended particles			0.5
22-Jan-01	Slightly dull; some suspended particles.			0.4
12-Feb-01	Slightly dull; slight amount of suspended particles.			0.5
23-Apr-01	Clear; slight amount of suspended particles		excessively hard.	0.5
21-May-01	Slightly dull, some suspended particles.			0.4
18-Jun-01	Slightly dull; slight to some suspended particles		Odour; stale type	0.5
9-Jul-01	Clear;slight amount of suspended particles		decay type	0.5
20-Aug-01	Slightly dull;slight amount of suspended particles			0.5
24-Sep-01	Clear;slight amount of suspended particles			0.5
8-Oct-01	Clear;slight amount of suspended particles		Vegetative type	0.5
3-Dec-01	Clear;slight amount of suspended particles		Odour; Sweet type	0.5
21-Jan-02	Clear;slight amount of suspended particles		Odour-stale	0.6
11-Feb-02	Clear; slight amount of suspended particles		sewage	0.6
11-Mar-02	Clear; slight amount of suspended particles		type Excess nitrate	0.5
22-Apr-02	Clear; slight amount of suspended particles		exceeded	0.5
20-May-02	Clear; slight amount of suspended particles		Excess Nitrates	0.5
25-Jun-02	Clear; slight amount of suspended particles		nitrate exceeds the	0.6
8-Jul-02	Clear;slight amount of suspended particles			0.6
19-Aug-02	Clear;slight amount of suspended particles			0.5
7-Oct-02	Clear;slight amount of suspended particles			0.5
11-Nov-02	Clear; slight amount of suspended particles			0.5
9-Dec-02	Clear; slight amount of suspended particles			0.6
17-May-04	Clear; slight amount of suspended particles			
16-Aug-04	Clear; slight amount of suspended particles			
5-Sep-04	Clear;slight amount of suspended particles			

Date of Sampling	Appearance	Chem-63	Comment	k:na
28-Sep-04				
11-Oct-04	Clear;slight amount of suspended particles			
9-Nov-04	Clear;slight amount of suspended particles			
5-Dec-04	Clear;slight amount of suspended particles			
17-Jan-05	Clear; slight amount of suspended particles			
7-Feb-05	Clear;slight amount of suspended particles			
1-Mar-05	Clear;slight amount of suspended particles			
5-Mar-05				
4-Apr-05	Clear;slight amount of suspended particles			
3-May-05	Clear;slight amount of suspended particles			
14-Nov-05				
6-Dec-05	Clear; slight amount of suspended particles			
10-Jan-06		0.09		
13-Feb-06	Clear;slight amount of suspended particles			
13-Mar-06		0.3		
10-Apr-06		0.7		
2-May-06		0.11		
2-Jun-06				
13-Jun-06		0.09		
17-Jul-06	Clear; slight amount of suspended particles	0.3		
14-Aug-06				
21-Aug-06		0.02		
5-Sep-06		0.09		
9-Oct-06	Clear; slight amount of suspended particles	0		
11-Dec-06		0		
7-Aug-07	Clear; slight amount of suspended particles			
9-Oct-07	Clear;slight amount of suspended particles			
11-Dec-07	Clear;slight amount of suspended particles			
12-Feb-08	Clear;slight amount of suspended particles			
5-Mar-08				
16-Apr-08				
21-Apr-08				
29-Apr-08				
23-Apr-08				
7-May-08				
14-May-08				
20-May-08				
27-May-08				
11-Jun-08				
16-Jun-08				

StationName	Sample Date	Completion Date	Easting	Northing	Hardness (Ca)	1,2-dichloroethane	Acrylamide	Aluminium	Ammonium (NH4)	Antimony	Arsenic	Benzene	Benzo-(a)pyrene	Boron	Bromate	Bromodi-chloromethane	Bromoform	Cadmium	Chloride	Chloroform	Chromium	Clostridium Perfringens	Coliform Bacteria	Colony Count 22°	Colour
	1-Jan-04																								
Springfield House	28-Sep-04																								
P Spain, well at RathCross	28-Sep-04																								
School Well	28-Sep-04																								
Road to Pump Station	28-Sep-04																								
Greenans Outfall S. Water	28-Sep-04																								
Pipes from Mill Yard	20-Oct-04								0.06																
Tap at Office (outside)	20-Oct-04																								
GAA Field	18-Oct-04																								
Joe O'Brien	18-Oct-04																								
Colm Gath	18-Oct-04																								
Denis O'Brien	18-Oct-04																								
Mrs Ryan	18-Oct-04																								
P. Nugent	18-Oct-04																								
P.Spain	18-Oct-04																								
D.O'Brien New House	18-Oct-04																								
P. Tumelty	18-Oct-04																								
M. Devery	18-Oct-04																								
Mrs Gill	18-Oct-04																								
J. Burke	18-Oct-04																								
Pauleen Dermody	18-Oct-04																								
Bennett, Fivealley	9-Oct-06	02/07/2007	211103	211318				<10	<0.08													NT	2		<5
Bennett, Fivealley	13-Mar-06	02/07/2007	211103	211318																		NT	0		
Bennett, Fivealley	21-Aug-06	02/07/2007	211103	211318																		NT	0		
Bennett, Fivealley	10-Dec-07	27/02/2008	211103	211318				<25	<0.08													0	0		<5
Claffey, Whigsborough	6-Aug-07	27/02/2008	210820	211786				<25	NT													0	0		<5
Connolly, Tinnacross	30-Jul-07	27/02/2008	212054	209285																		0	36		
Delaney, Coagh, Killyon	2-Feb-06	02/07/2007	214604	207792																		NT	0		
Duigan, Five Alley	4-Mar-08		11040	11251																		0	0		
Kearns, Rathure, Killyon	5-Sep-06	02/07/2007	212982	207101																		NT	0		
Kearns, Rathure, Killyon	28-May-07	27/02/2008	212982	207101																		0	0		
Kelly, Tinnacross	13-Nov-07	27/02/2008	212000	209524		<1	<0.02	<11	<0.13	0.17	<0.37	<1	<0.001	<0.1	0.7			<0.06	27.82		<0.7	0	<1	13	<2
Kelly, Tinnacross	17-Jul-06	02/07/2007	212000	209524				<10	<0.08													NT	0		<5
Kelly, Tinnacross	30-Jul-07																								
Mannion, Killyon Cross	11-Feb-08		213187	205760				<25	<0.08													0	0		<5
Mannion, Killyon Cross	14-Aug-07	27/02/2008	213187	205760																		0	0		
Mannion, Killyon Cross	19-Feb-07	27/02/2008	213187	205760																		NT	0		
Murphy, Coologue, Fivealle	13-Jun-06	02/07/2007	210071	211700																		NT	0		
Nugent, Rath	13-May-08		212840	209822																		0	0		
Oonagh Grennans Shop	17-Oct-06	02/07/2007	0	0																		NT	5		
P Kavanagh, Killyon	13-Feb-06	02/07/2007	213170	205752				<10	<0.08													NT	0		<5
P Kavanagh, Killyon	21-May-07	27/02/2008	213170	205752																		0	>100		
P Spain, Rath	14-Nov-06	02/07/2007	212877	209734		<1	NT	58	<0.13	0.18	<0.37	<1	<0.001	<0.1	3.3			<0.5	32.46		<5	0	<1	3	<2
P Spain, Rath	10-Jan-06	02/07/2007	212877	209734																		NT	0		
P Spain, Rath	10-Apr-06	02/07/2007	212877	209734																		NT	0		
P Spain, Rath	23-Oct-06	02/07/2007	212877	209734																		NT	0		
P Spain, Rath	3-Apr-07	27/02/2008	212877	209734																		NT	0		
P Spain, Rath	18-Jun-07	28/02/2008	212877	209734																		0	0		
P Spain, Rath	14-Jan-08		212877	209734																		0	0		
Spain, Ballindow	5-Mar-08																								
P Spain, Rath	15-Apr-08		212877	209734																		0	0		
Rath NS	9-Jan-07	27/02/2008	212932	209695																		NT	0		
Watkins, Fivealley	8-Oct-07	27/02/2008	211083	211300				<25	<0.08													0	0		<5
Watkins, Fivealley	11-Dec-06	02/07/2007	211083	211300																		NT	0		
Watkins, Fivealley	6-Mar-07	27/02/2008	211083	211300																		NT	0		
Whigsborough House	10-Sep-07	27/02/2008	210123	211896																		0	0		
Grennans	6-Feb-08																								
Quegans, Five Valley	4-Mar-08																								
GAA Field	7-Apr-08																								
Fleurys Field	7-Apr-08																								
Fleurys Well	7-Apr-08																								
Loonam, Parkmore	5-Mar-08																								
Byrne, Ballinree, Killyon	12-May-08																								
	31-Dec-08																								

StationName	Sample Date	Conductivity @ 20°C	Copper	Cyanide	Dibromo - chloromethane	E-Coli	Enterococci Species	Epichlorohydrin	Escherichia Coli (E.Coli)	Faecal Coliforms	Fluoride	Free Chlorine	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Nitrate (mg/L NO3)	Nitrites (NO2)	Odour	Oxidisability
	1-Jan-04																					
Springfield House	28-Sep-04																		19			
P Spain, well at RathCross	28-Sep-04																		108.9			
School Well	28-Sep-04																		35.1			
Road to Pump Station	28-Sep-04																		59.8			
Greenans Outfall S. Water	28-Sep-04																		<0.87	0.05		
Pipes from Mill Yard	20-Oct-04																		<0.87			
Tap at Office (outside)	20-Oct-04																		134			
GAA Field	18-Oct-04																		32.5			
Joe O'Brien	18-Oct-04																		90.8			
Colm Gath	18-Oct-04																		51.4			
Denis O'Brien	18-Oct-04																		59.3			
Mrs Ryan	18-Oct-04																		112.9			
P. Nugent	18-Oct-04																		52.7			
P.Spain	18-Oct-04																		121.3			
D.O'Brien New House	18-Oct-04																		37.8			
P. Tumelty	18-Oct-04																		54			
M. Devery	18-Oct-04																		38.9			
Mrs Gill	18-Oct-04																		37			
J. Burke	18-Oct-04																		34.41			
Pauleen Dermody	18-Oct-04																		22.1			
Bennett, Fivealley	9-Oct-06	749							0				<100							<0.018	0	
Bennett, Fivealley	13-Mar-06								0			0.3										
Bennett, Fivealley	21-Aug-06								0			0.2										
Bennett, Fivealley	10-Dec-07	771							0				<100						62.43	<0.018	0	
Claffey, Whigsborough	6-Aug-07	710							0			0.2	<100						51.37	<0.018	0	
Connolly, Tinnacross	30-Jul-07								5			0										
Delaney, Coagh, Killyon	2-Feb-06								0			0.11										
Duigan, Five Alley	4-Mar-08								0			0.1										
Kearns, Rathure, Killyon	5-Sep-06								0			0.09										
Kearns, Rathure, Killyon	28-May-07								0			0.26										
Kelly, Tinnacross	13-Nov-07	776	0.032	<0.7			<1	<0.1	<1		0.1		<7	0.5		<1.5	<0.012	1.1	45.14	<0.07	0	0
Kelly, Tinnacross	17-Jul-06	729							0				<100							<0.018	0	
Kelly, Tinnacross	30-Jul-07																		49.12			
Mannion, Killyon Cross	11-Feb-08	356							0	0		0.25	<100						58.49	<0.018	0	
Mannion, Killyon Cross	14-Aug-07					0			0			0.1										
Mannion, Killyon Cross	19-Feb-07								0			0.16								65.1		
Murphy, Coologue, Fivealle	13-Jun-06								0			0.09										
Nugent, Rath	13-May-08								0			0.1										
Oonagh Grennans Shop	17-Oct-06								0			0										
P Kavanagh, Killyon	13-Feb-06	748							0				<100						53.75	<0.018	0	
P Kavanagh, Killyon	21-May-07								0			0.06										
P Spain, Rath	14-Nov-06	803	<0.02	<0.4			<1	NT	<1		0.1		32.35	<2.5		<5	<0.015	<2	51.17	<0.07	0	NT
P Spain, Rath	10-Jan-06								0			0.09										
P Spain, Rath	10-Apr-06								0			0.5										
P Spain, Rath	23-Oct-06								0			0.26										
P Spain, Rath	3-Apr-07								0			0.29							67.41			
P Spain, Rath	18-Jun-07					0			0			0.16							50.27			
P Spain, Rath	14-Jan-08								0			0.2							64.31	<0.018		
Spain, Ballindow	5-Mar-08																		43.8			
P Spain, Rath	15-Apr-08								0			0.16										
Rath NS	9-Jan-07								0			0.17							67.32			
Watkins, Fivealley	8-Oct-07	749							0				<100						52.4	<0.018	0	
Watkins, Fivealley	11-Dec-06								0			0										
Watkins, Fivealley	6-Mar-07								0			0.21							71.6			
Whigsborough House	10-Sep-07					0			0			0.07							68.1			
Grennans	6-Feb-08																		37.6			
Quegans, Five Valley	4-Mar-08																		43.19			
GAA Field	7-Apr-08																		48.7			
Fleurys Field	7-Apr-08																		42.5			
Fleurys Well	7-Apr-08																		52.3			
Loonam, Parkmore	5-Mar-08																		46.5			
Byrne, Ballinree, Killyon	12-May-08																		49.16			
	31-Dec-08																					

StationName	Sample Date	PAH (Polycyclic Aromatic Hydrocarbons)	Pesticides	Pesticides - Total	pH	Potassium	Residual Chlorine(Cl)	Selenium	Sodium	Sulphate	Sulphite-Reducing Clostridia	Taste	Tetrachloroethane and Trichloroethane	Total Bacteria @ 22°C	Total Bacteria @ 37°C	Total Chlorine	Total Coliforms	Total Organic Carbon b	Trihalomethanes (Total)	Tritium	Turbidity
	1-Jan-04																				
Springfield House	28-Sep-04																				
P Spain, well at RathCross	28-Sep-04																				
School Well	28-Sep-04																				
Road to Pump Station	28-Sep-04																				
Greenans Outfall S. Water	28-Sep-04									19.1											
Pipes from Mill Yard	20-Oct-04					9.5				9.62											
Tap at Office (outside)	20-Oct-04					10.1				21.8											
GAA Field	18-Oct-04																				
Joe O'Brien	18-Oct-04																				
Colm Gath	18-Oct-04																				
Denis O'Brien	18-Oct-04																				
Mrs Ryan	18-Oct-04																				
P. Nugent	18-Oct-04																				
P.Spain	18-Oct-04																				
D.O'Brien New House	18-Oct-04																				
P. Tumelty	18-Oct-04																				
M. Devery	18-Oct-04																				
Mrs Gill	18-Oct-04																				
J. Burke	18-Oct-04																				
Pauleen Dermody	18-Oct-04																				
Bennett, Fivealley	9-Oct-06				7							NT									0.45
Bennett, Fivealley	13-Mar-06															0.39					
Bennett, Fivealley	21-Aug-06															0.23					
Bennett, Fivealley	10-Dec-07				7.1							NT									0.42
Claffey, Whigsborough	6-Aug-07				7.1							NT				0.36					0.29
Connolly, Tinnacross	30-Jul-07															0.09					
Delaney, Coagh, Killyon	2-Feb-06															0.2					
Duigan, Five Alley	4-Mar-08															0.17					
Kearns, Rathure, Killyon	5-Sep-06															0.13					
Kearns, Rathure, Killyon	28-May-07															0.21					
Kelly, Tinnacross	13-Nov-07	0	0.005	0	6.99			0.73	11	<20		0	<10					1.13	10.8		0.63
Kelly, Tinnacross	17-Jul-06				7.1							0									0.5
Kelly, Tinnacross	30-Jul-07																				
Mannion, Killyon Cross	11-Feb-08				7.1							NT				0.23	0				0.15
Mannion, Killyon Cross	14-Aug-07															0.13	0				
Mannion, Killyon Cross	19-Feb-07															0.22					
Murphy, Coologue, Fivealle	13-Jun-06															0.15					
Nugent, Rath	13-May-08															0.22					
Oonagh Grennans Shop	17-Oct-06															0					
P Kavanagh, Killyon	13-Feb-06				7.1							NT									0.51
P Kavanagh, Killyon	21-May-07															0.07					
P Spain, Rath	14-Nov-06	0	0.013	0.019	6.99			1.1	15.31	<20		0	<0.28					1.71	27	<3.5	10
P Spain, Rath	10-Jan-06															0.14					
P Spain, Rath	10-Apr-06															0.6					
P Spain, Rath	23-Oct-06															0.28					
P Spain, Rath	3-Apr-07															0.38					
P Spain, Rath	18-Jun-07															0.02					
P Spain, Rath	14-Jan-08															0.35					
Spain, Ballindow	5-Mar-08																				
P Spain, Rath	15-Apr-08															0.23					
Rath NS	9-Jan-07															0.19					
Watkins, Fivealley	8-Oct-07				7.1							NT									0.29
Watkins, Fivealley	11-Dec-06															0.01					
Watkins, Fivealley	6-Mar-07															0.29					
Whigsborough House	10-Sep-07															0.09					
Grennans	6-Feb-08																				
Quegans, Five Valley	4-Mar-08																				
GAA Field	7-Apr-08																				
Fleurys Field	7-Apr-08																				
Fleurys Well	7-Apr-08																				
Loonam, Parkmore	5-Mar-08																				
Byrne, Ballinree, Killyon	12-May-08																				
	31-Dec-08																				

StationName	Sample Date	Vinyl Chloride	Zinc	Drinking Water Standard	EPA IGV
	1-Jan-04			50	25
Springfield House	28-Sep-04			50	25
P Spain, well at RathCross	28-Sep-04			50	25
School Well	28-Sep-04			50	25
Road to Pump Station	28-Sep-04			50	25
Greenans Outfall S. Water	28-Sep-04			50	25
Pipes from Mill Yard	20-Oct-04			50	25
Tap at Office (outside)	20-Oct-04			50	25
GAA Field	18-Oct-04			50	25
Joe O'Brien	18-Oct-04			50	25
Colm Gath	18-Oct-04			50	25
Denis O'Brien	18-Oct-04			50	25
Mrs Ryan	18-Oct-04			50	25
P. Nugent	18-Oct-04			50	25
P.Spain	18-Oct-04			50	25
D.O'Brien New House	18-Oct-04			50	25
P. Tumelty	18-Oct-04			50	25
M. Devery	18-Oct-04			50	25
Mrs Gill	18-Oct-04			50	25
J. Burke	18-Oct-04			50	25
Pauleen Dermody	18-Oct-04			50	25
Bennett, Fivealley	9-Oct-06			50	25
Bennett, Fivealley	13-Mar-06			50	25
Bennett, Fivealley	21-Aug-06			50	25
Bennett, Fivealley	10-Dec-07			50	25
Claffey, Whigsborough	6-Aug-07			50	25
Connolly, Tinnacross	30-Jul-07			50	25
Delaney, Coagh, Killyon	2-Feb-06			50	25
Duigan, Five Alley	4-Mar-08			50	25
Kearns, Rathure, Killyon	5-Sep-06			50	25
Kearns, Rathure, Killyon	28-May-07			50	25
Kelly, Tinnacross	13-Nov-07	<1		50	25
Kelly, Tinnacross	17-Jul-06			50	25
Kelly, Tinnacross	30-Jul-07			50	25
Mannion, Killyon Cross	11-Feb-08			50	25
Mannion, Killyon Cross	14-Aug-07			50	25
Mannion, Killyon Cross	19-Feb-07			50	25
Murphy, Coologue, Fivealle	13-Jun-06			50	25
Nugent, Rath	13-May-08			50	25
Oonagh Grennans Shop	17-Oct-06			50	25
P Kavanagh, Killyon	13-Feb-06			50	25
P Kavanagh, Killyon	21-May-07			50	25
P Spain, Rath	14-Nov-06	<1		50	25
P Spain, Rath	10-Jan-06			50	25
P Spain, Rath	10-Apr-06			50	25
P Spain, Rath	23-Oct-06			50	25
P Spain, Rath	3-Apr-07			50	25
P Spain, Rath	18-Jun-07			50	25
P Spain, Rath	14-Jan-08			50	25
Spain, Ballindow	5-Mar-08			50	25
P Spain, Rath	15-Apr-08			50	25
Rath NS	9-Jan-07			50	25
Watkins, Fivealley	8-Oct-07			50	25
Watkins, Fivealley	11-Dec-06			50	25
Watkins, Fivealley	6-Mar-07			50	25
Whigsborough House	10-Sep-07			50	25
Grennans	6-Feb-08			50	25
Quegans, Five Valley	4-Mar-08			50	25
GAA Field	7-Apr-08			50	25
Fleurys Field	7-Apr-08			50	25
Fleurys Well	7-Apr-08			50	25
Loonam, Parkmore	5-Mar-08			50	25
Byrne, Ballinree, Killyon	12-May-08			50	25
	31-Dec-08			50	25

Appendix IV

RATH GROUP WATER SCHEME

NITRATES REPORT

Prepared By:
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Client: Rath GWSS

Date: February 2008

Report to Rath GWS – Nitrates Issues

Background

Rath GWS is a large group water scheme in south Offaly centred on the village of Rath about 8 km north east of Birr. The scheme is in operation since 2002. The scheme presently has 380 customers connected. The average daily volume of water supplied is about 370 m^3.

Water for the scheme is sourced from a borehole situated in an area of fen at Springfield townland about 1.4 km south west of Rath village. Analysis of the water has, for some time, indicated an exceedence of the MAC of nitrate. Detailed scrutiny of the water analyses indicates that the source of nitrate in the water is most likely organic.

It was agreed at a meeting between representatives of the GWSS and Offaly County Council's Water Services section on 14th of January 2008 that a survey of the area would be carried out primarily concentrating on agricultural activity.

Methodology

A provisional zone of contribution map prepared by Coran Kelly of the GSI was provided by Offaly County Council. Aerial photography from 2004 was also provided by the council. Older aerial photography available on the EPA website and the NPWS website was also reviewed.

The zone of contribution boundary was overlain on recent digital mapping and a new map was prepared. This map with farmyard premises and other relevant features shown and linked to a table giving ownership details and contact information is attached.

Two days of farmyard and land surveys were carried out. The surveys were carried out with the knowledge and co operation of the landowners in all cases and Mick Spain GWS chairman accompanied me during all surveys.

Septic tanks in the zone of contribution were not inspected as it was considered that gross output from these facilities (regardless of efficacy or condition) was not of a magnitude sufficient to elevate the nitrate level to the concentration occurring.

Findings

The soil type within the zone of contribution is primarily mineral. (The immediate vicinity to the borehole is fen i.e. organic and minerotropic.) The mineral soil grades to glacial sands and gravels which lie on fissured limestone. The land is generally exceptionally free draining. Indeed it was notable that there were no accumulations of surface water observed during the survey despite recent heavy rainfall.

The principal landuse in the zone of contribution is grassland. Tillage and forestry area comprise relatively minor components. The level of agricultural activity over about 80% of the zone of contribution is moderately intensive (estimated at <120-130 kgs organic nitrogen stocked per ha) with the balance of the zone of contribution farmed intensively (estimated at >130 kgs organic nitrogen stocked per ha).

A total of twelve farmyards and one business premises (Grennans) in the zone of contribution were visited. A walkover survey was carried out over a sizable portion of the zone.

The main findings arising from the survey are:

1. Two farms are clearly in breech of the present statutory requirements in relation to nitrates. In both cases there is very poor management of clean and soiled water, poor storage of dung/farmyard manure and soiled yard runoff is going directly into the groundwater.

2. There is a livestock management practice on a third farm which is probably also a breech of the nitrates regulations. Specifically, outwintering of animals on land is causing gross soil degradation.

3. There is landspreading of pig slurry in the zone of contribution. The extent to which this is regulated is not known.

4. A limestone quarry located within the zone of contribution was filled in recent years. The nature of the fill material used is not known.

5. Water from a surface drain from the filled quarry area and areas where the application of pig slurry was noted show high levels of nitrate. This surface drain conveys significant volumes of water. It 'disappears' at a point adjoining a public road.

Nor results?

Conclusions and Recommendations

The combination of free draining soil and productive agriculture in the zone of contribution here makes it difficult to draw definitive conclusions. It may be the case that the nitrate problem is a consequence of long term agricultural activity. However, the points set out above cannot be discounted as significant factors particularly as the nitrate problem is comparatively recent. The difficulty is that because the residence time of the water in the aquifer here is probably in years, rectifying the problems noted will not provide an immediate solution.

Nonetheless, I would recommend the following:

1. A circular letter from the scheme should be sent to all landowners and householders briefly outlining the risks posed to the local water resource from poor farming practice and defective septic tanks. A public information meeting in the local hall might also be of benefit. The problem is local; the solution should also be local.

2. The three farmers on whose holdings, where problems have been identified should be approached and asked to address the particular difficulties noted. Initially a sensitive and sensible approach is advised. The provision of professional advice to these farmers should be considered.

3. The owner of the nearby pig farm should be notified of the nitrate problem in the local water and the possible role of pig slurry in the issue. Landspreading of slurry from a second pig farm some distance away should be investigated. Again discretion and tact should be employed.

4. The water quality in the 'disappearing' drain should be monitored on an ongoing basis. If problems remain here it may be possible to redirect this drain out of the zone of contribution. The scheme should also monitor nitrate levels in surface water on a regular basis at selected other locations in the zone of contribution.

5. Nutrient Management Plans should be required to be prepared for all land holdings identified in the zone of contribution.

6. A management plan for dealing with water runoff and sludge trapping should be required for the Grennan premises.

7. All slurry spreading should be carried out in accordance with the Groundwater Protection Reponses as prepared by the GSI and EPA.

Signed:

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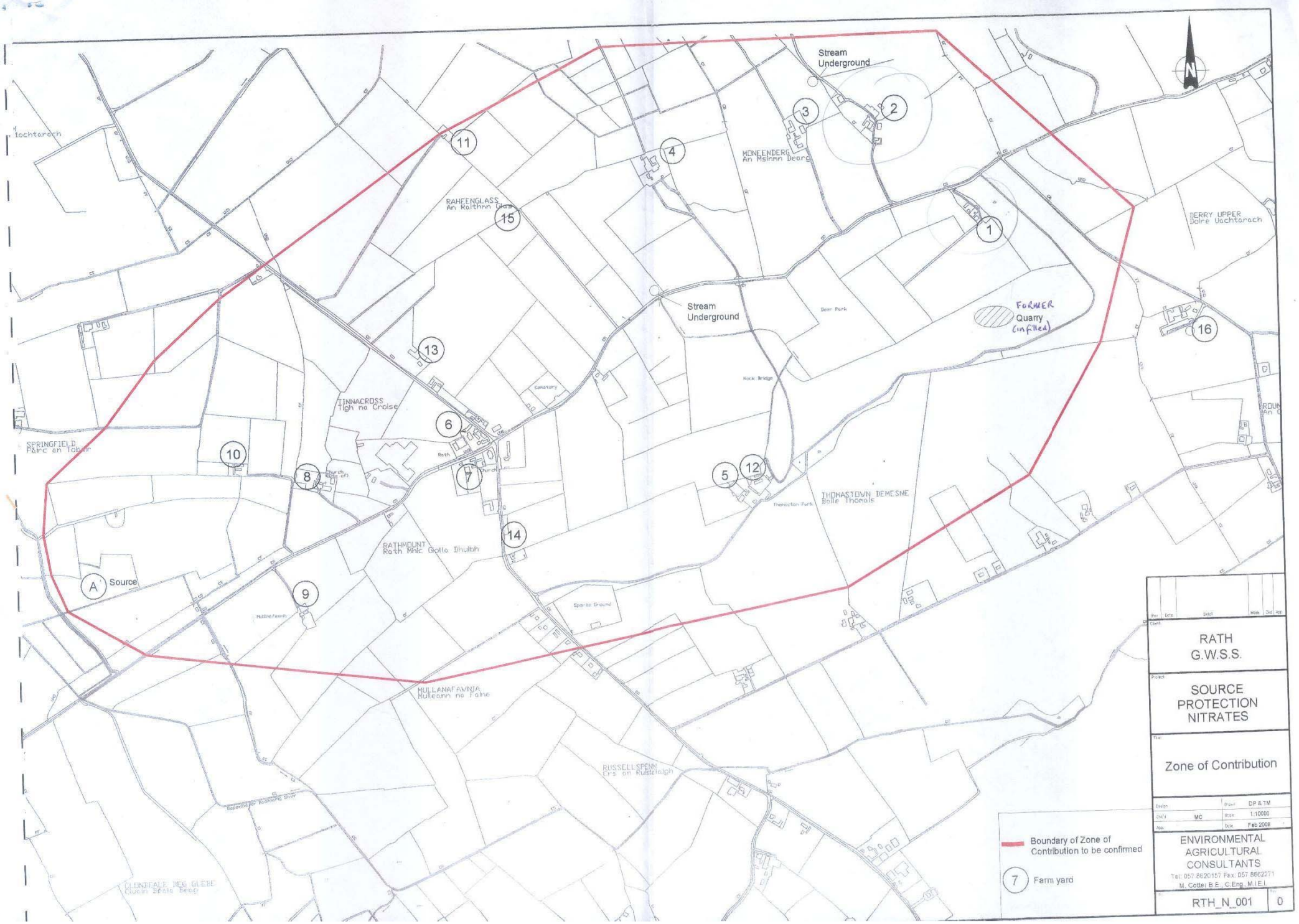
Andy Dunne – February 2008

Section	ID	First Name	Sir Name	Address 1	Address 2	Address 3	Address 4	Connection as of 31st Jan 08	Proposed Connection	No. on Map	Phone No.	Problem Observed during initial survey Feb 08 Y/N	Farmer adviser Y/N	REPS Y/N	NMP Y/N	Pig Slurry Y/N
B-S	230	Mark	Colgan	Thomastown	Rath	Birr	Co. Offaly	Domestic	HL	1	087-9231806	Y	N	N	Y	Y
B-S	96	Paddy	Walshe	Backlands	Rath	Birr	Co. Offaly	Domestic	HL	2	086-1649308 057-9133069	Y	N	Yes but expired		N
B-S	436	Fergal	Dooley	Thomastown	Birr	Co. Offaly		NON D		3	057-9133087	N	Y	Y	Y	N
B-S	94	Peadar	Lyons	Raheenglass	Rath	Birr	Co. Offaly	Domestic	HL	4	057-9133018	N	Y	Y	Y	Yes ocasionally
		Kieran	Coughlan	Thomastown Hse	Rath	Birr	Co. Offaly			5	057-9133021	N	N/A (Retired - Land set in grass)	Not available	Not available	Not available
B-C	266	Patrick	Spain	Rath	Birr	Co. Offaly		Domestic	HL	6	057-9133118	N	N/A (Retired - Land set in grass)	Not available	Not available	Not available
B-S	142	Kieran	Egan	Rath	Birr	Co. Offaly		NON D	LO	7	057-9133009	N	N	N	N	N
A-B	140	John	Grennan	Tinnacross	Rath	Birr	Co. Offaly	Domestic	HO	8	057-9133080 057-9133002	N	Y	N	Y	N
		Joe	Kinsella	Mullinafawnia	Rath	Birr	Co. Offaly			9	087-2451817	Y	Not available	Not available	Not available	Not available
		James	Burke	Springfield	Rath	Birr	Co. Offaly			10	086-1012200	N	Y	Y	Y	N
B-C	384	Sean	Bennett	Raheen glass	Rath	Birr	Co. Offaly	NON D	LO	11		N	Y	Y	Y	N
		Kieran	Egan	Thomastown	Gortnamona	Banagher	Co. Offaly			12	057-9151841	N	Not available	Not available	Not available	Not available
S1-S3	231	Michael	Gleeson	Thomastown	Rath	Birr	Co. Offaly	Domestic	HL	13	057-9133051	N	Not available	Not available	Not available	Not available
		Peadar	Nugent	Rath	Birr	Co. Offaly				14	057-9133050	N	Not available	N	N	N
		Seán	O' Brien	Russelspan	Rath	Birr	Co. Offaly			15	057-9133019	N	Not available	N	N	N
		Michael	Troy	Roundhill	Kilcormac	Birr	Co. Offaly			16	057-9123786	Pig Farm just outside the zone				
		James	Fryday	Kilcormac	Birr	Co. Offaly				17	057-9135025	Pig Farm in Kilcormac				


Stream Underground
MONEENDERG
An Mhínn Dearg
RAHEENGLASS
An Ráthán Glas
DERRY UPPER
Doire Uachtarach
Stream Underground
FORMER Quarry (infilled)
TINNACROSS
Tigh na Croise
SPRINGFIELD
Páirc an Tobair
RATHMOUNT
Ráth Mhic Giolla Dhuibh
THOMASTOWN DEMESNE
Baile Thomais
MULLANAFAVNIA
Mullean na Faine
RUSSELLSPENN
Crs an Ruiséalaigh
CLONREALE RES GLEBE
Cluain Réalt Beag
A Source
Boundary of Zone of Contribution to be confirmed
7 Farm yard
RATH
G.W.S.S.
SOURCE PROTECTION NITRATES
Zone of Contribution
DP & TM
MC
1:10000
Feb 2008
ENVIRONMENTAL AGRICULTURAL CONSULTANTS
Tel: 057 8620157 Fax: 057 8662271
M. Cotter B.E., C.Eng., M.I.E.I.
RTH_N_001
0