SLANE WATER SUPPLY

GROUNDWATER SOURCE PROTECTION ZONES

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SLANE WATER SUPPLY

1. WELL LOCATION AND SITE DESCRIPTION

This source is the main public supply well for Slane village and its surrounding hinterland. It is located 300 m due south of the village, on the southwestern bank of the River Boyne. The two Production Wells PW No.1 (drilled in November-December 1987) and PW No.2 (drilled around 1988) are approximately 90 m from the river bank and both are completed over 1 metre below ground level, each with a manhole covering the well. During flood conditions both pumping wells are submerged by flood water which will undoubtedly be of a poorer water quality. This flood water can seep into the pumping wells, mix with the groundwater and reduce the water quality from these wells. The well heads should be sealed and locked. The pumping wells are located in the field approximately 140 metres from the pumphouse and are not fenced off. There is no backup supply for these production wells. The Slane groundwater is chlorinated in the pumphouse before being pumped to the Slane Hill, Stanley Hill and Windmill Road reservoirs. These reservoirs have capacities of 100,000, 30,000 and 20,000 gallons respectively. There are no private wells being used in the vicinity of this source.

2. WELL DETAILS

2.1 PRODUCTION WELL NO.1

GSI no.:	2927SW012
Grid ref:	29606 27381
Owner:	Meath County Council
Well type:	Borehole
Elevation (top of casing):	16.09 m OD (Poolbeg). Ground level is 17.25 m OD.
Depth:	38 m
Depth of casing:	25m (250mm), 37.5m (200 mm, screened from 27.5 to 37.5 metres)
Diameter:	250 mm (10"), 200 mm (8")
Depth-to-rock:	16 m
Static water level:	0.0 m b.g.l. (1-12-87), 1.6 m b.g.l. (7-6-95)
Pumping water level:	23.68 m b.g.l. (after 72 hrs pumping) 14.12 m b.g.l. (after 12 hrs pumping)
Drawdown:	23.68 m (after 72 hrs pumping), 12.52 m (after 12 hrs continuous pumping)
Pumping rate:	2088 m^3/d (19,000 gal/hr), 780 m^3/d (7,150 gal/hr)
Normal consumption:	2600 m^3/d (570,000 gal/d on average, over 24 hrs)

Pumping test summary:

(i) abstraction rate:	780 m^3/d
(ii) specific capacity:	65 m^3/d/m (12 hours); 60 m^3/d/m (extrapolated to 1 week)
(iii) transmissivity:	70 – 130 m^2/d60 m^3/d/m

2.2

2.3 PRODUCTION WELL NO.2

GSI no.:	2927SW013
Grid ref.:	29608 27379
Owner:	Meath County Council
Well type:	Borehole
Elevation (top of casing):	16.02 m OD (Poolbeg). Ground level is 17.2 4m OD.
Depth:	approximately 24 m
Depth of casing:	?m
Diameter:	200 mm (8")

Depth-to-rock:	19.5 m
Static water level:	1.52 m b.g.l. (7-6-95)
Pumping water level:	13.7 m b.g.l. (after 12 hrs continuous pumping)
Drawdown:	12.18 m (after 12 hrs continuous pumping)
Pumping rate:	1640 m^3/d (15,000 gal/hr)
Normal consumption:	2600 m^3/d (570,000gal/d on average, over 24 hrs)

Pumping test summary:

(i) abstraction rate:	1640 m^3/d
(ii) specific capacity:	135 m^3/d/m (12 hours); 130 m^3/d/m (extrapolated to 1 week)
(iii) transmissivity:	150 – 200 m^2/d

3. METHODOLOGY

There were three stages involved in assessing the area: (a) detailed desk study, (b) site visits and fieldwork, and (c) analysis of the data. The desk study compiled the geology from all available data sources. Basic public supply well details were obtained from County Council personnel, including precise locations and any relevant borehole, chemistry and pumping test data available.

The second stage comprised site visits and fieldwork in the surrounding area. A twelve hour pumping test with a recovery test was carried out to examine the aquifer characteristics. Subsequently, the area around the sources was surveyed with regard to geology, hydrogeology, vulnerability to pollution and current pollution loading. Raw water samples were taken in March, June, September 1995 and January 1996 for full suites of chemical and bacterial analyses. Conductivity measurements were taken at regular intervals from early 1995 to mid-1996.

The assessment stage used analytical equations and hydrogeological mapping to delineate protection zones.

4. TOPOGRAPHY, DRAINAGE AND LAND USE

The source is located in the valley of the River Boyne, between two elevated areas which rise to over 120 m OD (400 ft) to the north and to around 60 m OD (200 ft) to the south.

The River Boyne meanders in an easterly direction, with numerous small streams draining the area and drainage is good with a general absence of small drainage ditches.

Excluding the village and its immediate surrounds, the land use in the area is primarily tillage and pasture. The field around the well is permanently in grassland.

5. GEOLOGY

5.1 Bedrock geology

The geology in the immediate vicinity of the pumping wells, as indicated by borehole logs, comprises up to 19.3 m of river gravels with sand, silt and clays, overlying grey calcarenite limestone (Calp Limestone). The limestone bedrock is extensively fissured and highly broken, particularly in the vicinity of the River Boyne. The logs indicated large inflows of water, particularly around 35 to 37 metres b.g.l. The uppermost 3 metres of bedrock was reported to be highly broken and weathered.

The Calp Limestones found around Slane tend to be much cleaner in nature than the typical Calp Limestones and they are also interpreted to be highly folded and faulted and as a result, they have a tendency to give higher than usual groundwater yields.

Slane village lies close to the boundary between the Lower Carboniferous limestones and the Lower Palaeozoic (Ordovician) rocks of the Longford-Down Massif. The Ordovician rocks consist of

basaltic lavas, tuffs, turbiditic sandstones, siltstones and shales. Thick Devonian lava flows occur around Slane Castle, each flow having a weathered top, and they are highly faulted.

To the south of Slane Castle and underlying the Calp Limestones are Argillaceous Bioclastic Limestones (ABL), which are dark grey bioclastic shaly limestones.

The River Boyne lies within a deep narrow valley bounded by rock outcrop to the north and south. The valley is 150 metres wide at Slane. The bedrock geology is shown in Figure 1.

5.2 Quaternary (subsoils) geology

Five types of Quaternary deposits are present in the vicinity of the Slane source (Figure 2).

Along the river, around the wells, is a narrow strip of alluvium varying in width from 60 m to 200 m across. The alluvium is generally sandy in texture and is usually 2 m to 3 m deep, generally thinning away from the river. Some gravel lenses are present within the alluvium.

Flanking the alluvium to the south and to the northwest is an area of fluvioglacial gravels, generally less than 10 m deep, and overlying till derived from Lower Palaeozoic rocks. The gravels are well sorted and well bedded, and were deposited as part of an outwash system which floored the valley during deglaciation. The gravels are pebble to cobble grade, with a sand matrix. Sand lenses and interbeds are common. Most of the gravel clasts are of Carboniferous limestone.

To the south and east is an extensive area of limestone dominated till which is gravelly to stony or sandy in texture, with fairly high proportions of clay present.

West of the River Boyne and flanking the alluvial deposits is an area of till derived from basic igneous rocks and which is clayey in texture.

To the north and immediately to the south of the River Boyne and flanking the alluvial deposits is an extensive area of Lower Palaeozoic dominated till which is clayey in texture.

5.3 Soils

The soils information is taken from the published soils map of Co. Meath (Finch *et al*, 1983).

The soils along the Boyne are primarily derived from a parent material of freshwater alluvium, laid down by the River. The soils are very immature with poor profile development. The Great Soil Group is the Boyne Alluvium Complex. The lithological composition of this alluvium is mainly limestones and shale. Further to the north and to the south of the River Boyne the soils are Grey Brown Podzolic, in which the Great Soil Group is the Dunboyne Gravelly Phase. The parent material of these soils are chiefly gravels intermixed with local limestones and shales. Because of the gravelly parent material the soil is well to excessively drained and is generally up to 80 cm thick.

5.4 Depth-to-rock

Rock outcrops throughout the area indicating that there is only a thin subsoil cover over much of the Slane area, but along the River Boyne from Slane Castle to beyond Slane Bridge there is a narrow deep infilled valley of sand and gravels. Depths to rock in the public supply boreholes are 16 m and 19.3 m and in the Trial Well adjacent to the pumphouse it is only 7.6 m. Site investigation boreholes drilled for a new bridge at Slane in 1987 indicated some 16 metres of fine sand and gravel just to the east of the present bridge, confirming that the sand and gravel aquifer extends along the River Boyne at Slane. The exact extent of this infilled valley is not known although the Council's pumping wells seem to be located close to the centre of the valley.

To the south the subsoils are on average much thicker (generally around 5 metres) than to the west and north. The depth to rock contours are based on limited data points and may need refining as further depth to bedrock records become available (see Figure 3.).

6. HYDROGEOLOGY

6.1 Data availability

Hydrogeological data for the Slane pumping wells are reasonably good, although lacking in the area of interest around the public supply. A 12 hour pumping test with a recovery test was carried out in June 1995 and a survey of pollution sources and wells was conducted to the south of the source (Figure 4). This survey indicated the lack of private wells in the area and thus water levels could not be obtained to construct a water table map to determine the exact groundwater flow direction.

In 1983 a resistivity survey consisting of six electrical soundings was conducted to determine the depths of the alluvial deposits along the River Boyne in the vicinity of the infiltration gallery, located 300 metres to the west of Slane Bridge. The survey indicated that the area was underlain by between 12 and 16 metres of saturated silty sands and gravels overlying limestone bedrock. Two trial wells were drilled in August 1983 to test the groundwater potential of the alluvial deposits at the infiltration gallery and at the pumphouse. Trial Well No.1 was located at the pumphouse and was completed at 150 mm with a well screen from 5.5 metres to the bottom of the well at 7.6 metres. The well was originally drilled to 10.6 metres, 3 metres into bedrock which was backfilled. Trial Well No.2 was drilled beside the gallery at 150mm to a depth of 19.5 metres with a 1 mm screen from 7.5 metres to the bottom of the well.

Production Well No.1 was drilled and tested in November-December 1987. The well was completed in the limestone bedrock with a well screen from 27.5 to 37.5 metres. Short reports on the investigations, drilling and testing of these wells were prepared by K.T. Cullen.

Production Well No.2 was drilled around 1988 and no drilling log or pumping test data are available.

6.2 Groundwater levels

Groundwater is generally close to the surface especially along the River Boyne. The static water level in the wells on 7/6/95, following overnight recovery and the pumping water levels after 12 hours pumping, are shown below.

Date	Well Number	Static Water Level metres (b.g.l)	Metres OD	Pumping Water Level metres (b.g.l)	Metres OD
7-6-95	PW No.1	1.60	15.65	14.11	3.14
7-6-95	PW No.2	1.52	15.72	12.18	5.06
7-6-95	TW No.1	2.07	15.58	2.13	15.52
7-6-95	TW No.2	1.28	15.97	2.56	14.69

The unsaturated zone therefore is generally thin, ranging from 0 - 3 m thick.

6.3 Groundwater flow directions and gradients

Regional groundwater flow is generally towards the River Boyne and eastwards, but locally it is dependent on topography and moves in all directions to the meandering River Boyne. It is inferred that the river is in hydraulic continuity with the water table, at least in the vicinity of the wells. The exact flow direction is difficult to assess due to the flat lying ground near the well.

Groundwater gradients in the general area may range from approximately 0.01 to 0.04. The steeper gradients occur from the valley sides, while along the river the gradients are quite shallow.

6.4 Meteorology and Recharge

Rainfall data for the area are taken from the nearest rainfall station in Slane, 0.5 km north. Mean annual rainfall as recorded by Met Eireann for 1951-1980 was 852 mm. Potential evapotranspiration

(P.E.) is estimated from a Met Eireann contoured map as 510 mm/yr. Actual evapotranspiration (A.E.) has been estimated at 485 mm by calculating a percentage (95%) of the interpolated P.E., to allow for seasonal soil moisture deficits.

Using the above figures the effective rainfall (E.R.) is taken to be approximately 367 mm/yr. As there are no drainage ditches or streams in the immediate area of the supply and the Quaternary deposits are free draining and generally thin, a high proportion of the effective rainfall infiltrates to the water table. Estimating run off to be of the order of 10%, the actual annual recharge to the aquifer is estimated to be 330mm per annum.

These calculations are summarised below:

Average annual rainfall	852 mm
Estimated P.E.	510 mm
Estimated A.E. (95% P.E.)	485 mm
Effective rainfall	367 mm
Recharge (90% E.R.)	330 mm

6.5 Hydrochemistry and Water Quality

The chemical analyses of groundwater at the Slane source (combined sample from PW No.1 & PW No.2) indicates a hard water (275-300 mg/l $CaCO_3$), with a high alkalinity (270-290 mg/l $CaCO_3$). Conductivities are also high ranging from 500-675 μS/cm. This groundwater can be classed as a calcium bicarbonate water. The groundwater analyses are in the Appendices.

The water quality at Slane is excellent with no bacterial contamination and all the major cations, anions and trace elements are within the Irish Drinking Water Standards. Calcium and sulphate levels are above the guide values. Levels of nitrates range between 11-16mg/l which are higher than the background levels for County Meath.

Historical Data

Raw water samples from the trial wells and the river were analysed in October 1983. The results indicated that the groundwater from the wells was of excellent quality except for the iron level in TW No.2 which was associated with the high turbidity recorded in the same sample, resulting from the underdevelopment of the well. The analyses from both wells indicated groundwaters with slightly different chemistry as indicated by the different levels of chloride and sulphate. The chloride and nitrate levels in TW No.2 were slightly elevated.

The groundwater from TW No.1 was similar to the River Boyne (chloride, sulphate, conductivity and nitrate values). This may indicate a hydraulic connection from TW No.1 to the Boyne River (adjacent to an inlet of the river).

A raw water sample from PW No.1 analysed in December 1987 indicated that the groundwater was of excellent quality with low iron and manganese levels. Chloride and nitrate were some what elevated at 30 and 10 mg/l respectively.

There has been no significant change in the hydrochemistry. Further comparative analyses of the river water are required to establish the degree of connection between the river and the supply well.

Table 1. Conductivity readings from the Slane Source

Date	Production Well		River	
	Conductivity (µS/cm)	Temperature (^{O}C)	Conductivity (µS/cm)	Temperature (^{O}C)
*14-3-95	882	13.4		
+21-3-95	504	11.7		
21-4-95	518	13.1		
22-5-95	540	14.5		
*7-6-95	630 - 660 (=510)	12.5 - 15.9		
+12-6-95	549	15.7		
26-6-95	549	12.5		
11-8-95	498	12.5	415	10.4
+26-9-95	509	13.4		
15-12-95	589	12.1	574	5.8
1-2-96	593	13.4	590	4.5
+8-1-96	595	11.4		
20-2-96	594	11.8	443	4.1
1-4-96	598	13.1	576	7.1
4-5-96	596	13.3	520	14.6

* Reading taken using a different conductivity meter + Full analyses

6.6 Aquifer coefficients

Analyses of the 12 hour pumping test provided an apparent transmissivity ranging from 70-200 m^2/d. The results are complicated by having two pumping wells in close proximity.

The specific capacity calculated was around 65 to 135 m^3/d/m after 12 hours pumping. After an initial drawdown in the pumping wells of between 11 and 12 metres during the first 30 minutes, drawdown was less than one metre over the remainder of the test period. This suggests that the yields of the wells could be increased. However, more comprehensive pumping tests would be needed to confirm the sustainable maximum yields of these wells.

After about half an hour the drawdown graphs from the pumping wells seem to indicate a recharge boundary, which can be explained as the cone of influence meets the River Boyne, water is drawn in from the river and the pumping water level in the wells is maintained at a near constant level.

The specific yield of 0.002 was calculated from the early data from the Trial Well No.2 and indicates that the aquifer is unconfined. The later data indicate a higher value, which would be too high for a bedrock aquifer and may be a composite value which probably relates to the influence of the river.

Analysis of the original (1987) 72 hour test on PW No.1 with a final pumping rate of 2080 m^3/d and a drawdown of 23.68 m indicated an apparent transmissivity of around 185m^2/d. The specific capacity calculated was 90 m^3/d/m. These figures are similar to those obtained from the 1995 12 hour test.

The pumping test data are in the Appendices.

6.7 Conceptual Model

The aquifer feeding the Slane source is the Calp Limestone. This is overlain by up to 19.5 metres of interbedded silts, sands and gravels that are highly permeable, therefore the aquifer is considered to be unconfined. Permeabilities within the bedrock are increased by joints and fractures. During drilling of Production Well No.1 major inflows of groundwater were recorded in fissured limestone between 27 and 38 metres below ground level (-9.75 and -20.75 m O.D) with a cavernous fissure from 35 to 37 metres.

Groundwater flow is influenced by topography and flows from the higher ground down to the Boyne Valley and discharges into the river. A groundwater divide can be deduced along the top of the ridges. Groundwater flow to the public supply is therefore assumed to be from the south-southeast.

In PW No.1, the top 16 metres of sands, gravels and tills overlie a layer of broken brown sandstone and weathered rock to a depth of 22 metres was lined with 250mm steel casing to a depth of 25 metres. 200mm steel casing was installed throughout the entire depth of the well (38 metres, -20.75 m O.D.) and screened from 27.5 to 37.5 metres. The main inflow into the well is from the screened fissured limestone. Direct inflows from the subsoils are prevented by the presence of the steel casing.

The pumping test results indicate that the groundwater is hydraulically connected to the river and a percentage of the well discharge is taken from the river. Further investigations are required to determine this percentage.

6.8 Aquifer category

The aquifer supplying the Slane source is the Calp Limestone and the overlying alluvial sand and gravel deposits, which seem to be receiving additional recharge from the river. In this area the aquifer is classed as a **locally important aquifer which is generally moderately productive (Lm).**

7. GROUNDWATER VULNERABILITY

The catchment area for the Slane source is generally highly to moderately vulnerable to pollution, but with some significant areas of 'extreme' vulnerability , mainly around the margins of the ZOC. The subsoils around the pumping wells are highly permeable. Since it is probable that a significant proportion of flow to the well may be from the river, the river water quality is as important as the vulnerability of the groundwater to pollution.

Areas where rock is less than 3 m below surface, mapped as having 'extreme' vulnerability under the GSI vulnerability mapping guidelines, are widely distributed throughout the area, especially along the banks of the River Boyne. Some of the surrounding areas are classified as 'highly' vulnerable due to the high permeability of the subsoil or the shallow cover. The remaining areas are classified as 'moderately' vulnerable. The vulnerability zones are shown on Figure 5.

8. SOURCE PROTECTION AREAS

Source protection areas are delineated for the output (2420 m^3/d) that is currently abstracted, and allows for expansion of the zone of contribution during dry weather.

8.1 Inner Protection Area (SI)

The Inner Protection Area is the area defined by a 100 day time of travel to the source 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.

The 100 day time of travel is very difficult to calculate due to the complexity of the geology and the hydrogeology (highly permeable gravels, fractured limestone bedrock and recharge from the river in the vicinity of the source) and the lack of good data to determine the aquifer coefficients for the Slane source. Thus the Inner Protection Area is based on the extent of the gravels directly upgradient and is taken to be approximately 200 metres from the well (Figure 6).

8.2 Outer Protection Area (SO)

The Outer Protection Area includes the remainder of the catchment area to the source, i.e. the zone of contribution (ZOC), and it is delineated as the area required to support an abstraction from long-term recharge. The ZOC at Slane is derived from hydrogeological mapping techniques and is controlled primarily by the groundwater divides to the south, the groundwater flow direction and the River

Boyne. The ZOC is shown in Figure 6, and its size is based largely on the Recharge Equation. Taking the average annual recharge to be 330 mm, the area required to supply the pumping rate of 2420 m^3/d is calculated to be 2.7 km^2. The null point or the downgradient boundary of the ZOC (the distance downgradient after which water is not contributing to the well) extends to the River Boyne. A buffer (safety margin) is NOT included in the final zone of contribution as it is not possible to incorporate a 20^O error margin for the estimated groundwater flow direction, and the additional area required for recharge is not realistically available. In addition the wells are recharged by water from the River Boyne, thus the total surface recharge area of 2.7 km^2 is not required, and the area of the ZOC is probably conservative. It is estimated that approximately a third of the discharge from the production wells is recharged from the River Boyne and thus the ZOC has been reduced by a third to 1.8km^2.

9. GROUNDWATER SOURCE PROTECTION ZONES

Combining the Inner and Outer Source Protection Areas, as described above, with the vulnerability ratings produces five groundwater protection zones for the Slane source. These are listed here in order of decreasing degree of protection required and are shown in Figure 7:

- Inner Protection Area / High (SI/H)
- Inner Protection Area / Moderate (SI/M)
- Outer Protection Area / Extreme (SO/E)
- Outer Protection Area / High (SO/H)
- Outer Protection Area / Moderate (SO/M)

10. POTENTIAL POLLUTION SOURCES

The primary threat to the public supply at Slane is the quality of the water in the river upstream of the source. Surface water quality may be affected in particular by surface run off, septic tanks and the sewage discharge point into the River Boyne upstream of the well field and the seasonal flooding of the river may also account for the slightly elevated background levels of nitrates, the higher chloride values and the changes in the conductivity.

A small number of houses and farmyards are present in the general area of the well. Two farmyards are located approximately 700 metres and 1 km up-gradient of the wells. These farms store silage and have cattle feeding yards which would pose a significant risk to the well if the present farmyard management is not maintained.

All the houses on the northern side of the River Boyne are on mains sewerage, while to the south all the houses are served by septic tanks, which may pose a threat to the groundwater.

11. CONCLUSIONS AND RECOMMENDATIONS

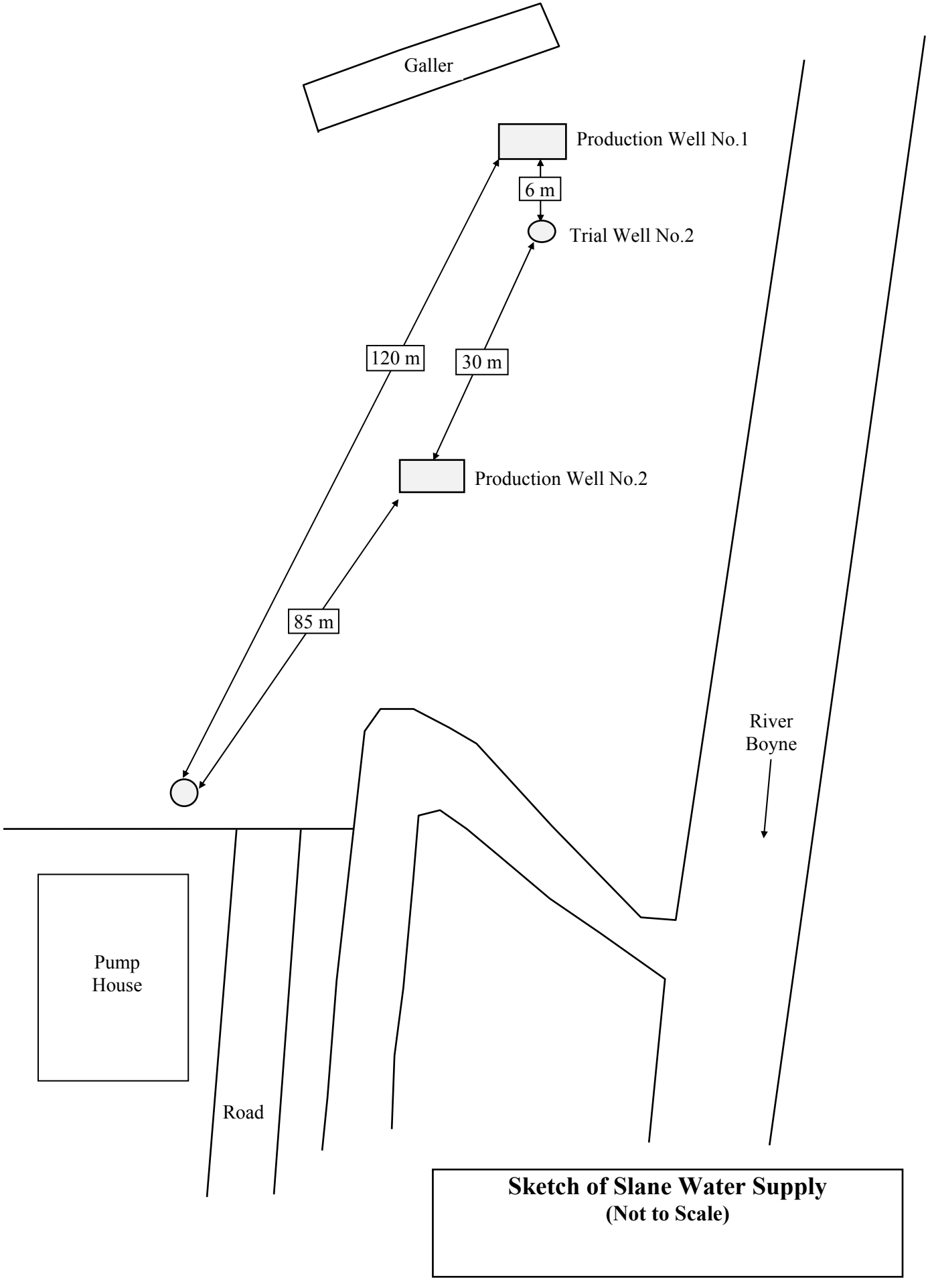
Overall the source at Slane has very high yielding wells which should be able to support an increased yield or the installation of another Production Well. The water analyses indicate that there were no water quality problems at this source, however the supply is highly vulnerable to pollution due to the thickness and permeability of the subsoils in the immediate vicinity of the supply. The groundwater quality is also dependent on the river water quality as they are hydraulically connected.

It is recommended that the Council monitor the raw water from the Slane public supply to monitor the nitrate, potassium, chloride and conductivity levels and to examine the effects of the potentially polluting activities near to the well. In addition it is recommended that the Council control and monitor potentially polluting activities being carried out within the delineated groundwater source protection zones. In particular, the Council should monitor the farmyards uphill from the well.

The well heads should be sealed from the influence of flood water and the wells fenced and secured from potential vandalism.

The outlet of the sewage treatment works should be moved to a suitable location down-gradient of the well field.

Further investigation work should be conducted to establish the amount of recharge from the River Boyne and refine the protection zones.



Sketch of Slane Water Supply
(Not to Scale)

Appendix 1
Pump Test Data

PUMPING TEST DATA SHEET

Location : CURRAGHA **Borehole name : PW No.1** **Date : 19-09-95**

Test : Recovery Data from PW No.1 while PW No.2 is pumping.

Duration : 9hrs. Weather : Fine

Distance from Pumping Well : 5m. Well depth : 40m.

Height of datum point above ground level : 0.03m Datum Point : Wooden plank across manhole.

Date	Time	Time since pumping ended (min.)	Water level below datum (metres)	Drawdown (metres)	Discharge m3/d	Temperature C	Conductivity uS/cm @20 C
19-09-95	21:00	0	31.9	0			
		0.5	31.85	0.05			
		1	31.3	0.6			
		1.5	30.8	1.1			
		2	30.6	1.3			
		2.5	30.5	1.4			
		3	30.41	1.49			
		3.5	30.39	1.51			
		4	30.29	1.61			
		4.5	30.27	1.63			
		5	30.13	1.77			
		6	30.05	1.85			
		12	29.2	2.7			
		14	29.05	2.85			
		16	28.93	2.97			
		18	28.85	3.05			
		20	28.72	3.18			
		22	28.61	3.29			
		24	28.48	3.42			
		26	28.39	3.51			
		28	28.33	3.57			
		30	28.24	3.66			
		35	28.02	3.88			
		40	27.89	4.01			
		45	27.78	4.12			
		50	27.65	4.25			
		55	27.54	4.36			
	22:00	60 (1hr)	27.46	4.44			
		75	27.17	4.73			
		90	27.08	4.82			
		105	26.74	5.16			
	23:00	120 (2hrs)	26.6	5.3			
		135	26.4	5.5			
		150	26.28	5.62			
		165	26.16	5.74			
	24:00	180 (3hrs)	26.04	5.86			
		200	25.88	6.02			
		220	25.72	6.18			
	01:00	240 (4hrs)	25.57	6.33			
	02:00	300 (5hrs)	25.2	6.7			
	03:00	360 (6hrs)	24.87	7.03			
		525	24.17	7.73			
	06:00	540 (9hrs)	24.12	7.78			

PUMPING TEST DATA SHEET

Location : CURRAGHA **Borehole name : PW No.1** **Date : 20-09-95**

Test : Drawdown Data from PW No.1 while PW No.2 is pumping.

Duration : 12hrs. Weather : Fine

Distance from Pumping Well : 5m. Well depth : 40m.

Height of datum point above ground level : 0.03m Datum Point : Wooden plank across manhole.

Date	Time	Time since pumping began (min.)	Water level below datum (metres)	Drawdown (metres)	Discharge m3/d	Temperature C	Conductivity uS/cm @20 C
20-09-95	06:00	0	24.12	0			
		0.5	24.48	0.36			
		1	24.71	0.59			
		1.5	24.95	0.83			
		2	25.17	1.05			
		2.5	25.38	1.26			
		3	25.54	1.42			
		3.5	25.7	1.58			
		4	25.84	1.72			
		4.5	25.92	1.8			
		5	26.04	1.92			
		6	26.26	2.14			
		7	26.5	2.38			
		8	26.65	2.53			
		9	26.84	2.72			
		10	26.94	2.82			
		12	27.25	3.13			
		14	27.32	3.2			
		16	27.47	3.35			
		18	27.53	3.41			
		20	27.74	3.62			
		22	27.83	3.71			
		24	27.95	3.83			
		26	28.05	3.93			
		28	28.1	3.98			
		30	28.15	4.03			
		35	28.28	4.16			
		40	28.47	4.35			
		45	28.58	4.46			
		50	28.61	4.49			
		55	28.77	4.65			
	07:00	60 (1hr)	28.9	4.78			
		75	29.15	5.03			
		90	29.38	5.26			
		105	29.6	5.48			
	08:00	120 (2hrs)	29.74	5.62			
		135	29.86	5.74			
		150	29.99	5.87			
		165	30.1	5.98			
	09:00	180 (3hrs)	30.19	6.07			
		200	30.34	6.22			
		220	30.44	6.32			
	10:00	240 (4hrs)	30.53	6.41			
		20	30.67	6.55			
	11:00	300 (5hrs)	30.82	6.7			
		330	30.88	6.76			
	12:00	360 (6hrs)	30.96	6.84			
		390	31.05	6.93			
	13:00	420 (7hrs)	31.14	7.02			
		450	31.21	7.09			
	14:00	480 (8hrs)	31.26	7.14			
		510	31.32	7.2			
	15:00	540 (9hrs)	31.38	7.26			
		570	31.42	7.3			
	16:00	600 (10hrs)	31.47	7.35			
		630	31.52	7.4			
	17:00	660 (11hrs)	31.55	7.43			
		690	31.6	7.48			
	18:00	720 (12hrs)	31.62	7.5			

PUMPING TEST DATA SHEET

Location : CURRAGHA **Borehole name : GSI OW No.1** **Date : 19-09-95**

Test : Recovery Data from GSI OW No.1

Duration : 9hrs. Weather : Fine

Distance from Pumping Well : 36.3m. Well depth : 53m.

Height of datum point above ground level : 0.15m Datum Point : Top of casing.

Date	Time	Time since pumping ended (min.)	Water level below datum (metres)	Drawdown (metres)	Discharge m3/d	Temperature C	Conductivity uS/cm @20 C
19-09-95	21:00	0	28.25	4.03			
		0.5	28.21	3.99			
		1	28.18	3.96			
		1.5	28.15	3.93			
		2	28.13	3.91			
		2.5	28.11	3.89			
		3	28.08	3.86			
		3.5	28.07	3.85			
		4	28.05	3.83			
		4.5	28.03	3.81			
		5	28.02	3.8			
		6	27.98	3.76			
		7	27.96	3.74			
		8	27.93	3.71			
		9	27.91	3.69			
		10	27.89	3.67			
		12	27.84	3.62			
		14	27.8	3.58			
		16	27.76	3.54			
		18	27.76	3.54			
		20	27.68	3.46			
		22	27.67	3.45			
		24	27.59	3.37			
		26	27.56	3.34			
		28	27.52	3.3			
		30	27.49	3.27			
		35	27.41	3.19			
		40	27.32	3.1			
		45	27.26	3.04			
		50	27.18	2.96			
		55	27.12	2.9			
	22:00	60	27.06	2.84			
		75	26.94	2.72			
		90	26.7	2.48			
		105	26.56	2.34			
	23:00	120	26.43	2.21			
		135	26.29	2.07			
		150	26.18	1.96			
		165	26.08	1.86			
	24:00	180	25.96	1.74			
		200	25.82	1.6			
		220	25.69	1.47			
20/09/95	01:00	240	25.56	1.34			
	02:00	300	25.22	1			
	03:00	360	24.93	0.71			
		525	24.28	0.06			
	06:00	540	24.22	0			

PUMPING TEST DATA SHEET

Location : CURRAGHA **Borehole name : PW No.1 (now abandoned)**

Test : Drawdown Data from PW No.1** Weather : Fair **Date: 07/08/84**

Duration : 72hrs Well depth : 41m

Date	Time	Time since pumping began (min.)	Water level below datum (metres)	Drawdown (metres)	Discharge m3/d	Conductivity uS/cm @20 C
07-08-84	15:30	0	1.38	0	2090	
		0.5	4.27	2.89		
		1	5.18	3.8		
		1.5	5.68	4.3		
		2	5.92	4.54		
		2.5	6.16	4.78		
		3	6.33	4.95		
		3.5	6.55	5.17		
		4	6.69	5.31		
		4.5	6.78	5.4		
		5	6.92	5.54		
		6	7.12	5.74		
		7	7.29	5.91		
		8	7.39	6.01		
		9	7.51	6.13		
		10	7.63	6.25	2090	
		12	9.11	7.73	2618	
		14	9.52	8.14		
		16	9.7	8.32		
		18	9.86	8.48		
		20	10	8.62		
		22	10.21	8.83		
		24	10.44	9.06		
		26	10.6	9.22		
		28	10.73	9.35		
		30	10.84	9.46		
		35	11.11	9.73		
		40	11.32	9.94		
		45	11.5	10.12		
		50	11.66	10.28		
		55	11.82	10.44		
	16:30	60 (1hr)	11.91	10.53		
		75	12.28	10.9		
		90	12.53	11.15		
		105	12.65	11.27		
	17:30	120 (2hrs)	12.9	11.52		
		150	12.96	11.58		
	18:30	180 (3hrs)	13.39	12.01		
		210	13.65	12.27		
	19:30	240 (4hrs)	13.8	12.42		
	20:30	300 (5hrs)	14.1	12.72		
	21:30	360 (6hrs)	14.37	12.99		
	22:30	420 (7hrs)	14.78	13.4	2618	
	23:30	480 (8hrs)	15.09	13.71	2618	
08-08-84	00:30	540 (9hrs)	15.28	13.9		
	01:30	600 (10hrs)	15.4	14.02		
	03:30	720 (12hrs)	15.8	14.42		
	05:30	840 (14hrs)	16.16	14.78		
	07:30	960 (16hrs)	16.43	15.05		
	09:30	1080 (18hrs)	16.5	15.12		
	11:30	1200 (20hrs)	16.67	15.29		
	15:30	1440 (24hrs)	16.66	15.28		
	17:30	1560 (26hrs)	16.78	15.4		
	19:30	1680 (28hrs)	16.86	15.48		
	22:30	1860 (31hrs)	17.08	15.7		
	23:30	1920 (32hrs)	17.18	15.8		
09-08-84	01:30	2040 (34hrs)	17.3	15.92		
	03:30	2160 (36hrs)	17.33	15.95		
	09:30	2520 (42hrs)	17.59	16.21		
	15:30	2880 (48hrs)	17.58	16.2		
	21:30	3240 (54hrs)	18.84	16.46		
10-08-84	03:30	3600 (60hrs)	18.1	16.72		
	09:30	3960 (66hrs)	18.2	16.82		
	15:30	4320 (72hrs)	18.29	16.91	2618	

PUMPING TEST DATA SHEET

Location : CURRAGHA **Borehole name : TW No.1 *** **Date : 07-05-84**

Test : Drawdown Data from TW No.1 * Weather : Fine

Duration Time : 71hrs Well depth : 40m

Height of datum point above ground level : ? Datum Point : ?

Date	Time	Time since pumping began (min.)	Water level below datum (metres)	Drawdown (metres)	Discharge m3/d	Temperature C	Conductivity uS/cm @20 C
07-05-84	14:00	0	0.75	0	1560		
		0.5	3.53	2.78			
		1	4.22	3.47			
		1.5	4.51	3.76			
		2	4.78	4.03			
		2.5	4.95	4.2			
		3	5.09	4.34			
		3.5	5.23	4.48			
		4	5.34	4.59			
		4.5	5.44	4.69			
		5	5.57	4.82			
		6	5.72	4.97			
		7	5.86	5.11			
		8	5.97	5.22			
		9	6.09	5.34			
		12	6.09	5.34			
		14	6.45	5.7			
		16	6.62	5.87			
		18	6.78	6.03			
		20	6.91	6.16			
		22	7.05	6.3			
		24	7.28	6.53			
		26	7.38	6.63			
		28	7.49	6.74			
		30	7.6	6.85			
		35	7.82	7.07			
		55	8.45	7.7	1560		
	15:00	60 (1hr)	8.58	7.83	1855		
		60.5	9.34	8.59			
		61	9.36	8.61			
		61.5	9.23	8.48			
		62	9.04	8.29			
		62.5	8.89	8.14			
		63	8.79	8.04			
		63.5	8.69	7.94			
		64.5	8.93	8.18			
		65	8.67	7.92			
		86	9.9	9.15			
		88	9.94	9.19			
		90	9.98	9.23			
		95	10.07	9.32			
		100	10.15	9.4			
		105	10.2	9.45	1855		
		110	10.33	9.58	1855		
		115	10.4	9.65			
	16:00	120 (2hrs)	10.53	9.78			
		150	10.94	10.19			
		165	11.05	10.3			
	17:00	180 (3hrs)	11.13	10.38			
		210	11.33	10.58			
	18:00	240 (4hrs)	11.34	10.59			
	19:00	300 (5hrs)	11.43	10.68			
	20:00	360(6hrs)	11.48	10.73			
	21:00	420 (7hrs)	11.55	10.8			
	22:00	480 (8hrs)	11.81	11.06			
	23:00	540 (9hrs)	11.91	11.16			
08-05-84	24:00	600 (10hrs)	11.9	11.15			
	01:00	660 (11hrs)	12	11.25			
	03:00	780 (13hrs)	12.14	11.69			
	05:00	900 (15hrs)	12.25	11.5			

PUMPING TEST DATA SHEET

Location : CURRAGHA **Borehole name : TW No.1 *** **Date : 07-05-84**

Test : Drawdown Data from TW No.1 * Weather : Fine

Duration Time : 71hrs Well depth : 40m

Height of datum point above ground level : ? Datum Point : ?

Date	Time	Time since pumping began (min.)	Water level below datum (metres)	Drawdown (metres)	Discharge m3/d	Temperature C	Conductivity uS/cm @20 C
	07:00	1020 (17hrs)	12.44	11.69			
	09:00	1140 (19hrs)	12.48	11.73			
	11:00	1260 (21hrs)	12.6	11.85			
	12:00	1320 (22hrs)	12.89	12.14			
	17:00	1620 (27hrs)	12.87	12.12			
	19:00	1740 (29hrs)	13.02	12.27			
	22:00	1920 (32hrs)	13.02	12.27			
	23:00	1980 (33hrs)	13.07	12.32			
09-05-84	01:00	2100 (35hrs)	13.12	12.37			
	03:00	2220 (37hrs)	13.34	12.59			
	09:00	2580 (43hrs)	13.47	12.72			
	15:00	2940 (49hrs)	13.69	12.84			
	21:00	3300 (55hrs)	12.77	12.92			
10-05-84	03:00	3660 (61hrs)	14	13.25			
	09:00	4020 (67hrs)	14.11	13.36			
	13:00	4260 (71hrs)	14.19	13.44	1855		

* TW No. 1 is now called PW No. 2.

PUMPING TEST DATA SHEET

Location : CURRAGHA **Borehole name : PW No.2** **Date : 19-09-95**

Test : Recovery Data from PW No.2 Weather : Fine

Duration : 9hrs. Well depth : 43.5m.

Height of datum point above ground level : 0m Datum Point : Inside rim of manhole cover.

Date	Time	Time since pumping ended (min.)	Water level below datum (metres)	Drawdown (metres)	Discharge m3/d	Temperature C	Conductivity uS/cm @20 C
19-09-95	21:00	0	34.5	10.6			
		0.5	32.1	8.2			
		1	31.9	8			
		1.5	31.6	7.7			
		2	31.3	7.4			
		2.5	31.1	7.2			
		3	30.95	7.05			
		3.5	30.8	6.9			
		4	30.7	6.8			
		4.5	30.58	6.68			
		5	30.48	6.58			
		6	30.3	6.4			
		7	30.1	6.2			
		8	29.96	6.06			
		9	29.85	5.95			
		10	29.72	5.82			
		12	29.5	5.6			
		14	29.33	5.43			
		16	29.15	5.25			
		18	29	5.1			
		20	28.85	4.95			
		22	28.7	4.8			
		24	28.52	4.62			
		26	28.45	4.55			
		28	28.35	4.45			
		30	28.29	4.39			
		35	28.03	4.13			
		40	27.84	3.94			
		45	27.73	3.83			
		50	27.59	3.69			
		55	27.44	3.54			
	22:00	60 (1hr)	27.36	3.46			
		75	27.04	3.14			
		90	26.75	2.85			
		105	26.54	2.64			
	23:00	120 (2hrs)	26.4	2.5			
		135	26.21	2.31			
		150	26.06	2.16			
		165	25.95	2.05			
	24:00	180 (3hrs)	25.78	1.88			
		200	25.54	1.64			
		220	25.49	1.59			
20/09/95	01:00	240 (4hrs)	25.35	1.45			
	02:00	300 (5hrs)	24.98	1.08			
	03:00	360 (6hrs)	24.65	0.75			
		525	23.96	0.06			
	06:00	540 (9hrs)	23.9	0			

PUMPING TEST DATA SHEET

Location : CURRAGHA **Borehole name : PW No.2 #** **Date : 27-10-87**

Test : Drawdown Data from PW No.2 #

Duration : 72hrs

Height of datum point above ground level : ?

Weather :

Well depth : 43.5m

Datum Point : ?

Date	Time	Time since pumping began (min.)	Water level below datum (metres)	Drawdown (metres)	Discharge m3/d	Temperature C	Conductivity uS/cm @20 C
27-10-87		0	11.85	0			
		1	24.98	13.13			
		2	30.75	18.9			
		3	32.85	21			
		5.3	33.15	21.3			
		8	33.15	21.3			
		10	33.15	21.3			
		13	33.15	21.3			
		15	22.21	10.36			
		18	22.65	10.8			
		21	22.6	10.75			
		22	22.6	10.75			
		24	22.5	10.65			
		26	22.6	10.75			
		28	22.65	10.8			
		30	22.75	10.9			
		35	22.75	10.9			
		52	22.33	10.48			
		60 (1hr)	22.79	10.94			
		75	22.68	10.83			
		90	22.87	11.02			
		105	22.73	10.88			
		120 (2hrs)	22.79	10.94			
		150	22.89	11.04			
		180 (3hrs)	28.35	16.5			
		210	28.68	16.83			
		240 (4hrs)	28.78	16.93			
		300 (5hrs)	29.18	17.33			
		360 (6hrs)	28.94	17.09			
		420 (7hrs)	29.16	17.31			
		660 (11hrs)	29.78	17.93			
		1020 (17hrs)	30.44	18.59			
		1320 (22hrs)	30.35	18.5			
		1380 (23hrs)	30.59	18.74			
28-10-87		1440 (24hrs)	30.55	18.7			
		1560 (26hrs)	30.49	18.64			
		1680 (28hrs)	30.48	18.63			
		1860 (31hrs)	30.48	18.63			
		2100 (35hrs)	30.22	18.37			
		2640 (44hrs)	30	18.15			
29-10-87		2940 (49hrs)	29.88	18.03			
		3240 (54hrs)	29.8	17.95			
		3600 (66hrs)	29.97	18.12			
		4165	30.18	18.33			
30-10-87		4320 (72hrs)	30.4	18.55			

PW No. 2 is now called PW No. 1.

PUMPING TEST DATA SHEET

Location : CURRAGHA **Borehole name : GSI OW No.1** **Date : 20-09-95**

Test : Drawdown Data from GSI OW No.1 while PW No.2 is pumping.

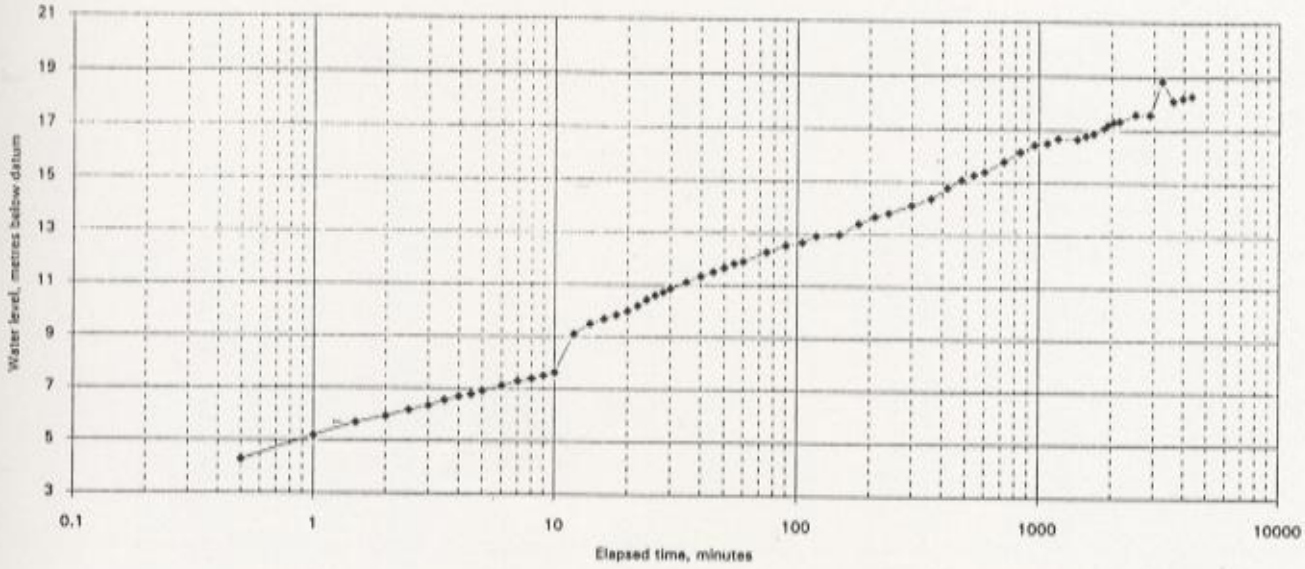
Duration : 12hrs. Weather : Fine

Distance from Pumping Well : 36.3m. Well depth : 53m.

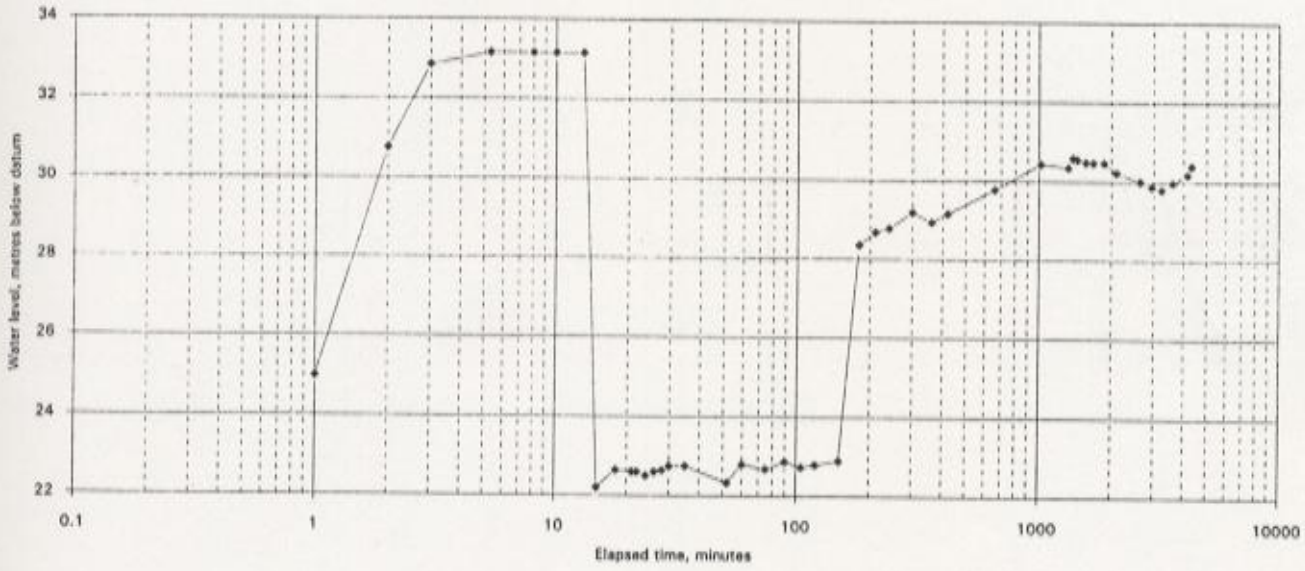
Height of datum point above ground level : 0.15m Datum Point : Top of casing.

Date	Time	Time since pumping began (min.)	Water level below datum (metres)	Drawdown (metres)	Discharge m3/d	Temperature C	Conductivity uS/cm @20 C
20-09-95	06:00	0	24.22	0			
		0.5	24.29	0.07			
		1	24.36	0.14			
		1.5	24.42	0.2			
		2	24.5	0.28			
		2.5	24.55	0.33			
		3	24.58	0.36			
		3.5	24.6	0.38			
		4	24.67	0.45			
		4.5	24.7	0.48			
		5	24.75	0.53			
		6	24.77	0.55			
		7	24.8	0.58			
		8	24.87	0.65			
		9	24.9	0.68			
		10	24.93	0.71			
		12	24.98	0.76			
		14	25.04	0.82			
		16	25.1	0.88			
		18	25.14	0.92			
		20	25.18	0.96			
		22	25.23	1.01			
		24	25.24	1.02			
		26	25.28	1.06			
		28	25.32	1.1			
		30	25.35	1.13			
		35	25.43	1.21			
		40	25.48	1.26			
		45	25.54	1.32			
		50	25.58	1.36			
		55	25.64	1.42			
	07:00	60 (1hr)	25.69	1.47			
		75	25.81	1.59			
		90	25.93	1.71			
		105	26.06	1.84			
	08:00	120 (2hrs)	26.13	1.91			
		140	26.25	2.03			
		150	26.3	2.08			
		165	26.37	2.15			
	09:00	180 (3hrs)	26.43	2.21			
		200	26.53	2.31			
		220	26.61	2.39			
	10:00	240 (4hrs)	26.67	2.45			
		270	26.76	2.54			
	11:00	300 (5hrs)	26.84	2.62			
		330	26.92	2.7			
	12:00	360 (6hrs)	26.98	2.76			
		390	27.05	2.83			
	13:00	420 (7hrs)	27.11	2.89			
		450	27.16	2.94			
	14:00	480 (8hrs)	27.21	2.99			
		510	27.26	3.04			
	15:00	540 (9hrs)	27.3	3.08			
		570	27.33	3.11			
	16:00	600 (10hrs)	27.38	3.16			
		630	27.42	3.2			
	17:00	660 (11hrs)	27.44	3.22			
		690	27.48	3.26			
	18:00	720 (12hrs)	27.52	3.3			

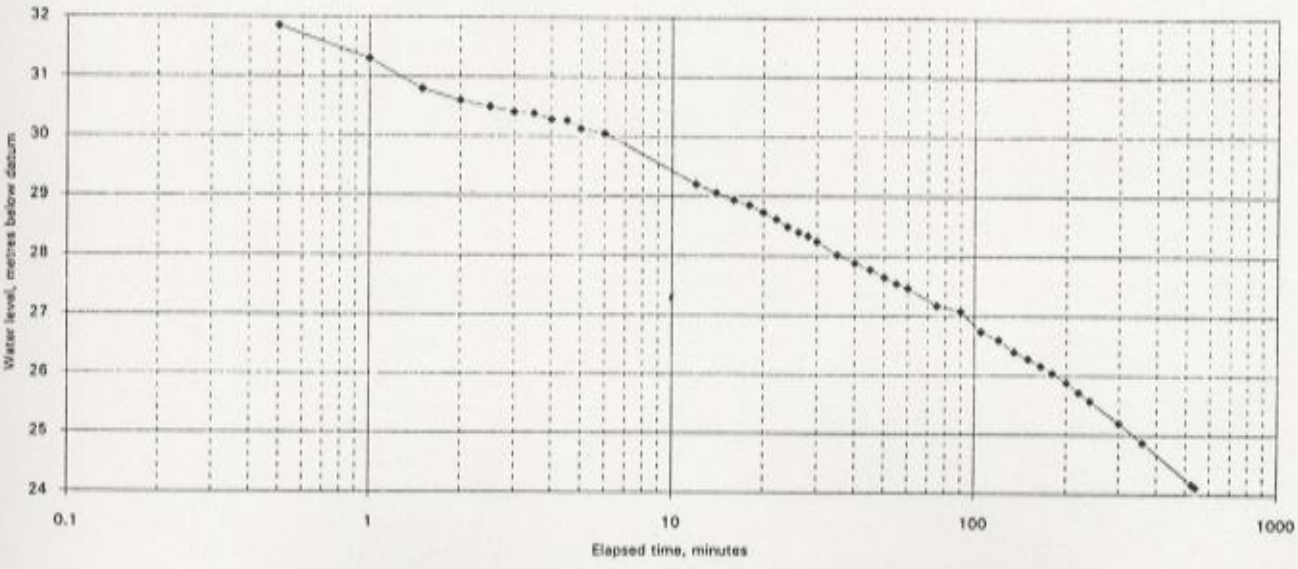
Curragha pumping test PW No.1, 7 August '84



Curragha pumping test PW No. 2, 27 October '87



Curragha recovery test PW No.1, 19 September '95



PUMPING TEST DATA SHEET

Location : CURRAGHA Borehole name : PW No.1 Date : 20-09-95

Test : Drawdown Data from PW No.1 while PW No.2 is pumping.

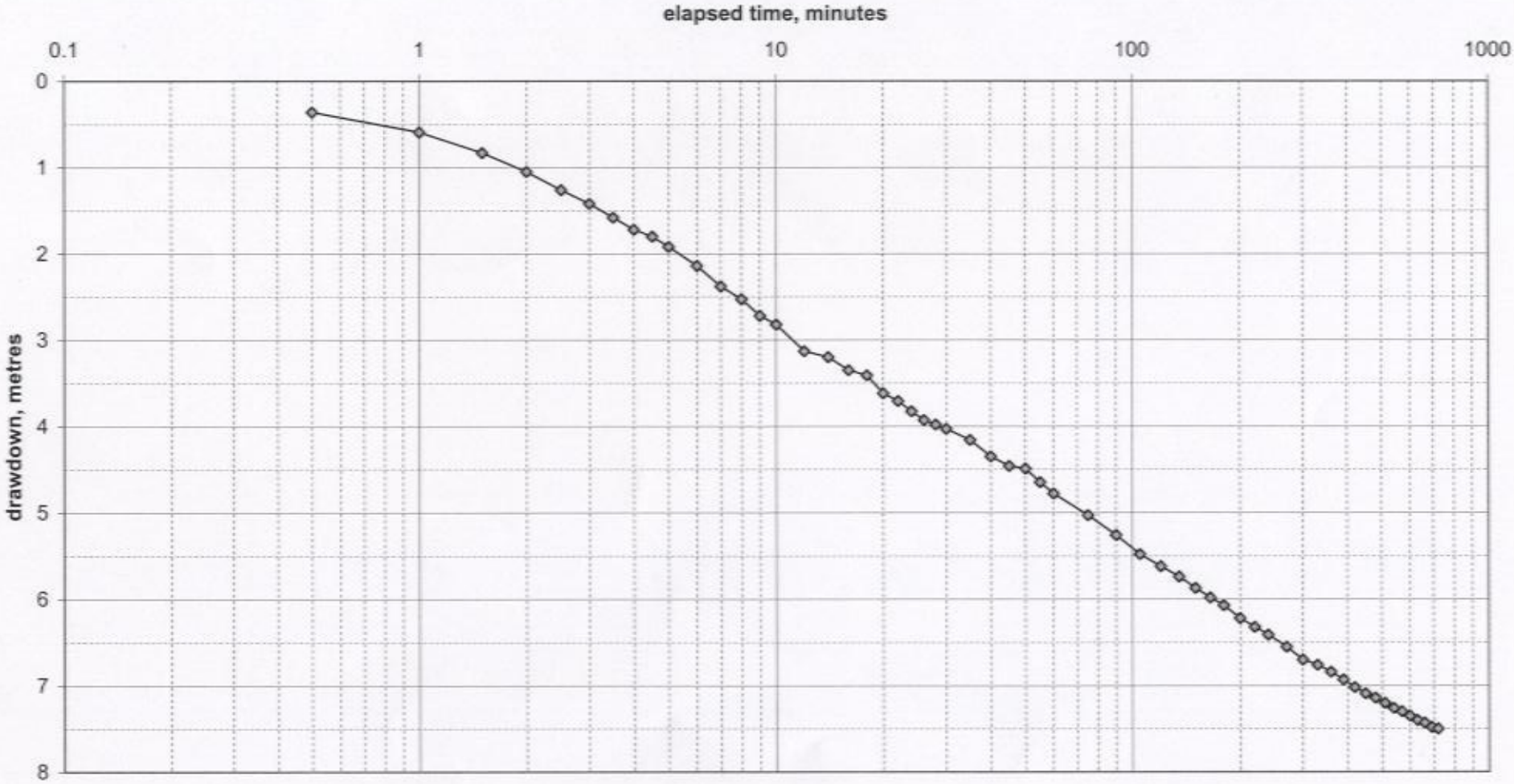
Duration Time : 12hrs. Weather : Fine

Distance from Pumping Well : 5m. Well depth : 40m.

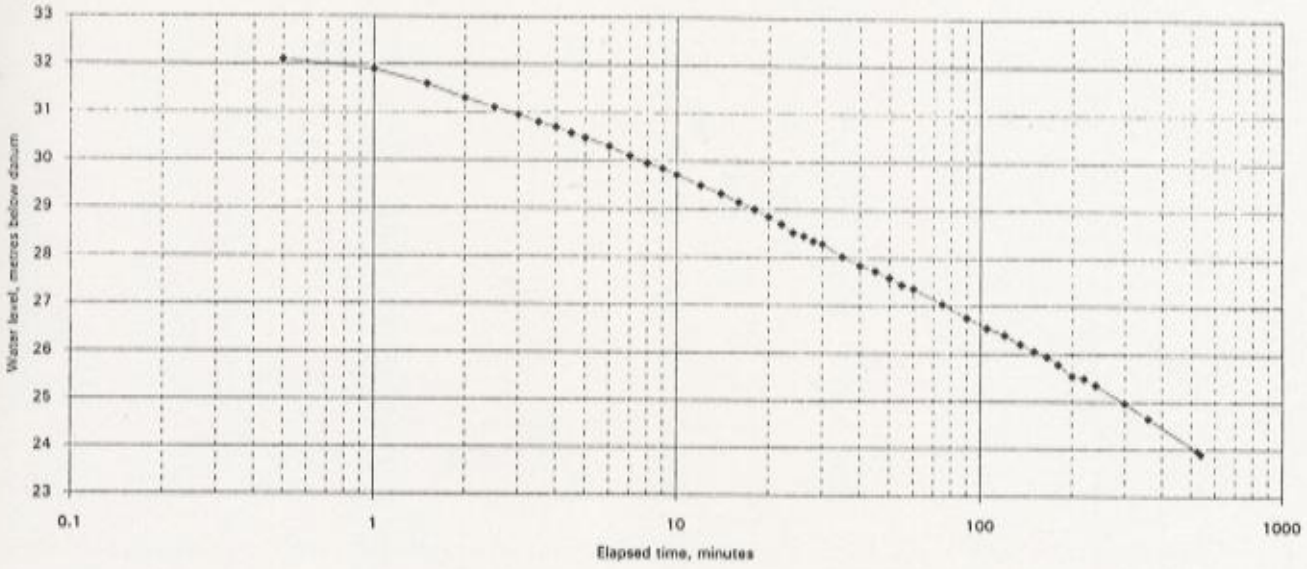
Height of datum point above ground level : 0.03m Datum Point : Wooden plank across manhole.

Date	Time	Time since pumping began/ended	Water level below datum (metres)	Drawdown (metres)	Discharge m3/d	Temperature C	Conductivity µS/cm @20 C
20-09-95	06:00	0	24.12	0			
		0.5	24.48	0.36			
		1	24.71	0.59			
		1.5	24.95	0.83			
		2	25.17	1.05			
		2.5	25.38	1.26			
		3	25.54	1.42			
		3.5	25.7	1.58			
		4	25.84	1.72			
		4.5	25.92	1.8			
		5	26.04	1.92			
		6	26.26	2.14			
		7	26.5	2.38			
		8	26.65	2.53			
		9	26.84	2.72			
		10	26.94	2.82			
		12	27.25	3.13			
		14	27.32	3.2			
		16	27.47	3.35			
		18	27.53	3.41			
		20	27.74	3.62			
		22	27.83	3.71			
		24	27.95	3.83			
		26	28.05	3.93			
		28	28.1	3.98			
		30	28.15	4.03			
		35	28.28	4.16			
		40	28.47	4.35			
		45	28.58	4.46			
		50	28.61	4.49			
		55	28.77	4.65			
	07:00	60	28.9	4.78			
		75	29.15	5.03			
		90	29.38	5.26			
		105	29.6	5.48			
	08:00	120	29.74	5.62			
		135	29.86	5.74			
		150	29.99	5.87			
		165	30.1	5.98			
	09:00	180	30.19	6.07			
		200	30.34	6.22			
		220	30.44	6.32			
	10:00	240	30.53	6.41			
		270	30.67	6.55			
	11:00	300	30.82	6.7			
		330	30.88	6.76			
	12:00	360	30.96	6.84			
		390	31.05	6.93			
	13:00	420	31.14	7.02			
		450	31.21	7.09			
	14:00	480	31.26	7.14			
		510	31.32	7.2			
	15:00	540	31.38	7.26			
		570	31.42	7.3			
	16:00	600	31.47	7.35			
		630	31.52	7.4			
	17:00	660	31.55	7.43			
		690	31.6	7.48			
	18:00	720	31.62	7.5			

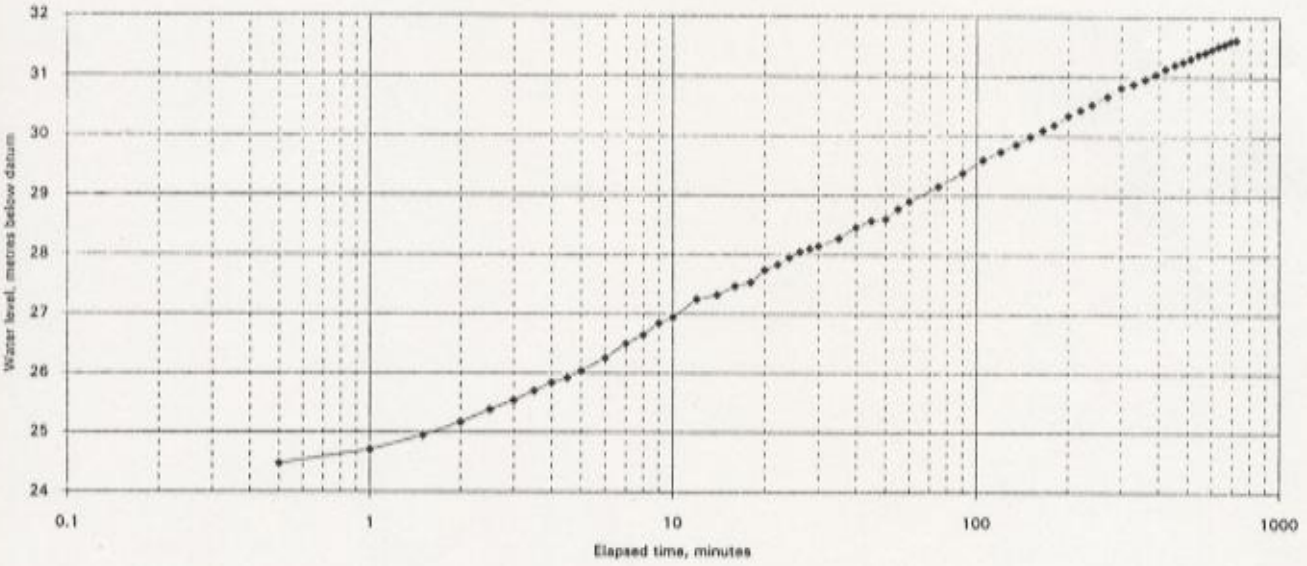
Curragha WSS, pumping test 20 September 1995
Data from PW1 (Obs Well) 5 metres from pumped well PW2



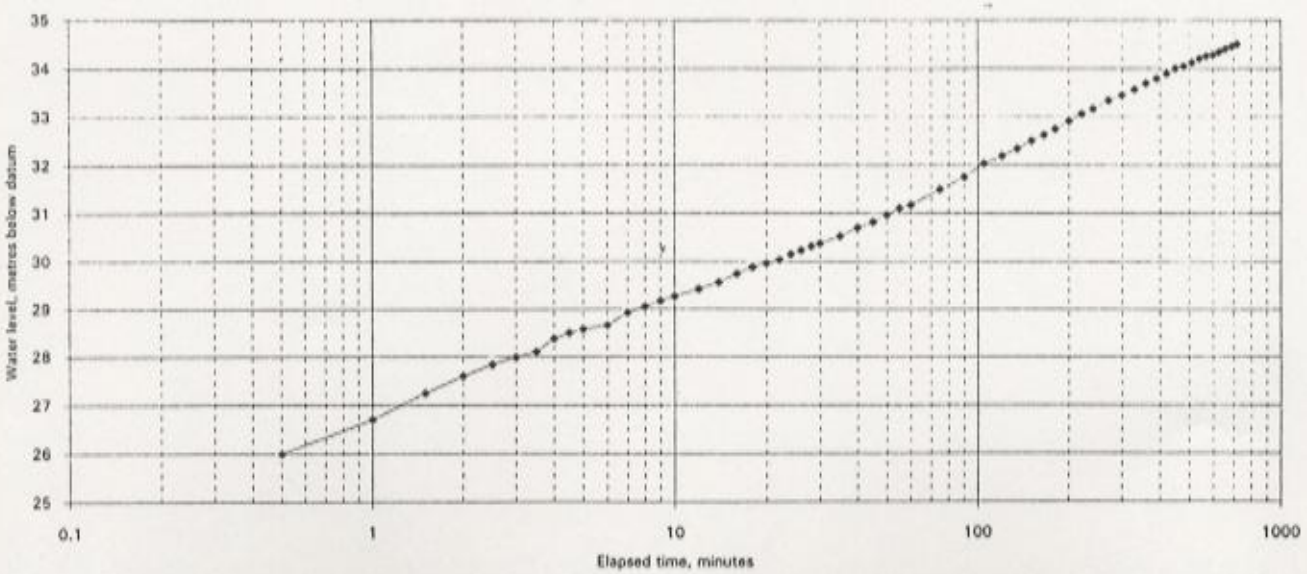
Curragha recovery test PW No.2, 19 September '95



Curragha pumping test PW No. 1, 20 September '95



Curragha pumping test PW No.2, 20 September '95



Groundwater Quality Analyses

Groundwater Source :		Curragha					
Sample Location :		*TW No.1	*TW No.1	R. Hurley	**PW No.1	***PW No.2	PW No. 2
Date :		8/5/84	10/5/84	10/5/84	10/8/84	??/10/87	19/4/93
Parameters	**Units**						
Alkalinity	mg/l	297	291	278	296	300	
Aluminium	mg/l						
Ammonium	mg/l	0.13	0.26	0.45	0.26	<0.01	0.07
Ammonium as Nitrogen	mg/l						
Arsenic	mg/l						
Barium	mg/l						
Bicarbonate	mg/l	410	422	407	424	366	
Boron	mg/l						
Cadmium	mg/l						
Calcium	mg/l	119	118	122	122	120	
Calcium Hardness	mg/l						
Total Hardness	mg/l	336	346	334	348	330	
Chloride	mg/l	22	22	30	20	16	
Chromium	mg/l						
Copper	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	
Cyanide	mg/l						
Electrical Conductivity	mS/cm	0.6	0.6	0.58	0.58	0.64	0.788
Fluoride	mg/l						
Iron (total)	mg/l	0.4	0.9	0.3	0.9	1.4	0.002
Lead	mg/l						
Magnesium	mg/l	9	13	7	11	7	
Magnesium Hardness	mg/l						
Manganese	mg/l	0.1	0.1	0.1	0.2	0.24	
Mercury	mg/l						
Nickel	mg/l						
Nitrate	mg/l	17.3	4.9	13.3	0.7	0.3	0.77
Nitrite	mg/l	<0.01	0.03	0.16	<0.002	<0.01	0
pH		7.2	7.6	7.6	6.9	7	6.8
Phosphate	mg/l						
Phosphorus	mg/l						
Potassium	mg/l	1.3	1.4	2.3	1.1	1.3	
Selenium	mg/l						
Silver	mg/l						
Sodium	mg/l	9	10	9	11	7.8	
Strontium	mg/l						
Sulphate	mg/l	37	32	28	32	40	
Temperature	C	11	11		11		14
Total dissolved solids	mg/l						
Zinc	mg/l						
Total Coliforms	/100 m	0	0	25	0	0	0
E. coli	/100 m	0	0	25	0	0	0

* TW No. 1 is now called PW No.2
** PW No. 1 is now abandoned
*** PW No. 2 is now called PW No. 1

Groundwater Quality Analyses

Groundwater Source : Curragha

Sample Location :	**	PW No. 2	PW No. 2	PW No.2	PW No.2	PW No.2	PW No.2
Date :		17/6/93	17/8/93	20/3/95	12/6/95	25/9/95	8/1/96
Parameters	**Units**						
Alkalinity	mg/l			326	324	318	312
Aluminium	mg/l			<0.02	<0.02	<0.02	<0.02
Ammonium	mg/l	0.09	0.007				
Ammonium as Nitrogen	mg/l			0.045	0.064	0.065	0.076
Arsenic	mg/l			<0.25		<0.05	<0.05
Barium	mg/l			0.071	0.083	0.083	0.09
Bicarbonate	mg/l						
Boron	mg/l			0.06	<0.02	0.026	0.036
Cadmium	mg/l			<0.025	<0.025	<0.005	<0.005
Calcium	mg/l			100	131	126	152.3
Calcium Hardness	mg/l			250	327	315	380
Total Hardness	mg/l			335	375	365	434
Chloride	mg/l			19.9	17.3	15.7	21.5
Chromium	mg/l			<0.025	<0.025	<0.005	<0.005
Copper	mg/l			<0.01	<0.01	<0.005	<0.005
Cyanide	mg/l			<0.01	<0.01	<0.01	<0.01
Electrical Conductivity	mS/cm	0.788	0.773	0.786	0.734	0.736	0.811
Fluoride	mg/l			<0.25	0.27	0.26	<0.25
Iron (total)	mg/l	0.001	0.001	0.075	1.153	1.2	1.201
Lead	mg/l			<0.25	<0.25	<0.02	<0.02
Magnesium	mg/l			21.1	12	12.2	13.13
Magnesium Hardness	mg/l			87	49	50	54
Manganese	mg/l			0.1	0.322	0.296	0.336
Mercury	mg/l						<0.02
Nickel	mg/l			<0.05	<0.05	<0.01	0.017
Nitrate	mg/l	0	0.08	<0.1	<0.1	<0.1	<0.1
Nitrite	mg/l	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
pH		7.7	7.21	7	7.2	7.2	6.8
Phosphate	mg/l			<0.5	<0.5	<0.5	<0.5
Phosphorus	mg/l			<0.25	<0.25	<0.25	<0.25
Potassium	mg/l			1.5	1.4	1	1.413
Selenium	mg/l						<0.05
Silver	mg/l			<0.01	<0.01	<0.005	<0.005
Sodium	mg/l			16.8	10.1	11.39	10.98
Strontium	mg/l			1.23	0.672	0.654	0.738
Sulphate	mg/l			100.5	74	62	99.9
Temperature	C	15	12	10.2	11.5	12	10.7
Total dissolved solids	mg/l			586	572	548	613
Zinc	mg/l			<0.01	<0.01	0.016	0.028
Total Coliforms	/100 ml		0	0	0	0	3
E. coli	/100 ml		0	0	0	0	0

** PW No. 2 was originally the Trial Well TW No. 1

Appendix 2
Maps

FIG. 1 GEOLOGY


North
Limestone Till
Lacustrine Clay
Lacustrine Clay/ Marl
Co. Dublin
COOLFORE
BALTRASNA
BORRASTOWN
KNAVINSTOWN
CRICKSTOWN
BALLYCLE
Curragha
Scale: 6 Inches to 1 Mile
CURRAGHA GROUNDWATER SOURCE PROTECTION
Subsoil boundaries
Outcrop
Quarry (used or disused)
FIG. 2 SUBSOILS


North
Co. Dublin
COOLFORE
BALRASNA
BORRANSTOWN
KNAVINSTOWN
CRICKSTOWN
BALLY
Curragha
St. Andrew's R. C. Ch.
Parochial Ho.
Crickalowen House
Liable to Flood
Burley Rick
Blackwater Br.
PW1&2 •1.5m
•1.8m
•3.6m
•2m
Scale: 6 Inches to 1 Mile
CURRAGHA GROUNDWATER SOURCE PROTECTION
5m Depth to bedrock contours
Outcrop
•5.0m Depth to bedrock at a well location
FIG. 3 DEPTH TO BEDROCK

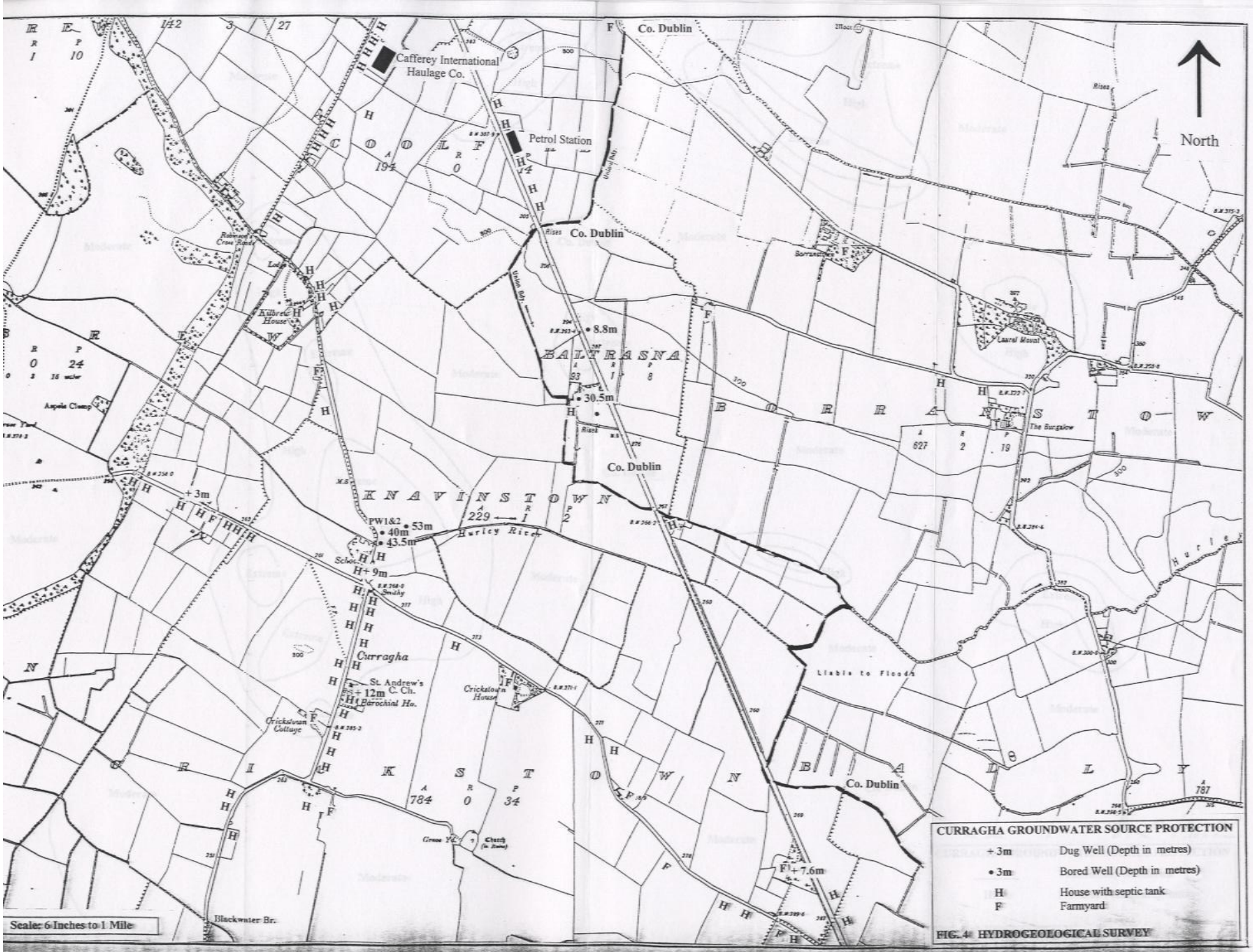


FIG. 4 HYDROGEOLOGICAL SURVEY

FIG. 5 VULNERABILITY


North
Co. Dublin
Co. Dublin
Co. Dublin
Co. Dublin
Co. Dublin
COOLFORE
A 194 R 0 P 14
BALTRASNA
A 93 R 1 P 8
BORRANSTOWN
A 627 R 2 P 19
KNAVINSTOWN
A 229 R 1 P 2
BRICKSTOWN
A 784 R 0 P 34
BALLY
A 787
BRE
A 153 R 1 P 10
BRE
A 803 R 0 P 24
PW1&2
Hurley Rd.
Curragha
St. Andrew's R. C. Ch.
Parochial Ho.
Crickstown House
Crickstown Cottage
Kilbride House
Laurel Mount
The Bungalow
Liable to Floods
Blackwater Br.
Scale: 6 Inches to 1 Mile
CURRAGHA GROUNDWATER SOURCE PROTECTION
Zone of Contribution (with buffer)
100 Day Time of Travel Distance
FIG.6 ZONE OF CONTRIBUTION AND 100 DAY TIME OF TRAVEL

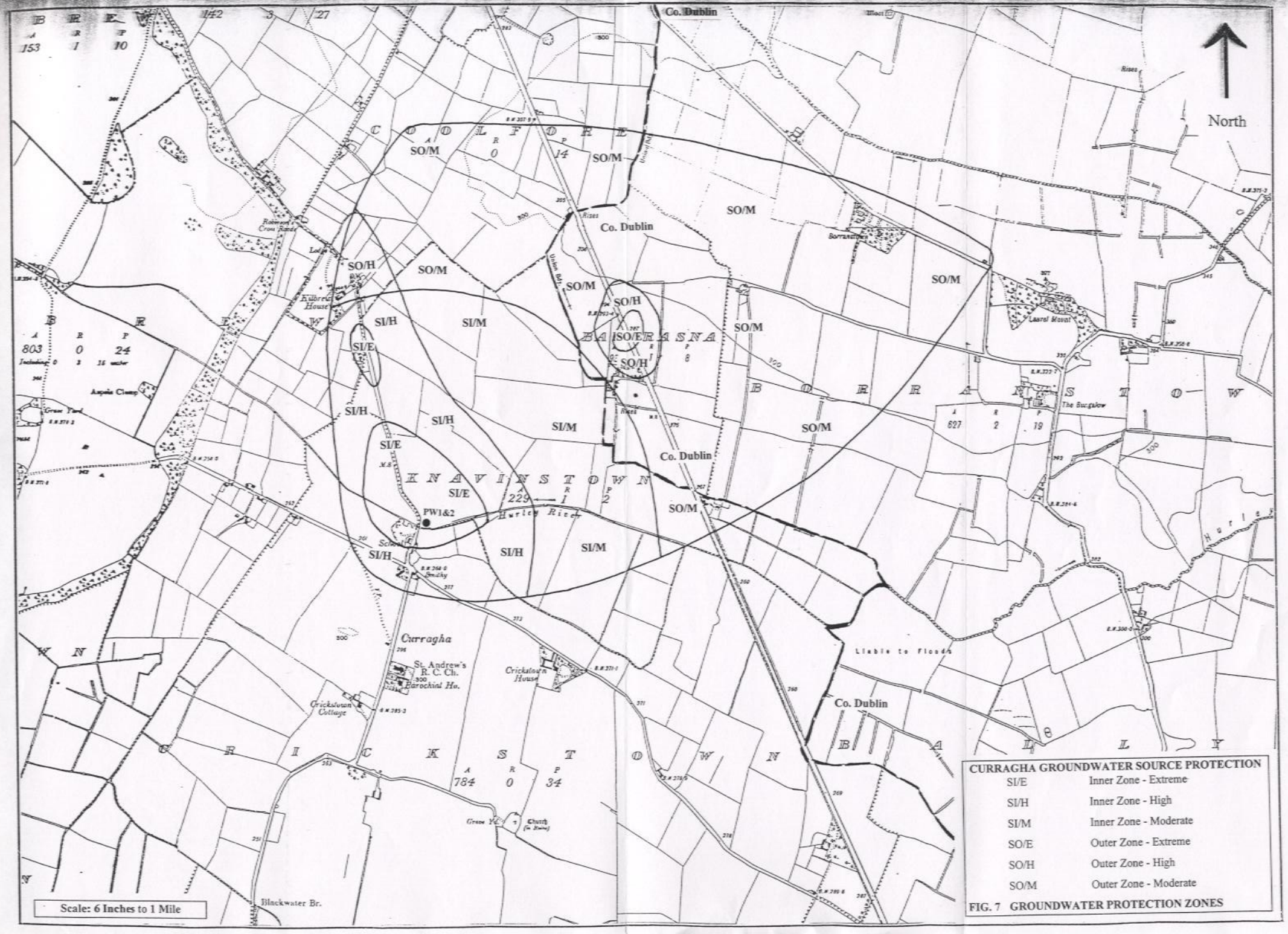
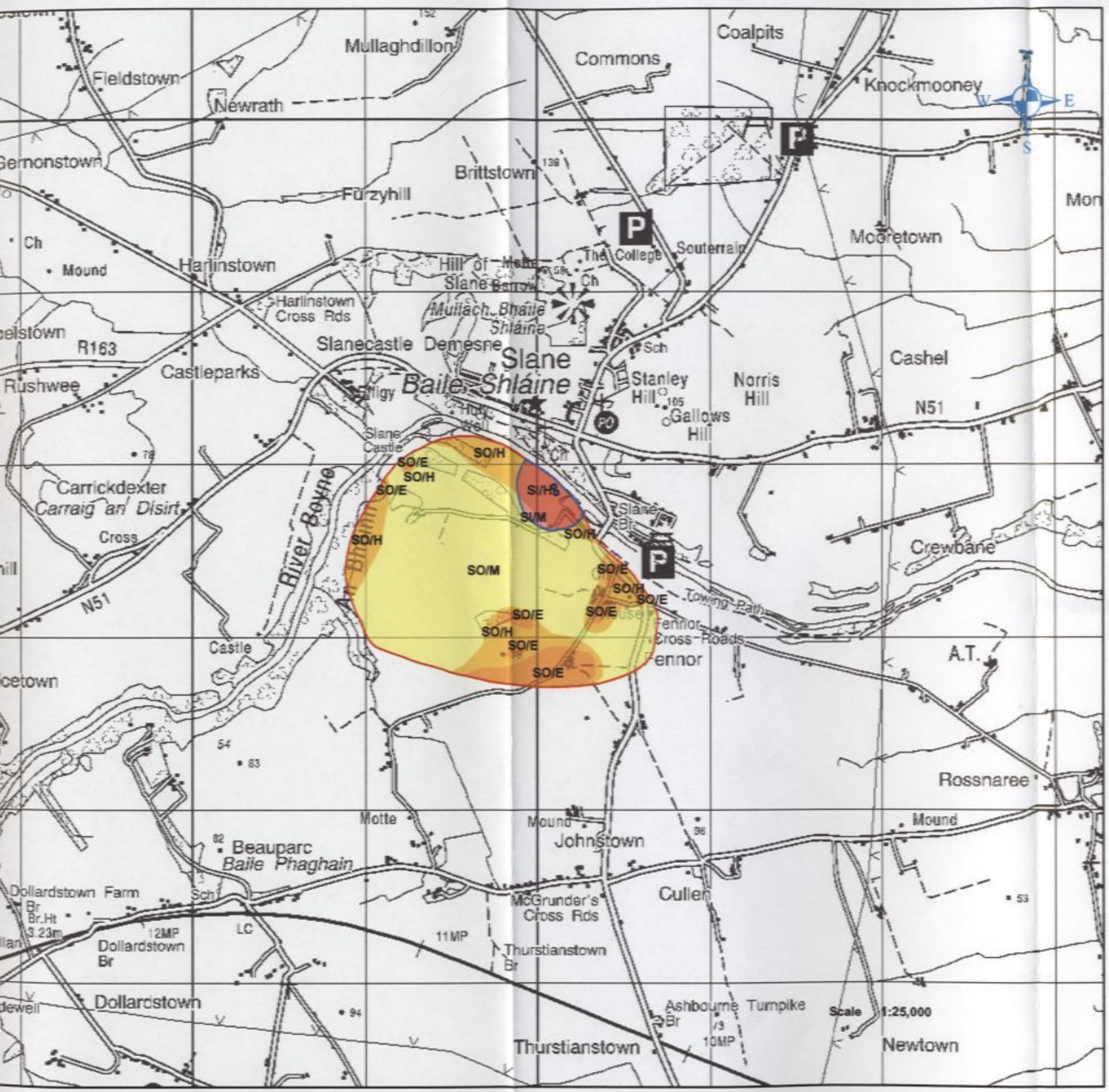


FIG. 7 GROUNDWATER PROTECTION ZONES



COUNTY MEATH
GROUNDWATER PROTECTION SCHEME
SOURCE PROTECTION ZONES

Vulnerability Rating	Source Protection Zones Inner (SI)	Outer (SO)
Extreme (E)	SI/E	SO/E
High (H)	SI/H	SO/H
Moderate (M)	SI/M	SO/M
Low (L)	SI/L	SO/L

Zone of Contribution of Wells (SO)

Inner protection area (SI)

County Boundary

Public Supply Well

Project Hydrogeologist: Conan Kelly
Project Manager: Geoff Wright
Digital Map Production: Silvia Calcoa

This Source Protection Zone map is designed for general information and strategic planning usage. The boundaries are based on the available evidence and local details have been generalised to fit the map scale. Evaluation of specific sites and circumstances will normally require further and more detailed assessments and will frequently require site investigations to determine the risk to groundwater.

The map is intended for use in conjunction with groundwater protection responses for potentially polluting activities, which lists the degree of acceptability of these activities in each zone and describes the control measures necessary to prevent pollution

GEOLOGICAL SURVEY OF IRELAND
Suirbhéireacht Gheolaíochta Éireann
Beggars Bush, Haddington Rd, Dublin 4

Slane

1:25,000

0 0.5 1 2 Kilometers