

## 9. Callan Source

### 9.1 Introduction

The objectives of this chapter are:

- To delineate source protection zones for the Callan Water Supply Scheme.
- To outline the principal hydrogeological characteristics of the Callan area.
- To assist Kilkenny 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).

### 9.2 Location and Site Description

The public drinking water source for Callan Town is a spring situated in the townland of Westcourt South (1.5 km to the north west of Callan). The location of the spring is shown on Map 8.

The spring is located within a concrete chamber which is 2 m wide, 5 m long and 0.7 m high. The area is fenced off from animals. The top of the chamber is at 70 m O.D. Overflow is channelled away from the spring into a ditch to the east, which, in turn, flows into the Kings River 400 m to the south east of the spring. The water from the spring flows under gravity along a six inch diameter pipe to the south side of the Kings River to a pump sump in the townland of Mullaunglass.

The spring is situated 100 m north of the Kings River with a height difference between the two of 2.6 m. County Council staff have indicated that the Kings River does not inundate the spring during flood periods.

### 9.3 Summary of Source Details

<b>GSI no.</b>	2313NWW273
<b>Grid ref. (1:25,000)</b>	24004 14446
<b>Townland</b>	Westcourt South
<b>Source type</b>	Spring
<b>Development date</b>	1934
<b>Owner</b>	Kilkenny County Council
<b>Elevation (ground level)</b>	69.55 m O.D.
<b>Depth to rock</b>	unknown
<b>Static water level</b>	surface
<b>Discharge summary:</b>	
(i) average consumption*	960 m <sup>3</sup> /d
(ii) estimated overflow**	480 m <sup>3</sup> /d
(iii) estimated total discharge***	1440 m <sup>3</sup> /d

\*Information supplied by County Council staff

\*\*Refer to Section 9.9

\*\*\* M.C. O'Sullivan Consulting Engineers (1999) report a dry weather flow of 1080 m<sup>3</sup>/day.

## 9.4 Methodology

### 9.4.1 Desk Study

Bedrock geology information was compiled from original 1:10560 (six inch) field sheets and from the GSI bedrock report for the area (Archer *et al*, 1996). Details of the current abstraction rate were obtained from Kilkenny County Council. Data on private groundwater wells in the area were taken from GSI archives. Information on flow regime's in the area was taken from reports and academic theses (Ball, 1972; Daly, 1993; and Naughton, 1978). Data on existing water quality were taken from the EPA (raw waters) and the County Council/Health Board (treated waters).

### 9.4.2 Site Visits and Field Work

- Site visits and fieldwork included walkover surveys undertaken by both the Groundwater (3 days) and Quaternary (1 day) sections of the GSI to further investigate the subsoil and bedrock geology, the hydrogeology, and the vulnerability to contamination.
- Overflow measurements were taken by the GSI from May to October of 2000, using a piping system installed by Kilkenny County Council.
- Water levels and elevations were recorded in the spring and river.
- Raw water samples were taken on 03/10/00 and 25/04/01 by GSI staff and submitted for analysis at the EPA laboratories in Kilkenny in accordance with their sampling and transportation guidelines.

### 9.4.3 Assessment

Analytical equations and hydrogeological mapping were utilised to delineate protection zones around the source.

## 9.5 Topography and Surface Hydrology

Westcourt spring is located 100 m north of the King's River (Map 8). At this point, the King's River meanders across a broad, flat plain with elevations of 60 to 70 m O.D. It's confluence with the Munster River is just 600 m to the west of the spring, and the Munster is joined by the Kilmanagh River just 2.3 km to the north of this confluence. All three rivers originate in the Slieveardagh Hills, which form the north western watershed of the area. The crests of the Slieveardagh hills rise to just over 320 m O.D. The area around the Callan spring appears to be a groundwater discharge zone, with at least three other springs coming to the surface in the vicinity (see Maps 4N and 4S). At least one of these, lying at the confluence of the Munster and Kings Rivers, is a warm spring.

Slopes on the wide valley floor are generally in the order of 0.0014 (1 in 714), and they only steepen appreciably 5.5 km to the north west of the spring, on the slope-side of the Slieveardagh Hills, where they are in the order of 0.08 (1 in 12).

There is a streamflow gauge on the Kings River at Callan, 1.5 km downstream of the spring. Low flow<sup>8</sup> measurements at this station are not thought to be reliable, but have been estimated to be in the order of 0.2 m<sup>3</sup>/sec (EPA, 2001).

The natural drainage density is very high on the valley floor upstream of the springs, with the Kings, Kilmanagh and Munster Rivers all flowing within a few square kilometres, and with many artificial drainage ditches.

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<sup>8</sup> Flow which is equalled or exceeded at least 95% of the time.

A permeability of 10 m/d and a porosity of 0.2 has been assumed for the gravel aquifer, based on experience in other sources.

### 8.13 Conceptual Model

This section provides a qualitative overview of the geological framework, recharge, flow and discharge patterns across the aquifer contributing groundwater to the source. It represents a summary of the main inferences drawn in previous sections, and provides a foundation upon which the quantitative analyses required for delineating source protection areas can be drawn.

- A schematic depiction is provided in Figure 8.1.
- Three main geological layers occur below the site: (i) sand and gravel overlying (ii) shaley limestone, which overlies (iii) dolomitised limestone. The sand and gravel supplies the infiltration gallery, while the dolomitised limestone is the main source of water for the borehole.
- In the vicinity of the site, groundwater in the sand and gravel and shaley limestone is considered to be unconfined, while groundwater in the dolomitised limestone is considered to be confined (see borehole water levels in Section 8.9).
- During pumping at the gallery, the sand and gravel aquifer is expected to be recharged by the River Nore, by rainfall falling on the aquifer outcrop, and by shallow flow in the top 10 to 15 m of the shaley limestone.
- During pumping from the borehole, the dolomitised limestone is expected to be recharged in generally equal proportions by downward percolation from the River Nore, and by rainfall falling on the dolomitised outcrop area almost 2 km to the east of the site.
- Faulting under the river is such that the dolomitised aquifer does not occur on the western bank and recharge to the source is not expected to occur from the western bank of the Nore.
- Groundwater gradients in the sand and gravel aquifer are estimated at 0.14 (1 in 7), with flow being from the river to the infiltration gallery. Groundwater gradients in the undolomitised limestone are estimated to be 0.1 (1 in 10), while a gradient of 0.02 (1 in 50) has been calculated in the dolomitised limestone, steepening to over 0.7 closer to the pumping well.

### 8.14 Delineation of Source Protection Areas

#### 8.14.1 Introduction

This section delineates the areas around the source that are believed to contribute groundwater to the source, and that therefore require protection. The areas are delineated on the basis of the conceptualisation of the groundwater flow pattern as described in Section 8.13.

Two source protection areas are delineated:

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

#### 8.14.2 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 pumping rate, (b) the groundwater flow direction and gradient, (c) the aquifer permeability and (d) the recharge in the area. The ZOC is delineated using both analytical modelling and the results of hydrogeological mapping and conceptualisation. Given the limited amount of calibration data available, a full groundwater numerical model was not undertaken.

## 9.6 Geology and Aquifers

### 9.6.1 Bedrock

The Callan source lies in the mid-Kilkenny limestone basin (see Maps 1N and 1S) where the main rock types in the vicinity of the Callan source are all limestones and consist of the Aghmacart, Durrow, Crosspatrick, and Waulsortian Formations. These formations are described in more detail in Chapter 2 of Volume I. Their distribution is quite complex, with vertical and horizontal dimensions playing an important role in groundwater flow to the source. Key points are highlighted below:

- The vertical distribution is presented schematically in Figure 9.1, while the horizontal distribution is presented on Map 8.
- The Callan spring is situated in the middle of an area of Aghmacart and Durrow shaley limestones. Both are classified as **locally important aquifers** which are **moderately productive only in local zones (Ll)** (see Section 4.13, Volume I). Fracture flow is expected to be dominant. Regionally, flows are expected to be concentrated in fractured and weathered zones. Given common weathering patterns, most flow is thought to be relatively shallow; concentrating in the top 10 m to 30 m of the rock profile. Crosspatrick Formation limestones lie close-by. They are ‘cleaner’ and classed as a slightly better aquifer - **locally important aquifer** which is **generally moderately productive (Lm)** – but flow patterns are believed to be similar to those in the shaley limestones.
- The regionally important, dolomitised Waulsortian limestone aquifer has been up-faulted nearer to the surface underneath the spring, or is linked to the surface via faults (refer to Figure 9.1). The unit may lie some 500 m below the spring, but deep flows can occur in this aquifer (refer to Chapter 4 of Volume I) and it may be contributing groundwater to the spring. This is supported by the presence of warm springs in the vicinity of the Callan spring.

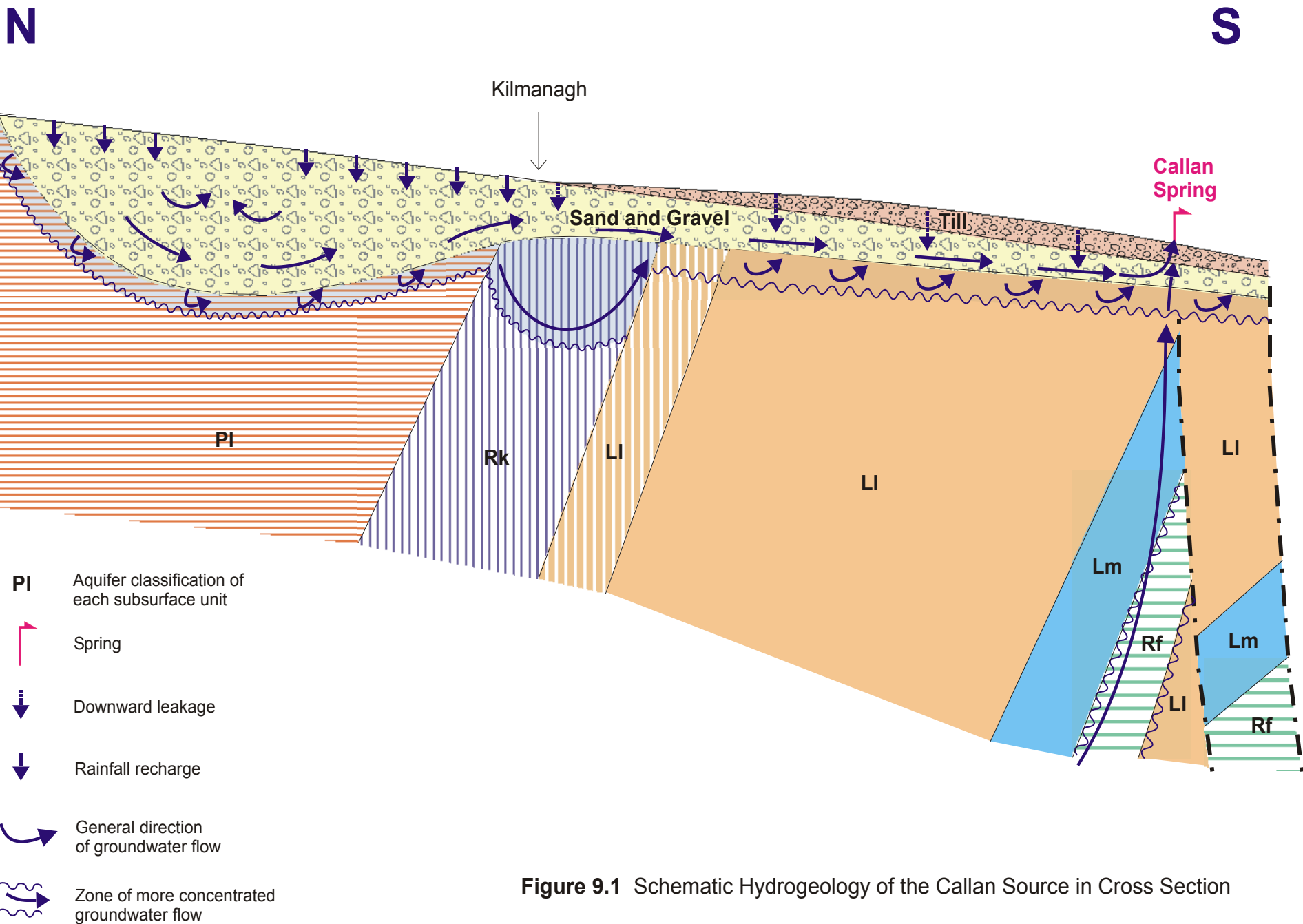
### 9.6.2 Subsoil

The main subsoil types are gravel, till and alluvium. These materials are described in more detail in Chapter 3 of Volume I and their distribution in the vicinity of the Callan source shown on Maps 2N, 2S and 8.

As described in Section 4.18.2 of Volume I, the gravels associated with the Kilmanagh and Kings Rivers are considered large, thick and clean enough to be classified as a **Regionally important (Rg)** aquifer. The gravels are considered to supply, and form the medium through which bedrock aquifers supply groundwaters to the Callan spring. The deposit is probably up to 15 m thick, and is believed to be predominantly composed of fine gravels and sands interbedded with silts and clays. The silts and clays are believed to become more common between Kilmanagh and the Callan spring. The area of gravel is 1 km wide at the spring, but widens to almost 2 km further north (see Map 8), and extends up to Tullaroan, 14 km to the north. A layer of till, generally 3-4 m in thickness, is thought to overly the gravels between Kilmanagh and Callan spring (see Figure 9.1)

In many places, the rivers have reworked the top layer of the sand and gravel deposit to form a well-sorted fine-grained alluvial deposit. It is only found in a narrow strip along the banks of the rivers, and is thought to be rarely more than 1 or 2 m thick.

Glacial till deposits cover the valley sides of the Munster and Kilmanagh Rivers. Their thickness is variable (less than 1 m to 10 m thick), but they are generally thicker towards the valley floor. The main significance of these tills is in vulnerability and recharge assessments. These issues are described in Sections 9.7 and 9.8.



**Figure 9.1** Schematic Hydrogeology of the Callan Source in Cross Section

## 9.7 Groundwater Vulnerability

### 9.7.1 Introduction

The concept of vulnerability is discussed in Chapter 5 of Volume I. In essence, however, groundwater vulnerability is dictated by the nature and thickness of the material overlying the uppermost groundwater ‘target’. As discussed in Section 9.6, the uppermost groundwater resource in the vicinity of the Callan spring occurs within sands and gravels. Where covered by tills, the vulnerability of groundwater within the sand and gravel aquifer is dictated by the permeability and thickness of the overlying till. Elsewhere, the vulnerability is dictated by the thickness of the unsaturated zone in the gravels.

### 9.7.2 Groundwater Vulnerability in Unconfined Areas to the North of Kilmanagh

Depth to water is a key influence on groundwater vulnerability in these areas. Hydrograph data from well 2315SWW233, lying within 100 m of the Kilmanagh River, indicates water levels frequently less than 2 m below ground (see Figure 4.20 in Volume I). Given that the depth to water will generally increase moving away from a river, it is likely that the thickness of the unsaturated zone will generally be less than 3 m close to the river and in excess of 3 m over most of the remainder of the aquifer. Consequently, the vulnerability has been mapped as generally ‘extreme’ along a band 100 m wide on either side of the Kilmanagh River where it flows over the unconfined portion of the aquifer. Elsewhere, the vulnerability is considered to be ‘high’.

### 9.7.3 Groundwater Vulnerability in Confined Areas Between Kilmanagh and Callan

Till thickness is a key influence on groundwater vulnerability in these areas. The overlying tills are believed to have a moderate permeability (see Section 5.3.3, Volume I) and a typical thickness of 3 m to 4 m. Consequently, the vulnerability of groundwater in the gravels below is expected to be generally ‘high’.

## 9.8 Rainfall, Evaporation and Recharge

The term ‘recharge’ refers to the amount of water replenishing the groundwater flow system. Recharge is generally estimated on an annual basis, and is assumed to consist of an input (i.e. annual rainfall) less water losses (i.e. annual evapotranspiration and runoff). The estimation of recharge is critical in source protection delineation as it largely dictates the size of the zone of contribution.

In areas where point recharge from sinking streams, etc, is discounted, the main parameters involved in recharge rate estimation are annual rainfall, annual evapotranspiration, and annual runoff<sup>9</sup>:

- Annual rainfall: 910 mm (average of Met Eireann average annual (1961-90) rainfall measured at two sites in Callan).
- Annual actual evapotranspiration (A.E.) losses: 370 mm. This figure (‘actual evapotranspiration’) was calculated using an extrapolation for the Callan area computed by Ball (1972), using the average 1968 to 1971 data from the station in Oak Park, Co Carlow. More local measurements of actual evapotranspiration are not available.
- Potential recharge: 540 mm/year, based on average annual rainfall less estimated evapotranspiration.
- Annual runoff losses:
  - *Area of thin till cover north of Kilmanagh*: 110 mm/year (20% of potential recharge). This is a typical figure used by the GSI in areas where the till cover is thin.

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<sup>9</sup> Estimations used in this report have generally been rounded off to two significant figures

- *Confined area south of Kilmanagh*: 510 mm/year (95% of potential recharge). This particularly high runoff estimation is based on visual observations in the area which indicate waterlogged soils and high drainage densities (Chapter 5, Volume I). Ball (1972) estimates that the annual baseflow to the Kings River at Callan is 12%. This suggests that 88% of potential recharge is lost to runoff over the sub-catchment as a whole. Given that this sub-catchment includes areas of high infiltration, it is likely that the proportion lost to runoff exceeds 88% in the poorly drained area to the south of Kilmanagh. The figure of 95% represents a nominal quantity between 88% and 100%.

The calculations are summarised below:

	Confined Portion:	Unconfined Portion:
Average annual rainfall (R)	910 mm	910 mm
Estimated A.E.	370 mm	370 mm
Potential Recharge (R – A.E.)	540 mm	540 mm
Runoff losses factor (RO)	95%	20%
Estimated Actual Recharge (R-A.E.) x (1-R.O)	30 mm	430 mm

## 9.9 Groundwater Discharge and Groundwater Levels

The supply scheme does not use all of the water discharging from the Callan spring; a proportion overflows from the concrete chamber (see Section 9.3). Discharge from this overflow was measured by the GSI, using a weir constructed by the Sanitary Services section of the County Council.

Results were as follows:

Date	Usage by Scheme (m <sup>3</sup> /d)	Overflow (m <sup>3</sup> /d)	Spring Discharge (m <sup>3</sup> /d)
19/05/2000	800	280	1080
31/05/2000	830	260	1090
18/08/2000	945	0	945
18/10/2000	1110	1390	2500
<b>Average</b>	920	480	1405

This indicates that the quantity of overflow is very much dependent on seasonal recharge to the aquifer. In August, when recharge is expected to be at its lowest, the overflow dried up. In October, after a week of heavy rain, the overflow exceeded the usage by the supply scheme.

The sand and gravels along the river are considered to be confined by the overlying tills between Callan and Kilmanagh. Ball (1972) found that a dug well in the portion of the aquifer from Kilmanagh to Callan was confined in the winter. In addition, a pumping test carried out by the GSI in 1977 provided evidence that there is little hydraulic connection between the sand and gravel and overlying sediments in the area. A dug well installed within the sediments overlying the sand and gravel aquifer was unaffected by pumping at a rate of 30 m<sup>3</sup>/day from the aquifer below in a well just 6 m away.

Upstream of Kilmanagh, Naughton (1978) has indicated that the gravel aquifer is unconfined.

## 9.10 Groundwater Flow Directions and Gradients

Due to the range of aquifer types in the Callan area, the groundwater flow directions are somewhat complex. Data is limited, but it is expected that flows to the spring will generally be from north to south.

The area around the Callan spring seems to be a groundwater discharge zone, with at least four springs in close proximity (Section 9.5). It is envisaged that the discharging water comes from two sources:

- *Northern unconfined portion of the sand and gravel aquifer, lying between Kilmanagh and Tullaroan:* The till cover is thin or absent, drainage densities are low, and there is evidence that rivers lose some or all of their water to ground as they flow across the area (see Section 4.18.2, Volume I). All three factors suggest recharge to the sand and gravel aquifer is high in this area. Though much of the groundwater is expected to discharge back to surface water close to Kilmanagh, it is likely that a significant quantity flows underground southward into the confined portion of the sand and gravel aquifer. Some evidence for this is described by Naughton (1978).
- *Deep groundwater flow from the dolomite aquifer:* As discussed in Section 9.6.1, deep faults are believed to link the dolomite aquifer with the surface in the vicinity of Callan. Figure 9.1 outlines a possible scenario whereby groundwater in the dolomite aquifer is forced to the surface along a fault zone by the presence of a low permeability shaley limestone barrier. Water that has come from depth is likely to have slightly elevated temperatures, and although this is not the case at the Callan spring, two springs a few hundred meters to the north-west are denoted as warm springs (Burdon, 1983).

In summary, it is expected that flows within the sand and gravel aquifer near Callan are being forced to the surface as springs as a result of constriction in the extent of the gravels, and the addition of flow from the deep dolomite aquifer below.

Groundwater gradients are difficult to calculate because of the limited well water level data available. However, assuming that the groundwater supplying the wells comes primarily from flow in the sand and gravels, and therefore has travelled through the sediments, below the river, the topographic gradient along the length of the river is considered to provide a broad indication of the groundwater gradient. The estimated gradient is 0.0014 (1 in 714).

## 9.11 Hydrochemistry and Water Quality

Data on recent trends in water quality at the Callan source are summarised graphically in Figure 9.2, and the source data can be found in Appendix V.

The following key points have been identified from the data:

- Data from analysis of hardness in five samples indicate a ‘very hard’ (>350 mg/l CaCO<sub>3</sub>) calcium-bicarbonate hydrochemical signature. This is typical of most Irish groundwaters, particularly those in limestone regions. Further, levels of magnesium are above 20 mg/l in four out of six analysis available. This supports the suggestion that the spring waters have mixed with waters from the deep magnesium-rich dolomite aquifer.
- Of the parameters examined in the raw<sup>10</sup> groundwater samples taken, only nitrite (in 3 out of 34 available analyses from 1993 to 1998) and faecal coliforms (in nine out of 10 available analyses from 1993 to 2000) were in excess of the European maximum admissible concentration.
- Reported nitrate levels are slightly elevated but are not generally in excess of GSI guide levels and do not appear to have increased significantly between 1983 (14.2 mg/l as NO<sub>3</sub>) and 2001 (19.9 mg/l as NO<sub>3</sub>).
- With the exception of faecal coliforms, the available analysis of contaminant indicator parameters do not indicate significant problems affecting the source. Most springs are susceptible to bacteriological contamination from surface washings of animal faeces. Where water-logging occurs, as at Callan, the susceptibility is increased. Passing wildfowl may even

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<sup>10</sup> Raw water samples are taken *prior to treatment*. Assessments are aimed at identifying contamination hazards rather than direct human health issues.

be the cause. Consequently, it may be that the levels of faecal coliforms identified are not indicative of significant groundwater contamination at the source.

The regional hydrochemistry of the Callan sand and gravel aquifer (**Rg**) and the underlying bedrock aquifers is discussed in Chapter 4 of Volume I.

## 9.12 Aquifer Parameters

The main aquifer parameters of significance are permeability and porosity. Together with groundwater gradients, these parameters are used to estimate the extent of the inner source protection area in Section 9.14.3.

Transmissivities of 200 m<sup>2</sup>/day to 250 m<sup>2</sup>/day and permeabilities of 30 m/day to 60 m/day were estimated from two pump tests carried out in the unconfined portion of the sand and gravel deposit near Kilmanagh (Naughton, 1978). There is evidence that the southern, confined portion of the aquifer contains more silt and clay overall than the northern portion where these transmissivity estimates were made. Consequently, it is likely that this southern portion has a lower overall permeability than the values given above.

A porosity of 20% is assumed to represent a reasonably conservative value for gravels.

## 9.13 Conceptual Model

This section provides a qualitative overview of the geological framework, recharge, flow and discharge patterns across the aquifer contributing groundwater to the source. It represents a summary of the main inferences drawn in previous sections, and provides a foundation upon which the quantitative analyses required for delineating source protection areas can be drawn.

- The main aquifers influencing water flowing to the Callan spring are the Kilmanagh sand and gravels and the dolomite aquifer (see Figure 9.1). The sands and gravels stretch from Callan, up the Kilmanagh River valley, to Tullaroan. They are believed to be unconfined between Tullaroan and Kilmanagh and confined by an overlying layer of till between Kilmanagh and Callan. In the vicinity of the Westcourt spring, the deposits are believed to be up to 15 m thick, and 1 km wide, and to be overlain by up to 4 m of confining fine-grained deposits. The dolomite aquifer is believed to be confined by over 500 m of limestone below the spring.
- Most recharge to the sand and gravel aquifer occurs over the unconfined portion, some 7 km north of spring. Very little recharge is believed to occur over the confined portion of the sand and gravel, mainly as a result of a high watertable. Most recharge to the dolomitised aquifer is likely to occur in the vicinity of Galmoy some 30 km north of the spring.
- Though most recharge to the unconfined sand and gravel is likely to discharge to the Kilmanagh River near Kilmanagh, a proportion is expected to flow southwards underneath the confining tills, and discharge at the Callan spring and the three other springs in the vicinity. Flow in the dolomitised aquifer is thought to be forced to surface, through one or more deep faults in the Callan area, by the presence of a faulted barrier of shaley limestone (see Figure 9.1). The addition of these deep flows, in combination with a constriction in the width of the sand and gravel aquifer, is thought to be the reason why several springs occur in the area.
- Recharge rates to the confined portion of the sand and gravel aquifer are thought to be of the order of 30 mm/year. In the unconfined portion further north, it is likely to be closer to 430 mm/year.
- Groundwater gradients within the sand and gravel are thought to be similar to topographic gradients along the river, around 0.0014 (1 in 714) (see Section 9.10).

## 9.14 Delineation of Source Protection Areas

### 9.14.1 Introduction

This section delineates the areas around the spring that are believed to contribute groundwater to the spring, and that therefore require protection. The areas are delineated on the basis of the conceptualisation of the groundwater flow pattern as described in Section 9.13.

Two source protection areas are delineated:

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

### 9.14.2 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 groundwater flow direction and gradient, (b) the aquifer permeability and (c) the recharge in the area. The ZOC was delineated using both analytical modelling and the results of hydrogeological mapping and conceptualisation.

Hydrogeological boundaries taken from hydrogeological mapping and the conceptualisation outlined in Section 9.13 are as follows:

- **Northern boundary:** Northern extent of the entire sand and gravel aquifer, including the unconfined portion as well as the confined portion. This extends up the Kilmanagh River valley to just north of Tullaroan.
- **Southern boundary:** The boundary between the sand and gravel aquifer and the glacial till.
- **Eastern boundary:** The boundary between the sand and gravel aquifer and the glacial till.
- **Western boundary:** The boundary between the sand and gravel aquifer and the glacial till.

These boundaries contain the whole sand and gravel aquifer and are the physical limits within which the ZOC is likely to occur. They encompass an area of 30 km<sup>2</sup>.

A water balance can be used to determine whether the delineation of the ZOC could be reasonably reduced to a smaller area within these quite extensive physical limits:

The estimated total recharge to the confined portion of the gravel aquifer is 600,000 m<sup>3</sup>/yr (30 mm/yr over 20 km<sup>2</sup>). A conservative estimate of spring discharge from the gravel aquifer is 1,300,000 m<sup>3</sup>/yr. This is derived from the maximum estimated total discharge from the Callan spring and the estimated discharge from the other springs in the vicinity (estimates taken from GSI records). Note that this figure does not represent the total discharge from the gravel aquifer, which would also comprise baseflow to the Kings River and groundwater abstractions. Nevertheless, three conclusions can be drawn from a comparison of recharge with discharge:

- Recharge to the confined portion of the aquifer near the Callan spring is insufficient to support discharge. It is necessary to include the unconfined portion to the north of Kilmanagh into the ZOC, even though this portion lies several kilometres from the source.
- Given that the recharge estimate from only the confined portion of the gravel aquifer comprises nearly 50% of the discharge estimate, the contribution from the dolomite aquifer is unlikely to be significant in comparison with the contribution from the sand and gravel aquifer as a whole. This is supported by evidence of minor nitrate contamination at the spring, which indicates a significant input of relatively young, shallow groundwaters. In addition, it is probable that groundwaters within the deeper, dolomitised aquifer are several hundred years old, having travelled underneath Slievardagh at depths of over 300 m (see Section 4.14). Consequently, it is

considered unlikely that the recharge area for the deeper dolomite groundwaters requires significant protection in the context of groundwater contamination at the Callan source.

- The total extent of the sand and gravel aquifer should be used as the boundary of the ZOC at the Callan spring.

### 9.14.3 Inner Protection Area

The Inner Protection Area (SI) is the area defined by a 100 day time of travel (TOT) to the source from a point below the water table and it is delineated to protect against the effects of potentially contaminating activities which may have an immediate influence on water quality at the source, in particular from microbial contamination.

Estimations of the extent of this area cannot be made by hydrogeological mapping and conceptualisation methods alone. Analytical modelling was therefore used to estimate the extent of this zone upgradient of the spring.

Subject to certain assumptions and conditions, Darcy's Law can be used to approximate groundwater flow velocities, as follows:

$$\text{Velocity} = \text{groundwater gradient} \times \text{permeability} \div \text{porosity}$$

Using the estimates derived in Sections 9.10 and 9.12 for gradient, permeability, and porosity (0.0014, 60 m/day, and 0.2 respectively), the equation gives a velocity of 0.4 m/day. This could be treated as a 'reasonable worst case estimate'. In other words, though some very rapid flow paths may occur, it is thought that most groundwater will move up to 40 m in 100 days. This has been rounded-up to 50 m and the boundary of the SI has been delineated 50 m upgradient of the source (refer to Map 10).

## 9.15 Groundwater Protection Zones

The groundwater protection zones are obtained by integrating the source protection areas and vulnerability categories – giving a possible total of 8 source protection zones (see the matrix in the table below). In practice, this is done 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 Source Protection area where the groundwater is highly vulnerable to contamination. All of the hydrogeological settings represented by the zones may not be present around any given source. Three groundwater protection zones are present around the Callan source (see Map 10), as shown in the matrix below.

**Matrix of Source Protection Zones**

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

The appropriate responses imposing restrictions on development are presented in the document 'Groundwater Protection Schemes' (DELG/EPA/GSI, 1999).

## 9.16 Land Use and Potential Pollution Sources

Agriculture in the area comprises mainly pasture and some tillage. Callan town lies outside the protection zone for Westcourt spring.

The main hazards within the ZOC are considered to be agricultural: in particular, animal activities at and within the perimeter of the spring site.

## 9.17 Conclusions and Recommendations

- ◆ The Callan spring is located in an extensive sand and gravel aquifer. Groundwater in the zone of contribution is generally considered to be ‘highly’ vulnerable to contamination.
- ◆ The protection zones delineated in this chapter 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:
  - chemical and bacteriological analyses of raw water as well as treated water should be carried out regularly. Given some of the raw water quality issues at the source, a monthly frequency has been recommended in Section 7.9. The chemical analyses should include all major ions - calcium, magnesium, sodium, potassium, ammonium, bicarbonate, sulphate, chloride, and nitrate. Analysis of other parameters such as pesticides and hydrocarbons is also recommended;
  - care should be taken in allowing any activities or developments which might significantly increase nitrate levels;
  - the potential hazards in the ZOC should be located and assessed;
  - though the site is fenced off, measures to prevent animal faeces from washing into the spring might be examined. These might include, for example, measures to discourage animal activity at the fence boundary and/or the consideration of drainage ditches to ensure surface waters are drained away from the spring.

## **Appendix V: Laboratory analytical results**

EPA Regional Water Laboratory, Kilkenny. Monitoring Data for County Kilkenny Groundwaters 1993 to 1999.

Source	Sampling Date	Sampling Time	To	Ref No	Sampling Location	Taken By	Lab No	EPARef	Stn Grid Ref	Water Supply	Public/Group/Private	Temperature	Odour 1/2/3	Colour Hazen	pH	Conductivity µS/cm	Turbidity NTU	TOC mg/lC	Ammonia mg/lN
Spring at Paulstown Castle	29/04/1992	11:38:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle		1648	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	9.1	1	5	7.3	623			0.03
Spring at Paulstown Castle	01/07/1992	15:55:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle		2681	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	11.4	1	5	7.4	640			0.02
Spring at Paulstown Castle	20/08/1992	15:15:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle		3737	KIK46	S 660 570	Gowran/Goresbr./P-town	Public		1	5	7.2	600			0.02
Spring at Paulstown Castle	18/11/1992	13:29:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle		5086	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	9.8	2	5	7.4	623			0.02
Spring at Paulstown Castle	10/03/1993	16:00:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle		1017	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	9.6	1	5	7.3	660			0.01
Borehole at Castletomer Yarns	02/06/1993		Kilkenny Co. Co.	KK00300	Tap in yard at Castletomer Yarns	J. Keohane	2269		25360 17330	Castletomer Yarns	Private		1	15	7.5	570	1	< 1	0.01
Spring at Paulstown Castle	02/06/1993		Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle	J. Keohane	2270	KIK46	S 660 570	Gowran/Goresbr./P-town	Public		1	5	7.2	696	0.4	5.7	0.01
Borehole at Rathcash	02/06/1993		Kilkenny Co. Co.	KK02000	Joe Pykes house, Rathcash, Clara.	J. Keohane	2271	KIK55	25870 15510	Rathcash	Group		1	5	7.3	682	0.2	< 1	0.01
Springs at Bausheenmore	02/06/1993		Kilkenny Co. Co.	KK00500	At source (springs at Bausheenmore)	J. Keohane	2272	KIK39	25520 14690		Private		1	5	7.3	814	0.35	0.9	0.01
Spring at Westcourt	02/06/1993		Kilkenny Co. Co.	KK00800	Spring at Earlsland, Westcourt, Callan	J. Keohane	2273	KIK91	S 407 442	Callan	Public		1	5	7.3	718	0.2	0.5	0.01
Borehole at Galmoy	03/06/1993	11:25:00	Kilkenny Co. Co.	KK00200	Leahy's House, Galmoy	P.Mullins	2292	KIK17	23020 17120	Galmoy	Group	10	1	5	7.4	790	0.2	< 1	0.01
Galmoy 35	03/06/1993	11:47:00	Kilkenny Co. Co.		M. Phelan	P.Mullins	2293				Private	10	1	5	7.4	792	0.15	< 1	0.01
Galmoy 37	03/06/1993	12:02:00	Kilkenny Co. Co.		Mr. Tom Maher's House	P.Mullins	2294				Private	11	1	5	7.4	769	0.2		0.01
Galmoy 25	03/06/1993	12:15:00	Kilkenny Co. Co.		Hennessy's at House	P.Mullins	2295				Private	10	1	5	7.3	894	0.25	0.2	0.01
Galmoy 202	03/06/1993	12:55:00	Kilkenny Co. Co.		Phelans	P.Mullins	2296				Private	11	1	5	7.4	755	0.3	< 1	0.01
Borehole at Bawnmore	03/06/1993	16:00:00	Kilkenny Co. Co.	KK00100	Phelan's house, Bawnmore	P.Mullins	2297	KIK50	22580 16610	Bawnmore	Group	12	1	5	7.3	820	0.2	0.14	0.01
Spring at Clomantagh	10/06/1993	11:40:00	Kilkenny Co. Co.	KK00900	Beside Nuenna river, 50m SE of roac	P.Mullins+J.Keohane	2395		23520 16320		Private		1	5	7.3	664	0.3		0.01
Spring at Clomantagh	10/06/1993	11:50:00	Kilkenny Co. Co.	KK00900	Beside Nuenna river, 50m SE of roac	P.Mullins+J.Keohane	2396		23520 16320		Private		1	5	7.3	677	0.35		0.01
Borehole at Dunmore	10/06/1993	12:28:00	Kilkenny Co. Co.	KK00700	C. Murray's house, Dunmore.	P.Mullins+J.Keohane	2397		24910 16200	Dunmore	Group		1	5	7.4	676	0.2		0.01
Spring Toberpatrick Urlingford	15/06/1993	10:45:00	Kilkenny Co. Co.	KK01500	In chamber at source	C. Murray	2417	KIK34	23000 16350	Urlingford/Johnstowr	Public		1	5	7.2	781	0.3	1.6	0.01
Borehole at Kilmanagh	15/06/1993	12:00:00	Kilkenny Co. Co.	KK01400	In pumphouse	C. Murray	2418	KIK45	23930 15250	Kilmanagh/Ballycuddihy	Group		1	5	7.5	659	0.3		0.01
Borehole at Dunmore S/G	15/06/1993	14:30:00	Kilkenny Co. Co.	KK01000	Canteen at Dunmore Sand & Gravel	C. Murray	2419	KIK53	25000 16020	Dunmore Sand & Gravel	Private		1	5	7.4	643	1.2	0.4	0.01
Borehole at Kilkenny Mar	15/06/1993	15:00:00	Kilkenny Co. Co.	KK01300	Cattle holding shec	C. Murray	2420		25070 15670	Kilkenny Mart	Private		1	5	7.6	691	0.2	0.4	0.01
Borehole at Windgap	01/07/1993		Kilkenny Co. Co.	KK01900	Overflow from boreholt	C. Murray	2769		24200 13580	Farm supply	Private		1	5	7.2	382	1.5		0.37
Spring at Paulstown Castle	05/08/1993	15:55:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle		3294	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	11.6	1	5	7.3	680			0.01
Galmoy	08/11/1993	11:15:00	Kilkenny Co. Co.		Leahy's House (A 82)	P.Mullins	4754			Galmoy	Group	8	1	5	7.3	806	0.09		0.01
Galmoy	08/11/1993	11:45:00	Kilkenny Co. Co.		Parochial House	P.Mullins	4755			Galmoy	Private	9	1	5	7.3	725	0.09		0.01
Galmoy	08/11/1993	12:20:00	Kilkenny Co. Co.		Phelans, original (A 35)	P.Mullins	4756			Galmoy	Private	8	1	5	7.1	996	0.21		0.01
Galmoy	08/11/1993	12:40:00	Kilkenny Co. Co.		Brophy's (A 25)	P.Mullins	4757			Galmoy	Private	9	1	5	7.4	849	0.15		
Galmoy	08/11/1993	13:50:00	Kilkenny Co. Co.		Phelans (A 24)	P.Mullins	4758			Galmoy	Private	9	1	5	7.4	874	0.19		< 0.01
Galmoy	08/11/1993	13:55:00	Kilkenny Co. Co.		Hennessy's	P.Mullins	4759			Galmoy	Private	9							
Galmoy	08/11/1993	14:44:00	Kilkenny Co. Co.		Gannons (A 36)	P.Mullins	4760			Galmoy	Private	9	1	5	7.3	864	0.13		< 0.01
Galmoy	08/11/1993	14:52:00	Kilkenny Co. Co.		Maher's (A 37)	P.Mullins	4761			Galmoy	Private	9	1	5	7.3	816	0.14		< 0.01
Borehole at Bawnmore	08/11/1993	15:15:00	Kilkenny Co. Co.	KK00100	Phelan's house, Bawnmore	P.Mullins	4762	KIK50	22580 16610	Bawnmore	Group	9	1	5	7.3	829	0.1		< 0.01
Galmoy	08/11/1993	15:45:00	Kilkenny Co. Co.		Dan Phelan (A 202)	P.Mullins	4763			Galmoy	Private	9	1	5	7.3	739	0.07		< 0.01
Spring Toberpatrick Urlingford	09/11/1993	11:45:00	Kilkenny Co. Co.	KK01500	In chamber at source	P. Mullins	4776	KIK34	23000 16350	Urlingford/Johnstowr	Public	10	2	< 5	7.3	808	0.22		0.01
Borehole at Castletomer Yarns	09/11/1993	12:35:00	Kilkenny Co. Co.	KK00300	Tap in yard at Castletomer Yarns	P. Mullins	4777		25360 17330	Castletomer Yarns	Private	10	2	5	7.6	568	3.5		0.01
Spring at Paulstown Castle	09/11/1993	14:40:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle	P. Mullins	4778	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	11	2	< 5	7.4	648	0.24		0.01
Borehole at Clara	09/11/1993	15:15:00	Kilkenny Co. Co.	KK00400	At pumphouse	P. Mullins	4779	KIK41	25770 15530	Clara	Group	10	1	< 5	7.4	677	0.17	67.3	0.01
Spring at Westcourt	09/11/1993	16:00:00	Kilkenny Co. Co.	KK00800	Spring at Earlsland, Westcourt, Callan	P. Mullins	4780	KIK91	S 407 442	Callan	Public	10	1	< 5	7.3	722	0.21		0.01
Borehole at Dunmore	10/11/1993	10:30:00	Kilkenny Co. Co.	KK00700	C. Murray's house, Dunmore.	C.Murray	4796		24910 16200	Dunmore	Group	8.4	1	5	7.5	702	0.1		0.01
Borehole at Dunmore S/G	10/11/1993	10:55:00	Kilkenny Co. Co.	KK01000	Canteen at Dunmore Sand & Gravel	C.Murray	4797	KIK53	25000 16020	Dunmore Sand & Gravel	Private	8.1	1	< 5	7.6	635	0.7		0.01
Borehole at Kilkenny Mar	10/11/1993	11:15:00	Kilkenny Co. Co.	KK01300	Cattle holding shec	C.Murray	4798		25070 15670	Kilkenny Mart	Private	4.9	2	< 5	8	690	0.14		0.01
Borehole at Kilmanagh	10/11/1993	12:22:00	Kilkenny Co. Co.	KK01400	In pumphouse	C.Murray	4799	KIK45	23930 15250	Kilmanagh/Ballycuddihy	Group	10	2	< 5	7.7	644	0.33		0.01
Springs at Bausheenmore	10/11/1993	14:30:00	Kilkenny Co. Co.	KK00500	At source (springs at Bausheenmore)	C.Murray	4800	KIK39	25520 14690		Private	10.2	1	< 5	7.4	812	0.23		0.01
Borehole No.9, Thomastowr	10/11/1993	15:10:00	Kilkenny Co. Co.	KK01600	At pumphouse	C.Murray	4801	KIK32	25890 14160	Thomastown	Public	11	2	< 5	7.4	798	0.15		0.01
Borehole at Windgap	10/11/1993	15:50:00	Kilkenny Co. Co.	KK01900	Overflow from boreholt	C.Murray	4802		24200 13580	Farm supply	Private	10.8	1	< 5	7.5	375	0.32		0.01
Borehole at Avonmore Dairy	11/11/1993	11:30:00	Kilkenny Co. Co.	KK01200	Holding tank on roof	C.Murray	4803			Avonmore Kilkenny City	Private		2	5	7.8	621	0.11		0.01
Rathcash, Clifden, Co. Kilkenny	08/12/1993	09:45:00	Kilkenny Co. Co.		Joe Pykes	J.Keohane	5212			Rathcash	Group		1	5	7.4	711	0.17		< 0.01
Spring at Paulstown Castle	10/11/1994	11:25:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle		5072	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	9.8	1	5	7.1	680			0.08
Graigae, Callan.	12/01/1995		Kilkenny Co. Co.		James Robinsons well	James Robinson	212			Proposed Supply for James Robinson	Private			< 5	7.6	528	14		
Spring at Paulstown Castle	23/01/1995	15:45:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle		255	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	9.5		5		680			0.01
Spring at Paulstown Castle	16/10/1995	15:23:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle		4410	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	11.8	1	5	7.3	595			< 0.01
Borehole at Castletomer Yarns	08/01/1996	11:10:00	Kilkenny Co. Co.	KK00300	Tap in yard at Castletomer Yarns	C. Murray	74		25360 17330	Castletomer Yarns	Private	11.6	2	20	7.4	583	5.5	2	< 0.01
Borehole at Dunmore	08/01/1996	11:30:00	Kilkenny Co. Co.	KK00700	C. Murray's house, Dunmore.	C. Murray	75		24910 16200	Dunmore	Group	8	1	5	7.3	615	0.2	3.4	< 0.01
Borehole at Dunmore S/G	08/01/1996	12:00:00	Kilkenny Co. Co.	KK01000	Canteen at Dunmore Sand & Gravel	C. Murray	76	KIK53	25000 16020	Dunmore Sand & Gravel	Private	10.1	2	5	7.7	627	1.6	2.2	< 0.01
Borehole at Kilkenny Mar	08/01/1996	12:15:00	Kilkenny Co. Co.	KK01300	Cattle holding shec	C. Murray	77		25070 15670	Kilkenny Mart	Private	9.5	1	5	7.9	690	0.2	2.4	< 0.01
Borehole at Clara	08/01/1996	12:55:00	Kilkenny Co. Co.	KK00400	At pumphouse	C. Murray	78	KIK41	25770 15530	Clara	Group	11	1	5	7.3	696	0.2	4.5	< 0.01
Borehole at Rathcash	08/01/1996	13:10:00	Kilkenny Co. Co.	KK02000	Joe Pykes house, Rathcash, Clara.	C. Murray	79	KIK55	25870 15510	Rathcash	Group	8.7	2	5	7.4	708	0.1		< 0.01
Spring at Paulstown Castle	08/01/1996	14:40:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle	C. Murray	80	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	10.6	1	5	7.2	623		5.	



EPA Regional Water Laboratory, Kilkenny. Monitoring Data for County Kilkenny Groundwaters 1993 to 1999.

Source	Sampling Date	Sampling Time	Cadmium mg/l Cd	Mercury mg/l Hg	Nickel mg/l Ni	Fluoride mg/l F	OMCTSiloxane µg/l	Comments1	Comments2	Comments3
Spring at Paulstown Castle	29/04/1992	11:38:00								
Spring at Paulstown Castle	01/07/1992	15:55:00								
Spring at Paulstown Castle	20/08/1992	15:15:00								
Spring at Paulstown Castle	18/11/1992	13:29:00								
Spring at Paulstown Castle	10/03/1993	16:00:00								
Borehole at Castlecemer Yarns	02/06/1993		< 0.0001					Copy to Castlecemer Yarns Ltd.		
Spring at Paulstown Castle	02/06/1993		< 0.0001							
Borehole at Rathcash	02/06/1993		< 0.0001					Copy to Rathcash G.W.S.		
Springs at Bausheenmore	02/06/1993		< 0.0001							
Spring at Westcourt	02/06/1993		< 0.0001							
Borehole at Galmoy	03/06/1993	11:25:00	< 0.0001		0.007					
Galmoy 35	03/06/1993	11:47:00	0.0001		0.001					
Galmoy 37	03/06/1993	12:02:00	0.0001		< 0.001					
Galmoy 25	03/06/1993	12:15:00	0.0001		0.005					
Galmoy 202	03/06/1993	12:55:00	0.0001		< 0.001					
Borehole at Bawnmore	03/06/1993	16:00:00	0.0001		< 0.001					
Spring at Clomantagh	10/06/1993	11:40:00	< 0.0001							
Spring at Clomantagh	10/06/1993	11:50:00	< 0.0001							
Borehole at Dunmore	10/06/1993	12:28:00	< 0.0001							
Spring Toberpatrick Urlingford	15/06/1993	10:45:00	< 0.0001							
Borehole at Kilmanagh	15/06/1993	12:00:00	< 0.0001							
Borehole at Dunmore S/G	15/06/1993	14:30:00	< 0.0001							
Borehole at Kilkenny Mar	15/06/1993	15:00:00	< 0.0001							
Borehole at Windgap	01/07/1993									
Spring at Paulstown Castle	05/08/1993	15:55:00								
Galmoy	08/11/1993	11:15:00	< 0.0001		< 0.001					
Galmoy	08/11/1993	11:45:00	< 0.0001		< 0.001					
Galmoy	08/11/1993	12:20:00	< 0.0001		< 0.001					
Galmoy	08/11/1993	12:40:00	< 0.0001		< 0.001					
Galmoy	08/11/1993	13:50:00	< 0.0001		< 0.001					
Galmoy	08/11/1993	13:55:00						Taken after well was pumped for approximately 1 1/2 hours.		
Galmoy	08/11/1993	14:44:00	< 0.0001		< 0.001					
Galmoy	08/11/1993	14:52:00	< 0.0001		< 0.001					
Borehole at Bawnmore	08/11/1993	15:15:00	< 0.0001		< 0.001					
Galmoy	08/11/1993	15:45:00	< 0.0001		< 0.001					
Spring Toberpatrick Urlingford	09/11/1993	11:45:00								
Borehole at Castlecemer Yarns	09/11/1993	12:35:00								
Spring at Paulstown Castle	09/11/1993	14:40:00								
Borehole at Clara	09/11/1993	15:15:00						167 Total Coliforms, 5 obvious coliform colonies, 162 probably coliform colonies.		
Spring at Westcourt	09/11/1993	16:00:00								
Borehole at Dunmore	10/11/1993	10:30:00	< 0.0001							
Borehole at Dunmore S/G	10/11/1993	10:55:00	< 0.0001							
Borehole at Kilkenny Mar	10/11/1993	11:15:00	< 0.0001							
Borehole at Kilmanagh	10/11/1993	12:22:00	< 0.0001					Copy to Mr. Liam Delaney.		
Springs at Bausheenmore	10/11/1993	14:30:00	< 0.0001							
Borehole No.9, Thomastown	10/11/1993	15:10:00	< 0.0001							
Borehole at Windgap	10/11/1993	15:50:00	< 0.0001							
Borehole at Avonmore Dairy	11/11/1993	11:30:00	< 0.0001					Chlorinated sample		
Rathcash, Clifden, Co. Kilkenny	08/12/1993	09:45:00	< 0.0001							
Spring at Paulstown Castle	10/11/1994	11:25:00								
Graigie, Callan.	12/01/1995		< 0.0003					High iron and elevated manganese levels leading to high turbidity.		
Spring at Paulstown Castle	23/01/1995	15:45:00						Interference < mixed background colonies (non-coliform) on Total Coliform plate.	Coliform plate.	
Spring at Paulstown Castle	16/10/1995	15:23:00						Interference from background colonies on Total Coliform plate.		
Borehole at Castlecemer Yarns	08/01/1996	11:10:00								
Borehole at Dunmore	08/01/1996	11:30:00								
Borehole at Dunmore S/G	08/01/1996	12:00:00						Total Coliform plate overgrown with non-coliforms.		
Borehole at Kilkenny Mar	08/01/1996	12:15:00								
Borehole at Clara	08/01/1996	12:55:00						Copy to: Paddy Coogan, Clifden, Clara, Co. Kilkenny		
Borehole at Rathcash	08/01/1996	13:10:00						Copy to: Mr. Joe Pyke, Rathcash, Clifden, Co. Kilkenny.		
Spring at Paulstown Castle	08/01/1996	14:40:00								
Spring at Clomantagh	09/01/1996	10:40:00							Spring in farmyard, sample taken at surface.	
Spring Toberpatrick Urlingford	09/01/1996	11:05:00								
Borehole at Bawnmore	09/01/1996	11:30:00								

**EPA Regional Water Laboratory, Kilkenny. Monitoring Data for County Kilkenny Groundwaters 1993 to 1999.**

Source	Sampling Date	Sampling Time	To	Ref No	Sampling Location	Taken By	Lab No	EPARef	Stn Grid Ref	Water Supply	Public/Group/Private	Temperature	Odour 1/2/3	Colour Hazen	pH	Conductivity µS/cm	Turbidity NTU	TOC mg/l C	Ammonia mg/l N	
Borehole at Galmoy	09/01/1996	12:40:00	Kilkenny Co. Co.	KK00200	Leahy's House, Galmoy	C. Murray	92	KIK17	23020 17120	Galmoy	Group	8.6	1	5	7.3	779	0.1	1.8	<0.01	
Borehole at Kilmanagh	09/01/1996	14:20:00	Kilkenny Co. Co.	KK01400	In pumphouse	C. Murray	93	KIK45	23930 15250	Kilmanagh/Ballycuddihy	Group	8.2	1	5	7.6	645	0.1	2.3	0.021	
Spring at Westcourt	09/01/1996	15:10:00	Kilkenny Co. Co.	KK00800	Spring at Earlsland, Westcourt, Callan	C. Murray	94	KIK91	S 407 442	Callan	Public	11.1	1	5	7.3	704	0.1	2.9	<0.01	
Borehole at Windgap	09/01/1996	15:40:00	Kilkenny Co. Co.	KK01900	Overflow from borehole	C. Murray	95		24200 13580	Farm supply	Private	11	1	5	7.4	380	0.2	<0.12	0.023	
Spring at Carrigeen,	15/01/1996	13:00:00	Kilkenny Co. Co.		Keoghans Field, Threecastles	J. Jennings	135						2	15	8	1045			0.03	
Belview	27/02/1996	14:15:00	Kilkenny County Council		Well No.2 for proposed new water supply	Brian Connor	763			Belview proposec				5	6.8	351			<0.01	
Belview	29/02/1996	11:45:00	Kilkenny County Council		Well No.2 for proposed new water supply	Brian Connor	822			Belview proposec			1	5	6.7	359			<0.01	
Belview No. 2	07/03/1996	16:00:00	Kilkenny Co Co		Belview Proposed water supply Well No. 2	Brian Connor	973						1	5	6.7	365				
Belview No. 2	14/03/1996	11:00:00	Kilkenny Co Co		Belview Proposed water supply Well No. 2	Brian Connor	1050						1	5	6.7	357			<0.01	
Belview No. 2	23/03/1996	14:10:00	Kilkenny Co Co		Belview Proposed water supply Well No. 2	Brian Connor	1157						1	5	6.4	290			<0.01	
Belview No. 1	25/03/1996	15:00:00	Kilkenny Co Co		Belview Proposed water supply Well No. 1	Brian Connor	1130						1	5	6.5	290		0.67	<0.01	
Belview No. 1	27/03/1996	13:00:00	Kilkenny Co Co		Belview Proposed water supply Well No. 1	Brian Connor	1173						1	5	6.4	289			<0.01	
Dunmore Wells	02/07/1996	10:10:00	Kilkenny Co. Co.		Readymix	C. Murray	2536						1	5	7.5	651		0.15	<0.01	
Dunmore Wells	02/07/1996	10:15:00	Kilkenny Co. Co.		Leahy's	C. Murray	2537						1	10	8.3	413		<0.12	<0.01	
Dunmore Wells	02/07/1996	10:15:00	Kilkenny Co. Co.		O'Dwyers	C. Murray	2538						2	5	7.5	513		<0.12	0.03	
Dunmore Wells	02/07/1996	10:35:00	Kilkenny Co. Co.		Tom Langtons	C. Murray	2539						1	10	7.9	350		<0.12	0.02	
Dunmore Wells	02/07/1996	10:55:00	Kilkenny Co. Co.		McDermotts	C. Murray	2540						1	10	7.4	599		0.69	<0.01	
Dunmore Wells	02/07/1996	11:10:00	Kilkenny Co. Co.		Nolans	C. Murray	2541						1	5	7.3	841		0.61	<0.01	
Dunmore Wells	02/07/1996	11:30:00	Kilkenny Co. Co.		O'Neill's	C. Murray	2542						1	10	7.4	700		0.15	<0.01	
Dunmore Wells	02/07/1996	11:45:00	Kilkenny Co. Co.		Fitzpatrick's	C. Murray	2543						1	5	7.4	737		0.53	<0.01	
Dunmore Wells	02/07/1996	12:10:00	Kilkenny Co. Co.		Canteen in Landfill Site	C. Murray	2544						1	15	7.4	563		2.07	0.05	
Dunmore Wells	02/07/1996	12:35:00	Kilkenny Co. Co.		Holohan's	C. Murray	2545						2	15	7.4	633		1.94	0.42	
Dunmore Wells	02/07/1996	12:45:00	Kilkenny Co. Co.		Murphy's/Stacks	C. Murray	2546						2	50	7.5	689		<0.12	0.013	
Belview	02/10/1996	11:10:00	Kilkenny Co. Co.		Well No. 3.	Brian Connor	3853						1	5	6.6	554	0.26		<0.01	
Belview	03/10/1996	10:30:00	Kilkenny Co. Co.		Well No. 3.	Brian Connor	3873						1	5	6.4	565	0.2			
Bellview Water Supply	08/10/1996	10:30:00	Kilkenny Co. Co.		Well No. 3.	B. O'Connor	3971						1	5	6.5	551			<0.01	
Spring at Paulstown Castle	09/01/1997	12:17:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle	P. Mullins	106	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	9.3	1	<5	7.3	613	0.23	1.9	<0.01	
Thomastown	10/01/1997	10:17:00	Kilkenny Co. Co.		Borehole No. 5	P. Mullins	111		S 589 411				9.6	1	<5	7.1	439	0.09	1.3	<0.01
Borehole No.9, Thomastown	10/01/1997	10:05:00	Kilkenny Co. Co.	KK01600	At pumphouse	P. Mullins	112	KIK32	25890 14160	Thomastown	Public	9.4	1	<5	7.3	721	0.11	1.5		
Borehole at Dunmore	13/01/1997		Kilkenny Co. Co.	KK00700	C. Murray,s house, Dunmore.	C. Murray	216		24910 16200	Dunmore	Group									
Spring at Paulstown Castle	17/02/1997	11:30:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle	C. Murray	726	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	10.3	1	<5	7.3	607	0.6		<0.1	
Springs at Bausheenmore	17/02/1997	12:30:00	Kilkenny Co. Co.	KK00500	At source (springs at Bausheenmore	C. Murray	727	KIK39	25520 14690		Private	10.5	1	<5	7.3	767			<1	<0.1
Spring at Westcourt	17/02/1997	14:05:00	Kilkenny Co. Co.	KK00800	Spring at Earlsland, Westcourt, Callan	C. Murray	728	KIK91	S 407 442	Callan	Public	11.3	1	<5	7.3	702			<1	<0.1
Dunmore	09/05/1997		Kilkenny Co. Co.		Doyle's	M. Daly	1936				Private							0.53	2	
Dunmore	09/05/1997		Kilkenny Co. Co.		Holohan's	M. Daly	1937				Private		3					1.8	0.5	
Dunmore	09/05/1997		Kilkenny Co. Co.		No. 8 Stack	M. Daly	1938				Private		3					0.1	<0.01	
Dunmore	09/05/1997		Kilkenny Co. Co.		Well in landfill site	M. Daly	1939				Private		2						17.6	
Dunmore	09/05/1997		Kilkenny Co. Co.		Unused Borehole, Doyle's Field	M. Daly	1940				Private		2					5.4	12.1	
Dunmore	12/05/1997	10:45:00	Kilkenny Co. Co.		Readymix	C. Murray	1944					10.2	1	5	7.7	631	0.65	0.22	1.5	
Dunmore	12/05/1997	10:55:00	Kilkenny Co. Co.		O'Dwyers	C. Murray	1945					10.8	2	15	7.6	473	3.8	0.09	0.05	
Dunmore	12/05/1997	11:05:00	Kilkenny Co. Co.		Langtons	C. Murray	1946					9.7	1	15	8	352	12	0.08	0.04	
Dunmore	12/05/1997	11:15:00	Kilkenny Co. Co.		Bergin's	C. Murray	1947					9.8	2	5	7.4	656	0.42	0.33	<0.01	
Dunmore	12/05/1997	11:25:00	Kilkenny Co. Co.		McDermott's	C. Murray	1948					10.8	2	5	7.3	615		0.39	<0.01	
Dunmore	12/05/1997	12:00:00	Kilkenny Co. Co.		Nolans	C. Murray	1949					10.8	2	5	7.3	794	0.19	0.64	<0.01	
Dunmore	12/05/1997	12:15:00	Kilkenny Co. Co.		O'Neill's	C. Murray	1950					10.9	1	5	7.4	700	0.42	0.09	<0.01	
Dunmore	12/05/1997	12:30:00	Kilkenny Co. Co.		Fitzpatricks	C. Murray	1951					10.4	2	5	7.3	736	0.21	0.43	<0.01	
Dunmore	12/05/1997	15:30:00	Kilkenny Co. Co.		Doyle's	C. Murray	1952					10.7	2	5	7.2	816	0.11	0.67	1.41	
Dunmore	12/05/1997	15:45:00	Kilkenny Co. Co.		Holohan's	C. Murray	1953					12	2		7.3	640	69	1.88	0.33	
Dunmore	12/05/1997	15:55:00	Kilkenny Co. Co.		Stacks/Murphys	C. Murray	1954					11.5	3		7.7	665	16	0.26	<0.01	
Dunmore	12/05/1997	14:35:00	Kilkenny Co. Co.		Canteen at landfill site.	C. Murray	1955			Canteen at landfill	private	11.5	3		7.9	1.8	100		110	
Dunmore	12/05/1997	14:50:00	Kilkenny Co. Co.		New Bore at landfill site.	C. Murray	1956					12.4	2		7.2	994	6.1	7.2	0.5	
Dunmore	12/05/1997	15:10:00	Kilkenny Co. Co.		Roches Pit, new cell	C. Murray	1957					10.8	2	5	7.3	653	1.2	0.64	<0.01	

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Source	Sampling Date	Sampling Time	o-Phosphate mg/l P	Nitrate mg/l N	Nitrite mg/l N	Chloride mg/l Cl	Ca Hardness mg/l CaCO <sub>3</sub>	Alkalinity mg/l CaCO <sub>3</sub>	TCS	Total Coliforms per 100 ml	FCS	Fecal Coliforms per 100 ml	Sulphate mg/l SO <sub>4</sub>	Dry Residue mg/l	Sus_Solids mg/l	Magnesium mg/l Mg	Total Hardness mg/l CaCO <sub>3</sub>	Sodium mg/l Na	Potassium mg/l K	Aluminium mg/l Al	Iron mg/l Fe	Manganese mg/l Mn	Copper mg/l Cu	Zinc mg/l Zn	Chromium mg/l Cr	Lead mg/l Pb
Borehole at Galmoy	09/01/1996	12:40:00	0.002	9.6	< 0.003	27.7		364	999		999	20			31.8		7.9	0.8		< 0.06	< 0.02		0.061			
Borehole at Kilmanagh	09/01/1996	14:20:00	0.099	3.5	< 0.003	20.4		327	>=	15	>=	2	11		18.4		9.1	0.9		< 0.06	< 0.02		0.035			
Spring at Westcourt	09/01/1996	15:10:00	0.02	3.6	< 0.003	24.1		365		52		64	15		29.2		9.5	0.9		< 0.06	< 0.02		0.028			
Borehole at Windgap	09/01/1996	15:40:00	0.122	1.8	< 0.003	16		164	999		999	4			19.2		6.9	1		< 0.06	< 0.02		0.03			
Spring at Carrigeen	15/01/1996	13:00:00	0.1	36.2	0.014	44		183				25														
Belview	27/02/1996	14:15:00	< 0.02	3.7	< 0.004	28		97	999		999						103									
Belview	29/02/1996	11:45:00	< 0.02	4.1	< 0.004	32.7		81	999		999						83									
Belview No. 2	07/03/1996	16:00:00						114		1	999						116				< 0.06	< 0.02		0.08		
Belview No. 2	14/03/1996	11:00:00	< 0.02	4.5	< 0.004	28		97		14		9									< 0.06	< 0.02		0.026		
Belview No. 2	23/03/1996	14:10:00	< 0.02	6.7	< 0.004	26		77		2		999														
Belview No. 1	25/03/1996	15:00:00	< 0.02	6.8	0.004	28		49	999		999										< 0.06	< 0.02		0.314		
Belview No. 1	27/03/1996	13:00:00	< 0.02	6.7	< 0.004	28		64		1	999															
Dunmore Wells	02/07/1996	10:10:00	< 0.02	< 0.1	0.004	20		317	999		999	29														
Dunmore Wells	02/07/1996	10:15:00	< 0.02	1.5	0.007	16		191	>=	3	999	11														
Dunmore Wells	02/07/1996	10:15:00	< 0.02	< 0.1	0.009	18		999	999		999	14														
Dunmore Wells	02/07/1996	10:35:00	< 0.02	< 0.1	0.003	13		164	>	80	999	4														
Dunmore Wells	02/07/1996	10:55:00	< 0.02	6.5	0.001	19		283	>=	3	6	15														
Dunmore Wells	02/07/1996	11:10:00	0.22	12	0.002	37		352	>	80	15	25														
Dunmore Wells	02/07/1996	11:30:00	< 0.02	7.4	0.002	28		323	999		999	15														
Dunmore Wells	02/07/1996	11:45:00	0.14	9.2	0.002	28		330	>	80	>	60	16													
Dunmore Wells	02/07/1996	12:10:00	0.03	2.6	0.041	22		250	>	80	6	25														
Dunmore Wells	02/07/1996	12:35:00	0.09	< 0.1	0.015	19		322		2	999	20														
Dunmore Wells	02/07/1996	12:45:00	< 0.02	< 0.1	0.005	21		323	>=	68	999	30														
Belview	02/10/1996	11:10:00	< 0.02	19.3	0.003	43			999		999				21.3		22.5	2.6		0.12	0.033		0.184			
Belview	03/10/1996	10:30:00							1		999				21.3		23.3	2.8		0.087	0.034	0.112				
Bellview Water Supply	08/10/1996	10:30:00	0.01	22	0.004	41		68	>=	2	999				21.3		22.8	2.8		0.087	0.029		0.074			
Spring at Paulstown Castle	09/01/1997	12:17:00	0.01	7	0.001	28		252		21		1	19													
Thomastown	10/01/1997	10:17:00	0.01	4.4	< 0.004	23	248		999		999															
Borehole No.9, Thomastown	10/01/1997	10:05:00	0.03	5.7	< 0.004	39	248		999		999															
Borehole at Dunmore	13/01/1997																									
Spring at Paulstown Castle	17/02/1997	11:30:00	< 0.02	6.4	0.01	22		245		200		22			11.5		8.7	2.6								
Springs at Bausheenmore	17/02/1997	12:30:00	< 0.02	7.1	< 0.004	26		345	>	80	50				29.5		8.7	3.6								
Spring at Westcourt	17/02/1997	14:05:00	< 0.02	4.8	0.011	20		329		3	2				23.3		8.3	0.9								
Dunmore	09/05/1997		< 0.02	11.2	< 0.004	45																				
Dunmore	09/05/1997		0.19	< 0.1	0.005	18																				
Dunmore	09/05/1997		< 0.02	< 0.1	< 0.003	21																				
Dunmore	09/05/1997		0.87	11.3	2	295																				
Dunmore	09/05/1997		0.08	3.3	0.1	29																				
Dunmore	12/05/1997	10:45:00	0.01	0.232	0.004	20				15		999														
Dunmore	12/05/1997	10:55:00	0.05	0.15	0.003	16				>=	37	6														
Dunmore	12/05/1997	11:05:00	0.01	0.16	0.004	13					999															
Dunmore	12/05/1997	11:15:00	< 0.02	16.2	0.007	23				>=	6	999														
Dunmore	12/05/1997	11:25:00	< 0.02	7.5	0.003	20				>=	13	999														
Dunmore	12/05/1997	12:00:00	0.17	12	0.004	30				>=	210	999														
Dunmore	12/05/1997	12:15:00	0.01	8.2	0.003	27						999														
Dunmore	12/05/1997	12:30:00	0.165	10.1	0.003	26					750	300														
Dunmore	12/05/1997	15:30:00	0.015	1.3	0.031	44				>	80	4														
Dunmore	12/05/1997	15:45:00	0.11	0.15	0.019	18																				
Dunmore	12/05/1997	15:55:00	< 0.02	0.18	2.2	19				>=	16	999														
Dunmore	12/05/1997	14:35:00	3	5.6	3.8	353				>	2000	>	2000													
Dunmore	12/05/1997	14:50:00	0.5	0.9	0.41	31						>	600													
Dunmore	12/05/1997	15:10:00	< 0.02	11	0.002	19				>=	9	999														

**EPA Regional Water Laboratory, Kilkenny. Monitoring Data for County Kilkenny Groundwaters 1993 to 1999.**

Source	Sampling Date	Sampling Time	Cadmium mg/l Cd	Mercury mg/l Hg	Nickel mg/l Ni	Fluoride mg/l F	OMCTSiloxane µg/l	Comments1	Comments2	Comments3
Borehole at Galmoy	09/01/1996	12:40:00								
Borehole at Kilmanagh	09/01/1996	14:20:00								
Spring at Westcourt	09/01/1996	15:10:00								
Borehole at Windgar	09/01/1996	15:40:00								
Spring at Carrigeen,	15/01/1996	13:00:00						Very high Nitrate.	High Conductivity and chloride.	
Belview	27/02/1996	14:15:00						Sample taken after pumping for 1 hour.		
Belview	29/02/1996	11:45:00								
Belview No. 2	07/03/1996	16:00:00						Sample delivered to the laboratory on 8/3/96 by Finbar Coughlan.		
Belview No. 2	14/03/1996	11:00:00								
Belview No. 2	23/03/1996	14:10:00								
Belview No. 1	25/03/1996	15:00:00								
Belview No. 1	27/03/1996	13:00:00								
Dunmore Wells	02/07/1996	10:10:00								
Dunmore Wells	02/07/1996	10:15:00								
Dunmore Wells	02/07/1996	10:15:00								
Dunmore Wells	02/07/1996	10:35:00								
Dunmore Wells	02/07/1996	10:55:00								
Dunmore Wells	02/07/1996	11:10:00								
Dunmore Wells	02/07/1996	11:30:00								
Dunmore Wells	02/07/1996	11:45:00								
Dunmore Wells	02/07/1996	12:10:00								
Dunmore Wells	02/07/1996	12:35:00								
Dunmore Wells	02/07/1996	12:45:00								
Belview	02/10/1996	11:10:00						Calcium Hardness = 152 mg/l CaCO3	Very high nitrate.	
Belview	03/10/1996	10:30:00						Calcium Hardness = 144 mg/l CaCO3		
Bellview Water Supply	08/10/1996	10:30:00						Calcium Hardness = 144 mg/l CaCO3	Interference from background colonies on Total Coliform plate.	Very high Nitrate.
Spring at Paulstown Castle	09/01/1997	12:17:00						See GC/MS Purge & Trap analyses on separate sheet.		
Thomastown	10/01/1997	10:17:00								
Borehole No.9, Thomastown	10/01/1997	10:05:00						See GC/MS Purge & Trap analyses on separate sheet.	Octamethylcyclotetrasiloxane < 0.2 ug/l.	
Borehole at Dunmore	13/01/1997							Sample for GC/MS Purge & Trap analyses only. Results on separate sheet.	Octamethylcyclotetrasiloxane 0.7 ug/l.	
Spring at Paulstown Castle	17/02/1997	11:30:00						Octamethylcyclotetrasiloxane = 0.3 ug/l.		
Springs at Bausheenmore	17/02/1997	12:30:00						Octamethylcyclotetrasiloxane = 1.7 ug/l.	K/Na Ratio = 0.41	
Spring at Westcourt	17/02/1997	14:05:00						Octamethylcyclotetrasiloxane = 1.4 ug/l.		
Dunmore	09/05/1997							Very high ammonia.	Sample taken after land-fill leachate escaped to groundwater.	Approximate ammonia concentration.
Dunmore	09/05/1997							Strong odour and high ammonia.	Sample taken after land-fill leachate escaped to groundwater.	Approximate ammonia concentration.
Dunmore	09/05/1997							Odour of sulphide.	Sample taken after land-fill leachate escaped to groundwater.	Approximate ammonia concentration.
Dunmore	09/05/1997							Very high TOC, ammonia and nitrite results < serious contamination.	Sample taken after land-fill leachate escaped to groundwater.	Approximate ammonia concentration.
Dunmore	09/05/1997							Very high ammonia and high nitrite.	Sample taken after land-fill leachate escaped to groundwater.	Approximate ammonia concentration.
Dunmore	12/05/1997	10:45:00						Ammonia >1.5 mg/l as N.	Sample taken after leachate at landfill site escaped to groundwater	Amended report, ammonia is >1.5 and not <1.5 as reported on 15/5/97.
Dunmore	12/05/1997	10:55:00							Sample taken after leachate at landfill site escaped to groundwater	
Dunmore	12/05/1997	11:05:00							Sample taken after leachate at landfill site escaped to groundwater	No coliforms detected but possible interference from suspended solids.
Dunmore	12/05/1997	11:15:00							Sample taken after leachate at landfill site escaped to groundwater	
Dunmore	12/05/1997	11:25:00							Sample taken after leachate at landfill site escaped to groundwater	
Dunmore	12/05/1997	12:00:00							Sample taken after leachate at landfill site escaped to groundwater	Interference from suspended solids on the total coliform test.
Dunmore	12/05/1997	12:15:00							Sample taken after leachate at landfill site escaped to groundwater	Background interference on the total coliform test.
Dunmore	12/05/1997	12:30:00							Sample taken after leachate at landfill site escaped to groundwater	Very high coliform levels (total and faecal).
Dunmore	12/05/1997	15:30:00						High ammonia and nitrite concentrations.	Sample taken after leachate at landfill site escaped to groundwater	
Dunmore	12/05/1997	15:45:00						Very turbid. High ammonia indicative of pollution.	Sample taken after leachate at landfill site escaped to groundwater	Interference from suspended solids on the coliform tests (total & faecal).
Dunmore	12/05/1997	15:55:00						Very turbid. High nitrite. Odour detected.	Sample taken after leachate at landfill site escaped to groundwater	Background interference on the total coliform test.
Dunmore	12/05/1997	14:35:00						Turbidity > 100 NTU and ammonia > 110 mg/l N. Very high coliform levels.	Sample taken after leachate at landfill site escaped to groundwater	
Dunmore	12/05/1997	14:50:00						High ammonia and nitrite levels.	Sample taken after leachate at landfill site escaped to groundwater	Interference on the total coliform test.
Dunmore	12/05/1997	15:10:00							Sample taken after leachate at landfill site escaped to groundwater	Interference on the total coliform test.

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Source	Sampling Date	Sampling Time	To	Ref No	Sampling Location	Taken By	Lab No	EPARef	Stn Grid Ref	Water Supply	Public/Group/Private	Temperature	Odour 1/2/3	Colour Hazen	pH	Conductivity µS/cm	Turbidity NTU	TOC mg/l C	Ammonia mg/l N
Borehole at Dunmore	18/06/1997	11:45:00	Kilkenny Co. Co.	KK00700	C. Murray,s house, Dunmore.	C. Murray	2630		24910 16200	Dunmore	Group	15		15	7.4	604			< 0.01
Dunmore	08/07/1997	14:50:00	Kilkenny Co. Co.		Stacks	M. Daly	2973						2	60	7.6	659	7.5		< 0.01
Dunmore	08/07/1997	15:00:00	Kilkenny Co. Co.		Holohans	M. Daly	2974						1		7.3	639	72		0.4
Borehole at Kilmanagh	01/09/1997	10:24:00	Kilkenny Co. Co.	KK01400	In pumphouse	P. Mullins	3796	KIK45	23930 15250	Kilmanagh/Ballycuddihy	Group	14.4	1	< 5	7.5	641	0.26	0.4	< 0.01
Spring at Westcourt	01/09/1997	11:17:00	Kilkenny Co. Co.	KK00800	Spring at Earlsland, Westcourt, Callan	P. Mullins	3797	KIK91	S 407 442	Callan	Public	11.9	1	< 5	7.3	701	0.14	0.28	< 0.01
Borehole at Windgap	01/09/1997	11:54:00	Kilkenny Co. Co.	KK01900	Overflow from borehole	P. Mullins	3798		24200 13580	Farm supply	Private	11.3	1	< 5	7.3	386	0.39	0.07	< 0.01
Springs at Bausheenmore	01/09/1997	13:36:00	Kilkenny Co. Co.	KK00500	At source (springs at Bausheenmore)	P. Mullins	3799	KIK39	25520 14690		Private	11.9	1	20	7.4	717	2.6	3.3	< 0.01
Borehole at Dunmore S/G	01/09/1997	14:17:00	Kilkenny Co. Co.	KK01000	Canteen at Dunmore Sand & Gravel	P. Mullins	3800	KIK53	25000 16020	Dunmore Sand & Gravel	Private	13.6	1	5	7.7	645	1	0.41	< 0.01
Borehole at Dunmore	01/09/1997	14:26:00	Kilkenny Co. Co.	KK00700	C. Murray,s house, Dunmore.	P. Mullins	3801		24910 16200	Dunmore	Group	16	1	< 5	7.4	643	0.14	0.34	< 0.01
Borehole at Kilkenny Mar	01/09/1997	15:13:00	Kilkenny Co. Co.	KK01300	Cattle holding shed	P. Mullins	3802		25070 15670	Kilkenny Mart	Private	16.7	1	60	8.4	130	27	3.2	0.03
Borehole at Galmoy	27/08/1997	11:19:00	Kilkenny Co. Co.	KK00200	Leahy's House, Galmoy	P. Mullins	3743	KIK17	23020 17120	Galmoy	Group	14.3	1	5	7.6	763	0.15	0.55	< 0.01
Borehole at Bawnmore	27/08/1997	11:39:00	Kilkenny Co. Co.	KK00100	Phelan's house, Bawnmore	P. Mullins	3744	KIK50	22580 16610	Bawnmore	Group	15.4	1	5	7.3	826	0.08	1.04	< 0.01
Spring Toberpatrick Urlingford	27/08/1997	12:05:00	Kilkenny Co. Co.	KK01500	In chamber at source	P. Mullins	3745	KIK34	23000 16350	Urlingford/Johnstown	Public	11.1	1	5	7.2	743	0.12	2.47	< 0.01
Spring at Clomantagh	27/08/1997	12:20:00	Kilkenny Co. Co.	KK00900	Beside Nuenna river, 50m SE of roac	P. Mullins	3746		23520 16320		Private	12.4	1	5	7.4	638	1.6	1.01	< 0.01
Borehole at Castlecomer Yarns	27/08/1997	14:00:00	Kilkenny Co. Co.	KK00300	Tap in yard at Castlecomer Yarns	P. Mullins	3747		25360 17330	Castlecomer Yarns	Private	12	1	5	7.4	600	5.8	0.56	0.033
Spring at Paulstown Castle	27/08/1997	14:51:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle	P. Mullins	3748	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	11.9	1	5	7.3	636	0.72	1.13	< 0.01
Borehole at Rathcash	27/08/1997	15:12:00	Kilkenny Co. Co.	KK02000	Joe Pykes house, Rathcash, Clara.	P. Mullins	3749	KIK55	25870 15510	Rathcash	Group	16.9	1	5	7.4	709	0.07	0.49	< 0.01
Borehole at Clara	27/08/1997	15:30:00	Kilkenny Co. Co.	KK00400	At pumphouse	P. Mullins	3750	KIK41	25770 15530	Clara	Group	16.3	1	5	7.4	673	0.06	0.59	< 0.01
Dunmore	03/03/1998	11:10:00	Kilkenny Co. Co.		1. Billy O'Dwyers	C. Murray	1116			1. Billy O'Dwyers		9.8	1	10	7.6	473	3.7	0.03	0.073
Dunmore Group Scheme	19/05/1998	11:45:00	Kilkenny Co. Co.			P. Mullins	2330					17.6	1	5	7.44	636			
	19/05/1998	11:55:00	Kilkenny Co. Co.		Readymix	P. Mullins	2331					14.8	1	< 5	7.59	648			
Borehole at Windgap	09/02/1999	09:30:00	Kilkenny Co. Co.	KK01900	Overflow from borehole	Redmond Bergir	815		24200 13580	Farm supply	Private			5	7.3	330	< 0.1		< 0.2
Spring at Clomantagh	17/02/1999	10:40:00	Kilkenny Co. Co.	KK00900	Beside Nuenna river, 50m SE of roac	C. Murray	998		23520 16320		Private	10	1	5	7.3	669	0.6	4	
Spring Toberpatrick Urlingford	17/02/1999	11:00:00	Kilkenny Co. Co.	KK01500	In chamber at source	C. Murray	999	KIK34	23000 16350	Urlingford/Johnstown	Public	9.2	1	5	7.3	747	0.2	4.3	
Borehole at Bawnmore	17/02/1999	11:30:00	Kilkenny Co. Co.	KK00100	Phelan's house, Bawnmore	C. Murray	1000	KIK50	22580 16610	Bawnmore	Group	7	1	5	7.1	881	< 0.1	4.5	
Borehole at Galmoy	17/02/1999	12:00:00	Kilkenny Co. Co.	KK00200	Leahy's House, Galmoy	C. Murray	1001	KIK17	23020 17120	Galmoy	Group			1	5	7.3	776	0.4	2.1
Borehole at Castlecomer Yarns	17/02/1999	12:50:00	Kilkenny Co. Co.	KK00300	Tap in yard at Castlecomer Yarns	C. Murray	1002		25360 17330	Castlecomer Yarns	Private	10.5	1	40	7.4	535	11.6	2	
Borehole at Dunmore	17/02/1999	14:05:00	Kilkenny Co. Co.	KK00700	C. Murray,s house, Dunmore.	C. Murray	1003		24910 16200	Dunmore	Group	7.7	1	5	7.3	663	< 0.1	1.7	< 0.2
Borehole at Kilkenny Mar	17/02/1999	15:00:00	Kilkenny Co. Co.	KK01300	Cattle holding shed	C. Murray	1004		25070 15670	Kilkenny Mart	Private	9.7	1	10	7.9	690	1.5	1.8	< 0.2
Borehole at Kilmanagh	17/02/1999	16:00:00	Kilkenny Co. Co.	KK01400	In pumphouse	C. Murray	1005	KIK45	23930 15250	Kilmanagh/Ballycuddihy	Group	7.3	1	5	7.6	658	< 0.1	3.9	< 0.2
Spring at Westcourt	14/04/1999	10:47:00	Kilkenny Co. Co.	KK00800	Spring at Earlsland, Westcourt, Callan	P. Mullins	1889	KIK91	S 407 442	Callan	Public	9.8	1	< 5	7.5	699	< 0.1		< 0.01
Borehole at Windgap	14/04/1999	11:14:00	Kilkenny Co. Co.	KK01900	Overflow from borehole	P. Mullins	1890		24200 13580	Farm supply	Private	10.5	1	< 5	7.3	388	0.2		< 0.01
Springs at Bausheenmore	14/04/1999	12:12:00	Kilkenny Co. Co.	KK00500	At source (springs at Bausheenmore)	P. Mullins	1891	KIK39	25520 14690		Private	9.6	1	< 5	7.4	772	0.2		< 0.01
Borehole at Rathcash	14/04/1999	14:00:00	Kilkenny Co. Co.	KK02000	Joe Pykes house, Rathcash, Clara.	P. Mullins	1892	KIK55	25870 15510	Rathcash	Group	9.4	1	< 5	7.3	722	< 0.1		< 0.01
Borehole at Clara	14/04/1999	14:18:00	Kilkenny Co. Co.	KK00400	At pumphouse	P. Mullins	1893	KIK41	25770 15530	Clara	Group	9.6	1	< 5	7.3	695	< 0.1		< 0.01
	07/09/1999	10:20:00	Kilkenny Co. Co.		Kenny's Well, Kilkenny City	T. Doherty	4410												
Bennettsbridge	29/03/2000	14:16:00	Kilkenny Co. Co.		New well - feeding the infiltration gallery	P. Mullins	1688			Bennettsbridge	Public	10.6	1	< 5	7.6	727			< 0.003
Borehole at Kilmanagh	27/09/2000	10:30:00	Kilkenny Co. Co.	KK01400	In pumphouse	C. Murray	5048	KIK45	23930 15250	Kilmanagh/Ballycuddihy	Group	13.8			7.3	664	0.1		< 0.003
Borehole at Windgap	27/09/2000	12:10:00	Kilkenny Co. Co.	KK01900	Overflow from borehole	C. Murray	5049		24200 13580	Farm supply	Private	11.5			7.3	388	0.6		< 0.003
Borehole No.9, Thomastown	27/09/2000	14:15:00	Kilkenny Co. Co.	KK01600	At pumphouse	C. Murray	5050	KIK32	25890 14160	Thomastown	Public	13.3			7.2	758	0.2		< 0.003
Springs at Bausheenmore	27/09/2000	14:50:00	Kilkenny Co. Co.	KK00500	At source (springs at Bausheenmore)	C. Murray	5051	KIK39	25520 14690		Private	11			7.1	787	0.6		0.005
Spring at Paulstown Castle	27/09/2000	15:40:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle	C. Murray	5052	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	11.1			7.1	656	0.4		0.016
Spring at Clomantagh	26/09/2000	10:20:00	Kilkenny Co. Co.	KK00900	Beside Nuenna river, 50m SE of roac	C. Murray	5026		23520 16320		Private	11.4	1	15	7.4	282			0.083
Spring Toberpatrick Urlingford	26/09/2000	10:40:00	Kilkenny Co. Co.	KK01500	In chamber at source	C. Murray	5027	KIK34	23000 16350	Urlingford/Johnstown	Public	10.3	1	5	7.2	813			< 0.003
Borehole at Bawnmore	26/09/2000	11:05:00	Kilkenny Co. Co.	KK00100	Phelan's house, Bawnmore	C. Murray	5028	KIK50	22580 16610	Bawnmore	Group	13.5	1	5	7.3	863			< 0.003
Borehole at Galmoy	26/09/2000	12:15:00	Kilkenny Co. Co.	KK00200	Leahy's House, Galmoy	C. Murray	5029	KIK17	23020 17120	Galmoy	Group	14.7	1	5	7.4	789			< 0.003
Borehole at Castlecomer Yarns	26/09/2000	14:00:00	Kilkenny Co. Co.	KK00300	Tap in yard at Castlecomer Yarns	C. Murray	5030		25360 17330	Castlecomer Yarns	Private	12.2	1	20	7.5	578			0.036
Borehole at Dunmore	26/09/2000	14:25:00	Kilkenny Co. Co.	KK00700	C. Murray,s house, Dunmore.	C. Murray	5031		24910 16200	Dunmore	Group	14.7	1	5	7.4	668			< 0.003
Borehole at Dunmore S/G	26/09/2000	14:40:00	Kilkenny Co. Co.	KK01000	Canteen at Dunmore Sand & Gravel	C. Murray	5032	KIK53	25000 16020	Dunmore Sand & Gravel	Private	12.4	1	5	7.6	660			< 0.003
Borehole at Kilkenny Mar	26/09/2000	14:55:00	Kilkenny Co. Co.	KK01300	Cattle holding shed	C. Murray	5033		25070 15670	Kilkenny Mart	Private	14.6	1	5	7.6	708			< 0.003
Borehole at Clara	26/09/2000	15:35:00	Kilkenny Co. Co.	KK00400	At pumphouse	C. Murray	5034	KIK41	25770 15530	Clara	Group	11.6	1	5	7.4	667			< 0.003
Kilshaua/Barna	03/10/2000	11:15:00	Kilkenny Co. Co./G.S.I.		GWS06	M. Daly	5218							7	663			0.015	
Tubrid Lower	03/10/2000	11:40:00	Kilkenny Co. Co./G.S.I.		GWS14	M. Daly	5219								7.2	766			0.012
Balief Clomantagh	03/10/2000	12:00:00	Kilkenny Co. Co./G.S.I.		GWS03	M. Daly	5220								7.3	794			0.007
Graine/Craddockstown	03/10/2000	12:30:00	Kilkenny Co. Co./G.S.I.		GWS07	M. Daly	5221								7.4	727			0.006
Pilltown (PWS07)	03/10/2000	09:45:00	Kilkenny Co. Co./G.S.I.			Ruth Buckley	5222								6.5	184			0.01
Tullahought (GWS16)	03/10/2000	10:30:00	Kilkenny Co. Co./G.S.I.			Ruth Buckley	5223								6.3	194			0.007
Hugginstown (GWS10)	03/10/2000	11:30:00	Kilkenny Co. Co./G.S.I.			Ruth Buckley	5224								6.7	448			0.005
Ahenure (PWS09)	03/10/2000	14:15:00	Kilkenny Co. Co./G.S.I.			Ruth Buckley	5225								7.3	743			0.005

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Source	Sampling Date	Sampling Time	o-Phosphate mg/l P	Nitrate mg/l N	Nitrite mg/l N	Chloride mg/l Cl	Ca Hardness mg/l CaCO <sub>3</sub>	Alkalinity mg/l CaCO <sub>3</sub>	TCS	Total Coliforms per 100 ml	FCS	Fecal Coliforms per 100 ml	Sulphate mg/l SO <sub>4</sub>	Dry Residue mg/l	Sus_Solids mg/l	Magnesium mg/l Mg	Total Hardness mg/l CaCO <sub>3</sub>	Sodium mg/l Na	Potassium mg/l K	Aluminium mg/l Al	Iron mg/l Fe	Manganese mg/l Mn	Copper mg/l Cu	Zinc mg/l Zn	Chromium mg/l Cr	Lead mg/l Pb		
Borehole at Dunmore	18/06/1997	11:45:00	< 0.02	10		19.7		240		999		999																
Dunmore	08/07/1997	14:50:00	< 0.02	< 0.1	0.003	20			<	100	<	100			Visible	19.5		10.2	0.6									
Dunmore	08/07/1997	15:00:00	0.1	< 0.1	0.016	19			<	200	<	100			Visible	10.3		15.2	0.4									
Borehole at Kilmanagh	01/09/1997	10:24:00	< 0.02	4.6	< 0.004	17	270	287	>	100	>	100	7															
Spring at Westcourt	01/09/1997	11:17:00	< 0.02	4.3	< 0.004	22	262	310		15		5	12															
Borehole at Windgap	01/09/1997	11:54:00	0.02	2.1	< 0.004	15	144	151		6		2	4															
Springs at Bausheenmore	01/09/1997	13:36:00	0.04	5.6	0.004	26	270	304	>	100	>	100	17															
Borehole at Dunmore S/G	01/09/1997	14:17:00	< 0.02	< 0.1	< 0.004	21	252			480		9	36															
Borehole at Dunmore	01/09/1997	14:26:00	< 0.02	10.6	< 0.004	19	272	272		2		999	20															
Borehole at Kilkenny Mar	01/09/1997	15:13:00	0.09	0.5	0.018	3	64		>	160	>	120	< 1.5															
Borehole at Galmoy	27/08/1997	11:19:00	< 0.02	16.1	< 0.004	20	228	298		1		999	19															
Borehole at Bawnmore	27/08/1997	11:39:00	< 0.02	11	< 0.004	23	316	363	>	80		7	17															
Spring Toberpatrick Urlingford	27/08/1997	12:05:00	< 0.02	8.1	< 0.004	22	292	332		51		9	17															
Spring at Clomantagh	27/08/1997	12:20:00	< 0.02	7.4	0.001	18	236	276	>	160	>	120	10															
Borehole at Castlecomer Yarn:	27/08/1997	14:00:00	< 0.02	0.13	0.004	20	144	262		999		999	25															
Spring at Paulstown Castle	27/08/1997	14:51:00	< 0.02	7	< 0.004	25	232	256	>	160	>	120	17															
Borehole at Rathcash	27/08/1997	15:12:00	< 0.02	6.2	< 0.004	24	212	314		999		999	15															
Borehole at Clara	27/08/1997	15:30:00	0.02	8.7	< 0.004	21	272	283		29		18	13															
Dunmore	03/03/1998	11:10:00	< 0.02			17.6		206	<	40	<	1																
Dunmore Group Schemc	19/05/1998	11:45:00	0.011	9.4		19				999		999																
	19/05/1998	11:55:00	0.011	0.4		22				12		999																
Borehole at Windgap	09/02/1999	09:30:00	0.05	2	< 0.003	13.3	93	148		999		999	6.1			13.9		7.2										
Spring at Clomantagh	17/02/1999	10:40:00	< 0.04	6.1	< 0.003	15.4		299		10		2	9.5															
Spring Toberpatrick Urlingford	17/02/1999	11:00:00	< 0.04	5.7	< 0.003	17.5		340		13		1	10.1															
Borehole at Bawnmore	17/02/1999	11:30:00	< 0.04	7.9	< 0.003	17.9		416		999		999	11.2															
Borehole at Galmoy	17/02/1999	12:00:00	< 0.04	11.5	< 0.003	24.5		317		29		999	13.3															
Borehole at Castlecomer Yarn:	17/02/1999	12:50:00	< 0.04	0.6	< 0.003	16.7		241		999		999	18.4															
Borehole at Dunmore	17/02/1999	14:05:00		8.9	< 0.003	21.3	303	262		999		999	15.1					9	0.9									
Borehole at Kilkenny Mar	17/02/1999	15:00:00	< 0.04	6.6	< 0.003	18.8	273	270		9		999	37.9					14.1	11.2	1.3								
Borehole at Kilmanagh	17/02/1999	16:00:00	< 0.04	4	< 0.003	15.2	276	308		999		999	9.7															
Spring at Westcourt	14/04/1999	10:47:00	< 0.04	4.2	< 0.004	20	288	330		1		1	11.4					24.2	8.9	0.6								
Borehole at Windgap	14/04/1999	11:14:00	< 0.04	2.2	< 0.004	13	138	174		999		999	5.6															
Springs at Bausheenmore	14/04/1999	12:12:00	< 0.04	5.7	< 0.004	23	272	360		74		2	15					30.5	8.3	2.3								
Borehole at Rathcash	14/04/1999	14:00:00	< 0.04	6.7	< 0.004	21	286	326		999		999	14					22.3	7.9	0.8								
Borehole at Clara	14/04/1999	14:18:00	< 0.04	8.5	< 0.004	19	288	318		45		2	12.8					17.1	7.8	1								
	07/09/1999	10:20:00								999		999																
Bennettsbridge	29/03/2000	14:16:00	< 0.006	5.1		22				999		999																
Borehole at Kilmanagh	27/09/2000	10:30:00	< 0.006	3.7	< 0.001	14	288		>=	43		999	13				15	349	11	1.2		< 0.06	< 0.02		0.026			
Borehole at Windgap	27/09/2000	12:10:00	0.019	2.4	< 0.001	14	143			999		999	9.1				15	204	7.9	1.4		< 0.06	< 0.02		0.024			
Borehole No.9, Thomastowr	27/09/2000	14:15:00	0.032	5.8	< 0.001	31	293			8		1	19				22	383	18	3.5		< 0.06	< 0.02		0.138			
Springs at Bausheenmore	27/09/2000	14:50:00	0.014	6	< 0.001	23	308		>	80	>	60	20				30	431	10	3.9		< 0.06	< 0.02		0.022			
Spring at Paulstown Castle	27/09/2000	15:40:00	0.008	4.7	0.007	23	290		>	80	>	60	18				11	335	11	3.4		< 0.06	< 0.02		0.021			
Spring at Clomantagh	26/09/2000	10:20:00	0.012	1.5	0.007	6.9	83		>	80	>	60	7.8				2.4	92.8	6	6.5		0.086	< 0.02		0.189			
Spring Toberpatrick Urlingford	26/09/2000	10:40:00	0.009	7.1	0.011	20	338		>	80	>	60	15				19	416	9.4	5		0.106	< 0.02		0.48			
Borehole at Bawnmore	26/09/2000	11:05:00	< 0.006	6.7	< 0.001	18	348		>=	50		28	16				30	471	8.1	3.4		0.114	< 0.02		0.421			
Borehole at Galmoy	26/09/2000	12:15:00	< 0.006	8.2	< 0.001	21	305			999		999	18				27	416	9.6	1.4		0.082	< 0.02		0.258			
Borehole at Castlecomer Yarn:	26/09/2000	14:00:00	0.077	1.1	0.003	17	150			7		999	25				17	220	43	1.7		0.664	0.536		0.152			
Borehole at Dunmore	26/09/2000	14:25:00	< 0.006	8.9	< 0.001	23	308			21	<	1	18				3.1	320	9.9	1.4		< 0.06	< 0.02		0.102			
Borehole at Dunmore S/G	26/09/2000	14:40:00	< 0.006	0.67	0.002	19	278		>=	44		999	38				14	294	12	1.4		0.063	0.273		0.076			
Borehole at Kilkenny Mar	26/09/2000	14:55:00	< 0.006	6.2	< 0.001	18	295			47		3	39				16	360	12	1.9		< 0.06	< 0.02		0.151			
Borehole at Clara	26/09/2000	15:35:00	0.03	5.9	< 0.001	18	275			5		999	16				16	340	9.7	1.9		< 0.06	< 0.02		0.068			
Kiloshau/Barna	03/10/2000	11:15:00	0.023	5.9	< 0.001	14	360	305	>	80	>	80	7.8				10.4	402	6.9	2.1	< 0.05	0.075	0.01	0.004	0.262	0.012	< 0.001	
Tubrid Lower	03/10/2000	11:40:00	0.009	8.5	< 0.001	18	413	353		7		1	10.6				15.5	476	7.7	0.6	< 0.05	0.097	0.003	0.005	0.463	0.034	< 0.001	
Balief Clomantagh	03/10/2000	12:00:00																										

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Source	Sampling Date	Sampling Time	Cadmium mg/l Cd	Mercury mg/l Hg	Nickel mg/l Ni	Fluoride mg/l F	OMCTSiloxane µg/l	Comments1	Comments2	Comments3
Borehole at Dunmore	18/06/1997	11:45:00								
Dunmore	08/07/1997	14:50:00						Total Coliforms present. Accurate count not possible due to	Suspended Solids.	
Dunmore	08/07/1997	15:00:00						Total Coliforms present. Accurate count not possible due to	Suspended Solids.	
Borehole at Kilmanagh	01/09/1997	10:24:00								
Spring at Westcourt	01/09/1997	11:17:00								
Borehole at Windgap	01/09/1997	11:54:00								
Springs at Bausheenmore	01/09/1997	13:36:00								
Borehole at Dunmore S/G	01/09/1997	14:17:00								
Borehole at Dunmore	01/09/1997	14:26:00								
Borehole at Kilkenny Mar	01/09/1997	15:13:00								
Borehole at Galmoy	27/08/1997	11:19:00								
Borehole at Bawnmore	27/08/1997	11:39:00								
Spring Toberpatrick Urlingford	27/08/1997	12:05:00								
Spring at Clomantagh	27/08/1997	12:20:00								
Borehole at Castlecomer Yarn:	27/08/1997	14:00:00								
Spring at Paulstown Castle	27/08/1997	14:51:00								
Borehole at Rathcash	27/08/1997	15:12:00								
Borehole at Clara	27/08/1997	15:30:00								
Dunmore	03/03/1998	11:10:00								
Dunmore Group Scheme	19/05/1998	11:45:00								
	19/05/1998	11:55:00								
Borehole at Windgap	09/02/1999	09:30:00						Sodium and calcium for guide only.		
Spring at Clomantagh	17/02/1999	10:40:00								
Spring Toberpatrick Urlingford	17/02/1999	11:00:00				< 0.1				
Borehole at Bawnmore	17/02/1999	11:30:00				< 0.1				
Borehole at Galmoy	17/02/1999	12:00:00				< 0.1				
Borehole at Castlecomer Yarn:	17/02/1999	12:50:00				< 0.1				
Borehole at Dunmore	17/02/1999	14:05:00				< 0.1				
Borehole at Kilkenny Mar	17/02/1999	15:00:00				< 0.1				
Borehole at Kilmanagh	17/02/1999	16:00:00				< 0.1				
Spring at Westcourt	14/04/1999	10:47:00				< 0.1				
Borehole at Windgap	14/04/1999	11:14:00				< 0.1				
Springs at Bausheenmore	14/04/1999	12:12:00				< 0.1				
Borehole at Rathcash	14/04/1999	14:00:00				< 0.1				
Borehole at Clara	14/04/1999	14:18:00				< 0.1				
	07/09/1999	10:20:00						Sample for bacteriological analyses only.		
Bennettsbridge	29/03/2000	14:16:00						This is a sample from a new well that feeds the old infiltration gallery for	Bennettsbridge water supply.	
Borehole at Kilmanagh	27/09/2000	10:30:00					3.2		VOC analysis results on separate sheet.	
Borehole at Windgap	27/09/2000	12:10:00					2.1	Total Coliforms not reported.	VOC analysis results on separate sheet.	
Borehole No.9, Thomastown	27/09/2000	14:15:00					1.8		VOC analysis results on separate sheet.	
Springs at Bausheenmore	27/09/2000	14:50:00								
Spring at Paulstown Castle	27/09/2000	15:40:00					10.3		VOC analysis results on separate sheet.	
Spring at Clomantagh	26/09/2000	10:20:00					0.6		VOC analysis results on separate sheet.	
Spring Toberpatrick Urlingford	26/09/2000	10:40:00					1.7		VOC analysis results on separate sheet.	
Borehole at Bawnmore	26/09/2000	11:05:00					0.7	Background interference on Total Coliform plate.	VOC analysis results on separate sheet.	
Borehole at Galmoy	26/09/2000	12:15:00					2.4		VOC analysis results on separate sheet.	
Borehole at Castlecomer Yarn:	26/09/2000	14:00:00					0.6		VOC analysis results on separate sheet.	
Borehole at Dunmore	26/09/2000	14:25:00					1.1	Small underdeveloped colonies on Total Coliform plate.	VOC analysis results on separate sheet.	
Borehole at Dunmore S/G	26/09/2000	14:40:00					2.2	Background interference on Total Coliform plate.	VOC analysis results on separate sheet.	
Borehole at Kilkenny Mar	26/09/2000	14:55:00					1.3		VOC analysis results on separate sheet.	
Borehole at Clara	26/09/2000	15:35:00					2.9		VOC analysis results on separate sheet.	
Kiloshau/Barna	03/10/2000	11:15:00	< 0.0001	< 0.0001	0.008	< 0.1		Samples as part of Kilkenny Groundwater Protection Scheme.		
Tubrid Lower	03/10/2000	11:40:00	< 0.0001	< 0.0001	0.015	< 0.1		Samples as part of Kilkenny Groundwater Protection Scheme.		
Balief Clomantagh	03/10/2000	12:00:00	< 0.0001	< 0.0001	0.012	< 0.1		Samples as part of Kilkenny Groundwater Protection Scheme.		
Graine/Craddockstown	03/10/2000	12:30:00	< 0.0001	< 0.0001	0.007	< 0.1		Samples as part of Kilkenny Groundwater Protection Scheme.		
Pilltown (PWS07)	03/10/2000	09:45:00	< 0.0001	< 0.0001	0.004	< 0.1		Samples as part of Kilkenny Groundwater Protection Scheme.		
Tullahought (GWS16)	03/10/2000	10:30:00	< 0.0001	< 0.0001	0.002	< 0.1		Samples as part of Kilkenny Groundwater Protection Scheme.		
Hugginstown (GWS10)	03/10/2000	11:30:00	< 0.0001	< 0.0001	0.002	< 0.1		Samples as part of Kilkenny Groundwater Protection Scheme.		
Ahenure (PWS09)	03/10/2000	14:15:00	< 0.0001	< 0.0001	0.024	< 0.1		Samples as part of Kilkenny Groundwater Protection Scheme.		

**EPA Regional Water Laboratory, Kilkenny. Monitoring Data for County Kilkenny Groundwaters 1993 to 1999.**

Source	Sampling Date	Sampling Time	To	Ref No	Sampling Location	Taken By	Lab No	EPAREf	Stn Grid Ref	Water Supply	Public/Group/Private	Temperature	Odour 1/2/3	Colour Hazen	pH	Conductivity µS/cm	Turbidity NTU	TOC mg/l C	Ammonia mg/l N
Callan (PWS06)	03/10/2000	15:00:00	Kilkenny Co. Co./G.S.I.			Ruth Buckley	5226								7.3	705			0.004
Windgap (GWS17)	03/10/2000	12:45:00	Kilkenny Co. Co./G.S.I.			Ruth Buckley	5227								6.7	267			0.007
Highrath (GWS11)	04/10/2000	12:00:00	Kilkenny Co. Co./G.S.I.		Highrath (GWS11)	M. Daly	5260						1	5	7.1	999			0.024
Maddoxtown (GWS12)	04/10/2000	12:30:00	Kilkenny Co. Co./G.S.I.		Maddoxtown (GWS12)	M. Daly	5261						1	5	7.2	931			0.022
Glenmore Spring (PWS02-1)	04/10/2000	11:10:00	Kilkenny Co. Co./G.S.I.		Glenmore Spring (PWS02-1)	Ruth Buckley	5266							5	6.4	259			0.018
Glenmore Spring (PWS02-2)	04/10/2000	13:25:00	Kilkenny Co. Co./G.S.I.		Glenmore Spring (PWS02-2)	Ruth Buckley	5267												
Cuffesgrange No. 1 (GWS13)	02/10/2000	11:00:00	Kilkenny Co. Co./G.S.I.		Cuffesgrange No. 1 (GWS13)	M. Daly	5094						1	5	7.3	772			0.011
Ballymack (GWS02)	02/10/2000	11:20:00	Kilkenny Co. Co./G.S.I.		Ballymack (GWS02)	M. Daly	5095						1	5	7.2	800			0.004
Newtown Kells (GWS04)	02/10/2000	11:45:00	Kilkenny Co. Co./G.S.I.		Newtown Kells (GWS04)	M. Daly	5096						1	5	7.3	789			0.007
Caherlesk Goolaghmore	02/10/2000	12:20:00	Kilkenny Co. Co./G.S.I.		Caherlesk Goolaghmore	M. Daly	5097						1	5	6.8	459			0.008
Paulstown (PWS7)	04/10/2000	10:30:00	Kilkenny Co. Co./G.S.I.		Paulstown (PWS7)	V. Fitzsimons	5262						1	5	7.3	676			0.016
Tullaroan (PWS5)	04/10/2000	11:30:00	Kilkenny Co. Co./G.S.I.		Tullaroan (PWS5)	V. Fitzsimons	5263						1	5	7.5	616			0.004
Urlingford (PWS5-S)	04/10/2000	12:30:00	Kilkenny Co. Co./G.S.I.		Urlingford (PWS5-S)	V. Fitzsimons	5264						1	5	7.2	803			0.007
Urlingford (PWS5-R)	04/10/2000	12:40:00	Kilkenny Co. Co./G.S.I.		Urlingford (PWS5-R)	V. Fitzsimons	5265							10	7.3	825			0.094
Thomastown BH1 (PWS01-1)	02/10/2000	10:30:00	Kilkenny Co. Co./G.S.I.		Thomastown BH1 (PWS01-1)	Ruth Buckley	5114							5	7	466			0.003
Thomastown BH2 (PWS01-2)	02/10/2000	10:50:00	Kilkenny Co. Co./G.S.I.		Thomastown BH2 (PWS01-2)	Ruth Buckley	5115							5	7.3	748			< 0.003
Bennettsbridge BH (PWS04-B)	02/10/2000	12:10:00	Kilkenny Co. Co./G.S.I.		Bennettsbridge BH (PWS04-B)	Ruth Buckley	5116							5	7.3	721			< 0.003
Bennettsbridge River (PWS04-R)	02/10/2000	12:15:00	Kilkenny Co. Co./G.S.I.		Bennettsbridge River (PWS04-R)	Ruth Buckley	5117							175	8	447			0.022
Bennettsbridge Gravel (PWS04-G)	02/10/2000	12:25:00	Kilkenny Co. Co./G.S.I.		Bennettsbridge Gravel (PWS04-G)	Ruth Buckley	5118							20	7.5	563			0.006
Bennettsbridge Mixed (PWS04-M)	02/10/2000	12:50:00	Kilkenny Co. Co./G.S.I.		Bennettsbridge Mixed (PWS04-M)	Ruth Buckley	5119						1	5	7.4	681			< 0.003
Kilree Stoneyford (GWS08)	02/10/2000	15:00:00	Kilkenny Co. Co./G.S.I.		Kilree Stoneyford (GWS08)	Ruth Buckley	5120						1	5	7.1	866			< 0.003
Spring at Clomantagh	12/02/2001	11:00:00	Kilkenny Co. Co.	KK00900	Beside Nuenna river, 50m SE of roac		633		23520 16320		Private	9.7			7.2	615	1.4		0.007

EPA Regional Water Laboratory, Kilkenny. Monitoring Data for County Kilkenny Groundwaters 1993 to 1999.

Source	Sampling Date	Sampling Time	o-Phosphate mg/l P	Nitrate mg/l N	Nitrite mg/l N	Chloride mg/l Cl	Ca Hardness mg/l CaCO <sub>3</sub>	Alkalinity mg/l CaCO <sub>3</sub>	TCS	Total Coliforms per 100 ml	FCS	Fecal Coliforms per 100 ml	Sulphate mg/l SO <sub>4</sub>	Dry Residue mg/l	Sus_Solids mg/l	Magnesium mg/l Mg	Total Hardness mg/l CaCO <sub>3</sub>	Sodium mg/l Na	Potassium mg/l K	Aluminium mg/l Al	Iron mg/l Fe	Manganese mg/l Mn	Copper mg/l Cu	Zinc mg/l Zn	Chromium mg/l Cr	Lead mg/l Pb
Callan (PWS06)	03/10/2000	15:00:00	0.006	4.1	< 0.001	19	334	336		24		10	11.6			25.1	437	10.1	0.9	< 0.05	< 0.05	0.0014	< 0.001	0.046	0.004	< 0.001
Windgap (GWS17)	03/10/2000	12:45:00	0.062	9.6	< 0.001	15	99.7	64		1		999	6.8			2.8	75.5	7.8	< 0.3	< 0.05	< 0.05	< 0.001	< 0.001	0.039	0.003	< 0.001
Highrath (GWS11)	04/10/2000	12:00:00	0.023	5.3	0.003	49	443	436	>	80	>	60	13.5			30	566	11	5.6	< 0.05	< 0.05	0.003	0.004	0.027	0.024	< 0.001
Maddoxtown (GWS12)	04/10/2000	12:30:00	0.015	11.7	< 0.001	25	383	404		17		4	18.6			29.1	502	11.1	3.3	< 0.05	< 0.05	< 0.001	< 0.001	0.003	0.021	< 0.001
Glenmore Spring (PWS02-1)	04/10/2000	11:10:00	< 0.006	9.6	0.001	22	44	38		45		1	12.8			11.5	91.3	10.9	3.8	< 0.05	< 0.05	< 0.001	< 0.001	0.02	0.003	< 0.001
Glenmore Spring (PWS02-2)	04/10/2000	13:25:00								36		1														
Cuffesgrange No. 1 (GWS13)	02/10/2000	11:00:00	0.02	4.2	0.009	19	362	362	>	80		29	13.1			25	464	11.2	3.6	< 0.05	< 0.05	< 0.001	0.005	0.037	0.005	< 0.001
Ballymack (GWS02)	02/10/2000	11:20:00	< 0.006	6.4	< 0.001	23	345	365		52		7	13.9			36.2	494	11.7	1.5	< 0.05	< 0.05	< 0.001	< 0.001	0.035	0.005	< 0.001
Newtown Kells (GWS04)	02/10/2000	11:45:00	0.006	5.6	< 0.001	26	359	367	>	80		7	13			29.2	479	12.5	1.5	< 0.05	< 0.05	< 0.001	0.004	0.049	0.003	< 0.001
Caherlesk Goolaghmore	02/10/2000	12:20:00	0.008	5.3	< 0.001	19	197	178		51		8	10			15.5	260	9.2	2.3	< 0.05	< 0.05	< 0.001	0.003	0.046	0.004	< 0.001
Paulstown (PWS7)	04/10/2000	10:30:00	0.008	5.7	0.008	22	330	286	>	80	>	60	12.8			11.5	377	10.9	3.8	< 0.05	< 0.05	< 0.001	< 0.001	0.014	0.016	< 0.001
Tullaroan (PWS5)	04/10/2000	11:30:00	< 0.006	2.9	< 0.001	14	301	284		999		999	7.4			10	342	8.2	1.4	< 0.05	< 0.05	< 0.001	< 0.001	< 0.001	0.015	< 0.001
Urlingford (PWS5-S)	04/10/2000	12:30:00	0.006	8	0.002	18	377	369	>	80	>	60	10.7			18.5	453	8	5.9	< 0.05	< 0.05	< 0.001	< 0.001	< 0.001	0.012	< 0.001
Urlingford (PWS5-R)	04/10/2000	12:40:00	0.039	7.2	0.056	19	375	375		1080		370	15.9			13.5	430	10.8	1.1	< 0.05	< 0.05	< 0.001	< 0.001	0.013	0.021	< 0.001
Thomastown BH1 (PWS01-1)	02/10/2000	10:30:00	0.012	4.9	< 0.001	18	186	105		8		999	10.4			15.5	249	11	1.3	< 0.05	< 0.05	< 0.001	0.005	0.05	0.004	< 0.001
Thomastown BH2 (PWS01-2)	02/10/2000	10:50:00	0.037	6.2	< 0.001	30	325	320		6		1	16			22.5	417	17.6	3.3	< 0.05	< 0.05	0.001	0.013	0.046	0.006	< 0.001
Bennettsbridge BH (PWS04-B)	02/10/2000	12:10:00	< 0.006	4.3	0.002	24	320	317		17		999	28.5			25.4	424	16.1	2.3	< 0.05	< 0.05	0.004	< 0.001	0.034	0.002	< 0.001
Bennettsbridge River (PWS04-R)	02/10/2000	12:15:00	0.083	2.1	0.014	16	223	185		42000		5600	15.8			7.8	255	10.3	4.4	0.119	0.279	0.02	0.003	0.037	0.004	< 0.001
Bennettsbridge Gravel (PWS04-G)	02/10/2000	12:25:00	0.05	1.1	0.051	22	260	253	>=	76		4	21.2			10.1	301	18.3	3.8	< 0.05	< 0.05	0.066	0.037	0.042	0.005	< 0.001
Bennettsbridge Mixed (PWS04-M)	02/10/2000	12:50:00	0.02	4.5	0.009	23	311	291		104		5	23			19.2	390	16.7	3.3	< 0.05	< 0.05	0.025	0.002	0.046	0.006	< 0.001
Kilree Stoneyford (GWS08)	02/10/2000	15:00:00	0.131	15.4	< 0.001	19	397	370	>	80		60	11.3			29.9	520	11.4	3	< 0.05	< 0.05	< 0.001	0.008	0.039	0.002	< 0.001
Spring at Clomantagh	12/02/2001	11:00:00	0.015	4.1	0.002	14	305	270		15		12	34.9			6.5	331	5.5	1.3		< 0.01	< 0.02		0.031		

**Appendix VI: Summary of trends in  
water quality over time for selected  
supply sources in Kilkenny**

**Figure 9.2- Callan Spring**  
**Key indicators of Agricultural and Domestic Groundwater Contamination.**

