NOBBER WATER SUPPLY

GROUNDWATER SOURCE PROTECTION ZONES

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Revised June 2004
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NOBBER PUBLIC SUPPLY

1. WELL LOCATION AND SITE DESCRIPTION

This source is the main public supply well for Nobber and its surrounds and is located 0.3 km southeast of the village, off the Kingscourt Road, in the GAA grounds, adjacent to the railway. The pumping well (PW No.1) is located inside the pumphouse and is completed above the floor level inside a raised manhole (0.55 metres above floor level). The pumphouse is fenced off. There is no backup supply for this well, which was drilled over 40 years ago. The Nobber groundwater is chlorinated in the pump house before being pumped to the storage tower, which has a capacity of 112m^3 (24,600 gallons). There are no private wells used in the vicinity of this source, as the mains supply has been in operation for over 40 years.

The original pumping well (PW No.2), drilled in 1985, is located in the next field and was abandoned due to contamination (due to E. coli and high iron levels).

2. WELL DETAILS

GSI no.:	2627NEW055
Grid ref.:	28264 28614
Owner:	Meath County Council
Well type:	Borehole
Elevation (top of casing):	61.27 m OD (Poolbeg). Ground level is 60.70 m OD.
Depth:	approximately 24m
Depth of casing:	Unknown
Diameter:	150 mm (6")
Depth-to-rock:	Unknown
Static water level:	8.15 m b.g.l. (20-7-95)
Pumping water level:	14.15 m b.g.l. (after 8 hrs continuous pumping)
Drawdown:	6 m (after 8 hrs continuous pumping)
Pumping rate:	175 m^3/d (9,900 gal/hr)
Normal consumption:	130 m^3/d (28,600gal/d) on average, over 24 hrs

Pumping test summary:

(i) pumping rate:	175m^3/d
(ii) specific capacity:	30m^3/d/m (8 hours); 20m^3/d/m (extrapolated to 1 week)
(iii) transmissivity:	20 - 40m^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. An eight hour pumping test with a recovery test was carried out to examine the aquifer characteristics. Subsequently, the area within 500 metres of the source was surveyed with regard to geology, hydrogeology, vulnerability to pollution and current pollution loading. Raw water samples were taken in March, June, and 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 Nobber supply is located 400 metres from the River Dee. The topography varies from drumlin to hummocky to gently undulating ranging from to 54 m OD (180 ft) to 73 m OD (240 ft).

The River Dee meanders in a south to southeasterly direction, with numerous small streams draining the area. Drainage is moderate and there are several small drainage ditches.

Agriculture is the principal activity in the area, with most of the land around the public supply source being used primarily for pasture. The field below the well is the GAA playing pitch.

5. GEOLOGY

5.1 Bedrock geology

There are no borehole logs available for either of the Nobber wells. The geology map for the area indicates that the area is underlain by Calp Limestone, and to the north of Nobber there are the equivalent clean shallow water limestones. The bedrock geology is shown in Figure 1.

5.2 Quaternary (subsoils) geology

Several types of Quaternary deposits are present around the Nobber source as shown in Figure 2. The subsoils are very complicated in this area and only brief descriptions are given below.

Along the River Dee, and to the north of the pumping well, are narrow strips of alluvium of varying width, up to 200 m across. The alluvium is generally sandy to silty in texture and is usually more than 2 metres deep. Some gravel lenses occur within the alluvium.

To the south and west of the well there are small areas of fluvioglacial gravels, generally less than 3 m deep, and overlying limestone till. The gravels are poorly exposed, and were deposited as part of an outwash system during deglaciation. The gravels are pebble to cobble grade, with a sand matrix. Most of the gravel clasts are of Carboniferous limestone.

Around the wells and flanking the alluvial and gravel deposits are areas of limestone dominated till which is gravelly to stony or sandy in texture, with fairly high proportions of clay present.

Small areas of lacustrine deposits which are clayey to marly in texture occur within the limestone till.

5.3 Soils

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

Soils of the area are primarily derived from a parent material of limestone till, with some Lower Palaeozoic shales. The soils are deep and moderately well drained, although they may show signs of water impedance after prolonged rainfall, with the development of a perched watertable. The Great Soil Group is the Grey Brown Podzolic, Rathowen Series. Northeast of Nobber is an area of Brown Earth Group, of the Kells Soil Series. These soils have a parent material of Lower Palaeozoic shales with sandstones and siltstones. These soils are well drained, with a wide range of agricultural uses.

5.4 Depth to rock

Depth to rock in the Council borehole is unknown. There are few outcrops of limestone in the area and these occur in old small quarries at Bridge Farm, Ballynee and Brittas.

Around Nobber and the pumping wells the depth to bedrock is assumed to be greater than 10 metres and further to the west, north and south the subsoils are on average much thinner (generally around 5 metres). 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 Nobber area is poor, especially in the area of interest around the public supply. An 8 hour pumping test with a recovery test was carried out in July 1995 and a survey of pollution sources and wells was conducted around 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 ascertain the groundwater flow direction.

The disused pumping well (PW No.2) was drilled in 1985. The pumping test results (June 1985) were available for analysis. No information was available for the present pumping well (PW No.1).

6.2 Groundwater levels

Groundwater is generally close to the surface (less than 10 m). The static water level in the public supply well on 20/7/95, following overnight recovery, was 8.15 m b.g.l. (52.55 m OD). The static water level in the original pumping well (PW No.2) was 5.60 m below measuring point, 54.25 m OD.

The pumping water level in the public supply well on 20/7/95 was 14.15 m b.g.l. (46.55 m OD) and in the original pumping well 148 metres away the drawdown was zero.

6.3 Groundwater flow directions and gradients

Regional groundwater flow is generally towards the southeast, but locally it is dependent on topography and moves in all directions to the River Dee. The local flow direction is difficult to assess due to the hummocky nature of the topography near the well and the absence of private wells to draw a groundwater contour map.

Groundwater gradients in the general area are also difficult to assess due to the lack of private wells, but may range from approximately 0.01 to 0.02.

6.4 Rainfall, Evaporation and Recharge

Rainfall data for the area are taken from the nearest rainfall station in Nobber, 300 metres northeast. Mean annual rainfall as recorded by Met Eireann for 1951-1980 was 868 mm. Potential evapo-transpiration (P.E.) is estimated from a Met Eireann contoured map as 505 mm/yr. Actual evapotranspiration (A.E.) is estimated at 480 mm by calculating a percentage (95%) of the P.E., to allow for seasonal soil moisture deficits.

Using the above figures the effective rainfall (E.R.) is approximately 388 mm/yr. As there are numerous drainage ditches or streams in the immediate area of the supply and the Quaternary deposits are relatively free draining and generally thick, a moderate proportion of the effective rainfall infiltrates to the water table. Estimating run off to be of the order of 30%, the actual annual recharge to the aquifer is estimated to be 310 mm/yr.

These calculations are summarised below:

Average annual rainfall	868 mm
Estimated P.E.	505 mm
Estimated A.E. (95% P.E.)	480 mm
Effective rainfall	388 mm
Recharge (70% E.R.)	270 mm

6.5 Hydrochemistry and Water Quality

The chemical analyses of groundwater at the Nobber source indicate a very hard water (350-390 mg/l $CaCO_3$), with a high alkalinity (300-320 mg/l $CaCO_3$). Conductivities are also high, ranging from 525-760 μS/cm. This groundwater can be classed as a calcium bicarbonate water. The groundwater analyses are included in the Appendices.

The water quality at Nobber is excellent with no bacterial contamination and all the major cations, anions and trace elements are within the Irish Drinking Water Standards. Levels of nitrate range between 6-18 mg/l, and potassium between 5-8mg/l, which are higher than background levels for County Meath. The sample taken on 22 March 1995 indicated a lead level above the Irish Drinking Water Standards. Regular sampling of the raw water from Nobber should be continued to monitor the water quality and in particular the lead, nitrate, potassium and conductivity levels.

During pumping of the present well small sand size grains accumulate in sumps in the pipes within the pumphouse.

Table 1. Conductivity readings from the Nobber Source

	Production Well	
Date	**Conductivity (μS/cm)**	**Temperature (^{O}C)**
14-3-95	528	11.1
+22-3-95	525	10.1
5-4-95	560	11.8
29-5-95	539	10.1
+13-6-95	543	10.3
28-6-95	545	10.6
20-7-95	547 - 571	10.0 - 11.0
1-8-95	562	11.3
+26-9-95	549	10.4
9-12-95	556	11.1
+10-1-96	654	9.7
27-2-96	656	9.9
22-3-96	667	9.7
5-6-96	672	10.7

+ Full analyses

6.6 Aquifer coefficients

As a result of the water level being lowered to the pump intake level the pumping test was limited to eight hours. Analysis of the 8 hour pumping test gave an apparent transmissivity of around 30 m^2/d.

The specific capacity calculated was 30 m^3/d/m after 8 hours pumping. After an initial drawdown in the well of 5 metres during the first 35 minutes, drawdown was only 1 metre over the next 7 hours. This suggests that the yield of the well could be increased if the pump intake was lowered in the well, as the present pumping rate reduces the water level to the pump intake. However, more comprehensive pumping tests would be needed to confirm the sustainable maximum yield of the well at a lower intake level.

The specific yield of the aquifer could not be calculated from the observation well data as no drawdown was observed, but it is assumed to be around 0.02.

Analysis of the 72 hour pumping test (1985) on the original pumping well, with a pumping rate of 260 m^3/d and a drawdown of 45 metres, indicated a transmissivity of around 35 m^2/d. The specific capacity calculated was 6 m^3/d/m. These figures are similar to those obtained from the 12 hour test; although the specific capacity was lower it indicates that the transmissivity value obtained is accurate for the area.

The pumping test data are included in the Appendices.

6.7 Conceptual Model

The aquifer feeding the Nobber source is the Calp Limestone. This is overlain by around 10 metres of limestone till that is moderately permeable, therefore the aquifer is considered to be unconfined. The unsaturated zone (<10m) in the vicinity of the well suggests that the aquifer is only moderately permeable and this is supported by the yield from the well. Permeabilities within the bedrock are increased by joints and fractures.

Groundwater flow is influenced by topography. A local groundwater divide can be deduced along the top of small hills or drumlins. The groundwater flow to the public supply is assumed to be from the northwest.

There are no details for the pumping well, except it is a 150 mm diameter borehole with a minimum depth of 24 m and the depth of the pump is around 15 m. It is assumed the well is only cased into bedrock and is open within the limestone bedrock (minimum of 10 m). It is assumed that the main inflow into the well is from the rock head, at the base of the steel casing, and that inflows from the subsoils are prevented by the presence of the steel casing, although this is not grouted.

There are no historical raw water analyses available from either well, but the original pumping well was abandoned due to bacterial contamination.

6.8 Aquifer category

The aquifer supplying the Nobber source is the Calp Limestone. Considering the aquifer in terms of its well yields and specific capacities over the county it is classed as a **locally important aquifer which is generally moderately productive (Lm).**

7. GROUNDWATER VULNERABILITY

The catchment area for the source at Nobber is mapped as highly to moderately vulnerable to pollution. The subsoils are generally highly to moderately permeable.

The areas which were quarried are areas where rock is less than 3 m below surface and are mapped as having an ‘extreme’ vulnerability under the GSI vulnerability mapping guidelines. Much of the surrounding area is classified as ‘highly’ vulnerable due to the high permeability of the subsoil or the shallow cover. Around the source, the subsoils are assumed to be thicker than 10 metres and the area is classified as ‘moderately’ vulnerable. The vulnerability zones are shown on Figure 5.

8. DELINEATION OF SOURCE PROTECTION AREAS

Source protection areas are delineated for the output (175 m^3/d) that is currently abstracted, and allows for expansion of the zone of contribution during dry weather by including a buffer zone.

8.1 Inner Protection Area

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

As a result of the inferred highly permeable zone close to the surface (upper 15 m) in the vicinity of the source, higher aquifer coefficients are used to determine the 100 day time of travel distance.

Using the following aquifer coefficients: permeability (k) = 6 m/d, porosity = 0.02, and hydraulic gradient (i) = 0.01, the 100 day time-of-travel distance to the well is estimated at 300 m. The Inner Protection Area and the catchment area are almost the same size, as shown on Figure 6.

8.2 Outer Protection Area

The Outer Protection Area (SO) includes the remainder of the 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 at Nobber is derived from hydrogeological mapping techniques and is controlled primarily by the local groundwater divide around the source and by the general groundwater flow direction. The ZOC is shown in Figure 6, and its size is based largely on the Recharge Equation. Taking the average annual recharge to be 270 mm as previously indicated, the area required to supply the pumping rate of 175 m^3/d is calculated to be 0.25 km^2. A buffer (safety margin) is included in the final zone of contribution.

9. GROUNDWATER PROTECTION SCHEME

Combining the Source Protection Areas, as described above, with the vulnerability ratings produces four groundwater protection zones for the source at Nobber. 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 / High (SO/H)
- Outer Protection Area / Moderate (SO/M)

10. POTENTIAL POLLUTION SOURCES

The primary threat to the public supply at Nobber is the presence of some houses with septic tanks to the south of Nobber and/or leaky sewers (if present) in the village. This may account for the slightly elevated background levels of nitrates and potassium. The sewage treatment plant for Nobber is located 400 metres north of the supply well and the effluent is discharged into the River Dee.

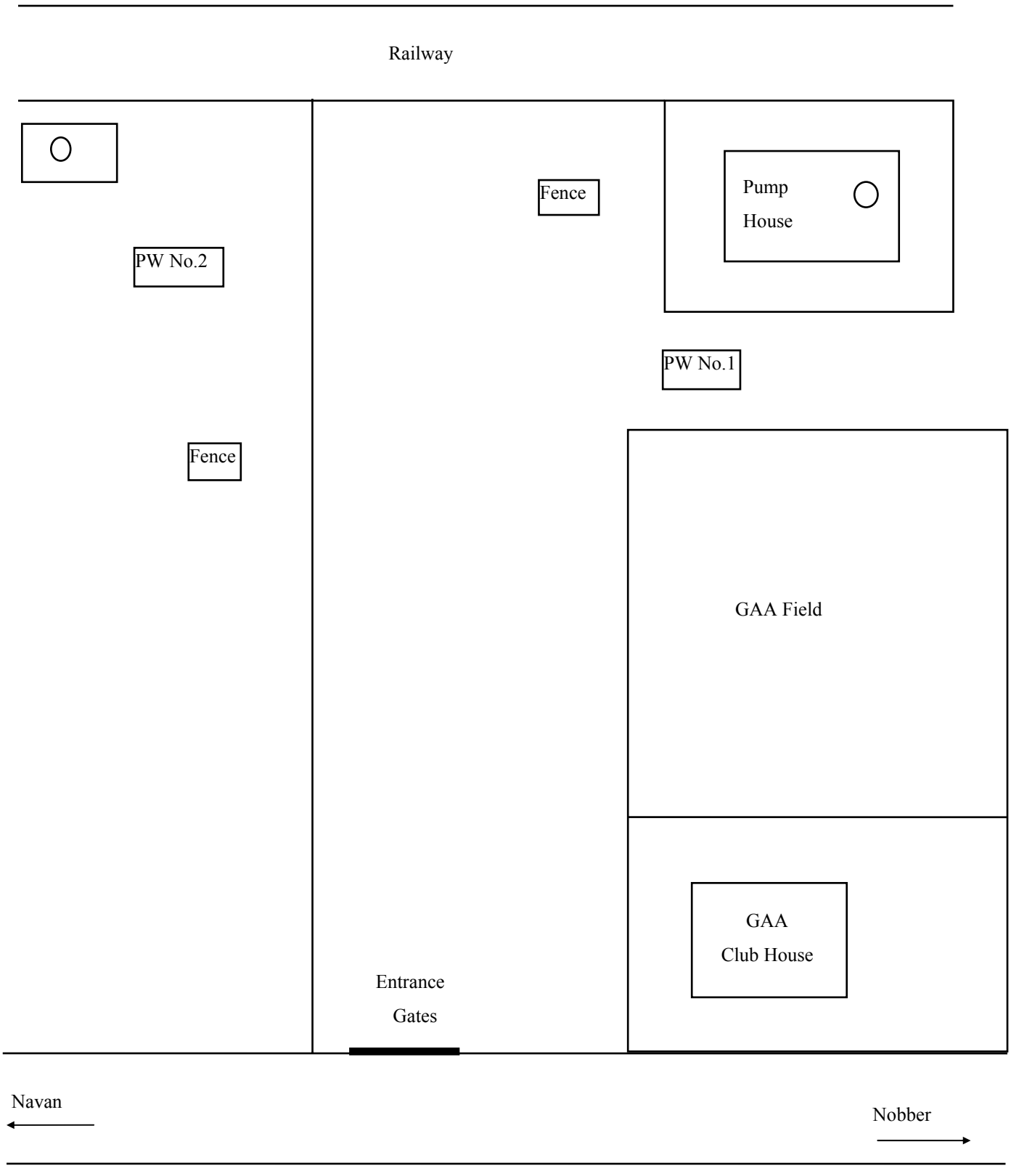
A small number of houses are present in the general area of the well. The possible storage of silage and the presence of cattle feeding yards within the ZOC would pose a significant risk to the well if good farmyard management was not maintained.

The use of chemicals on the adjacent railway line or spillages could pose a significant threat to the groundwater in the pumping well.

11. CONCLUSIONS AND RECOMMENDATIONS

Overall the source at Nobber is a moderately high yielding well which may be able to support a small increase in the yield. The water analyses indicate that there were no water quality problems at this source, however the catchment for the supply is moderately vulnerable to pollution due to the assumed permeability of the subsoils in the immediate vicinity of the supply.

It is recommended that the Council continue to sample the raw water from the Nobber public supply to monitor in particular the nitrate and potassium 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 on the delineated groundwater source protection zones, in particular, activities in Nobber village to the north of the well.



Sketch of Nobber Water Supply

(Not to Scale)

Water Quality Analyses

Groundwater Source : **Nobber**

Sample Location :		PW No.1	PW No.1	PW No.1	PW No.1
Date :		22/3/95	13/6/95	26/9/95	10/1/96
Parameters	**Units**				
Alkalinity	mg/l	314	322	316	298
Aluminium	mg/l	<0.02	<0.02	<0.02	<0.02
Ammonium	mg/l				
Ammonium as N	mg/l	<0.01	<0.01	<0.015	<0.015
Arsenic	mg/l	<0.25		<0.05	<0.05
Barium	mg/l	0.122	0.126	0.149	0.125
Bicarbonate	mg/l				
Boron	mg/l	0.038	0.022	0.043	0.033
Cadmium	mg/l	<0.025	<0.025	<0.005	<0.005
Calcium	mg/l	141	125	141.4	138
Calcium Hardness	mg/l	352	312	352	345
Total Hardness	mg/l	388	347	393	379
Chloride	mg/l	18.7	18.2	17.6	16.9
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	0.736	0.755	0.756	0.748
Fluoride	mg/l	<0.25	<0.25	<0.25	<0.25
Iron (total)	mg/l	0.023	<0.01	0.009	<0.005
Lead	mg/l	0.482	<0.25	<0.02	<0.02
Magnesium	mg/l	8.7	8.3	9.8	8.4
Magnesium Hardness	mg/l	36	34	40	35
Manganese	mg/l	0.025	0.036	0.049	0.035
Mercury	mg/l				<0.02
Nickel	mg/l	<0.05	<0.05	<0.01	<0.01
Nitrate	mg/l	17.6	9.4	6.4	15.4
Nitrite	mg/l	<0.1	<0.1	<0.1	<0.1
pH		7.2	7.1	7.4	7.05
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	5.7	7.4	7.4	5.2
Selenium	mg/l				
Silver	mg/l	<0.01	<0.01	<0.005	<0.005
Sodium	mg/l	10.1	10.7	14.2	10.2
Strontium	mg/l	0.315	0.313	0.358	0.31
Sulphate	mg/l	64.9	68	65.5	68.4
Temperature	C	10.3	10.3	11.5	10.1
Total dissolved solids	mg/l	563	560	572	545
Zinc	mg/l	<0.01	0.036	0.015	0.047
Total Coliforms	/100 ml	0	0	0	0
E. coli	/100 ml	0	0	0	0

Location : NOBBER Borehole name : PW No.2 (Original) Date : 04-06-85
Test : Drawdown Data from PW No.2 (Well currently abandoned)
Duration : 72hrs. Weather : Fine
Height of datum point above ground level : ? Well depth : 60m

Date	Time	Time since pumping began (min.)	Water level below datum (metres)	Drawdown (metres)	Discharge m3/d	Temperature C	Conductivity uS/cm @20 C
04-06-85		0	4.14	0			
		0.5	7.9	3.76			
		1	10.9	6.76			
		1.5	12.44	8.3			
		2	14.3	10.16			
		2.5	15.82	11.68			
		3	16.04	11.9			
		3.5	16.09	11.95			
		4	16.1	11.96			
		5	17.8	13.66			
		6	19.56	15.42			
		7	22.26	18.12			
		8	24.5	20.36			
		9	26.45	22.31			
		10	28.03	23.89	327		
		12	30.67	26.53			
		14	33.13	28.99			
		16	35.05	30.91			
		18	36.54	32.4			
		20	37.82	33.68			
		22	38.74	34.6			
		24	39.6	35.46			
		26	40.3	36.16	280		
		28	40.9	36.76			
		30	41.53	37.39			
		35	42.7	38.56			
		40	43.4	39.26			
		45	44.01	39.87			
		50	44.34	40.2			
		55	44.7	40.56			
		60(1hr)	45.1	40.96			
		75	45.69	41.55	262		
		90	46.32	42.18			
		105	46.51	42.37			
		120 (2hrs)	46.76	42.62			
		150	46.27	42.13			
		180 (3hrs)	46.55	42.41			
		210	47.05	42.91	262		
		240 (4hrs)	47.55	43.41			
		300 (5hrs)	47.89	43.75			
		360 (6hrs)	47.6	43.46	262		
		420 (7hrs)	47.8	43.66			
		480 (8hrs)	47.55	43.41	262		
		540 (9hrs)	47.7	43.56			
		600 (10hrs)	47.9	43.76	262		
		720 (12hrs)	48.32	44.18			
		840 (14hrs)	48.1	43.96	262		
		960 (16hrs)	48.2	44.06			
		1080 (18hrs)	48.2	44.06	262		
		1260 (21hrs)	48.2	44.06	262		
		1440 (24hrs)	48.07	43.93	262		
		1620 (27hrs)	48.4	44.26	262		
		1800 (30hrs)	48.29	44.15	262		
		2160 (36hrs)	48.35	44.21	262		
		2520 (42hrs)	49.35	45.21	262		
		2880 (48hrs)	49.14	45	262		
		3240 (54hrs)	49.4	45.26	245		
		3600 (60hrs)	49.1	44.96	245		
		3960 (66hrs)	49.32	45.18	245		
		4320 (72hrs)	49.15	45.01	245		

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Location : NOBBER Borehole name : PW No.2 (Original) Date : 07-06-85

Test : Recovery Data from PW No.2 (Well currently abandoned)

Duration : 1hr Weather : Fine

Distance from Pumping Well : 148m. Well depth : 60m. Depth of Pump: (Removed

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

Date	Time	Time since pumping ended (min.)	Water level below datum (metres)	Drawdown (metres)	Discharge m3/d	Temperature C	Conductivity uS/cm @20 C
07-06-85		0	49.15	45.01			
		0.5	47.74	43.6			
		1	42	37.86			
		2	38.3	34.16			
		2.5	35.9	31.76			
		3	33	28.86			
		3.5	31.54	27.4			
		4	29.11	24.97			
		4.5	27.7	23.56			
		5	25.53	21.39			
		6	22.36	18.22			
		7	21.9	17.76			
		8	19.72	15.58			
		9	16.27	12.13			
		10	14.96	10.82			
		12	12.41	8.27			
		14	10.5	6.36			
		16	9.5	5.36			
		18	8.59	4.45			
		20	8.05	3.91			
		22	7.7	3.56			
		24	7.46	3.32			
		26	7.27	3.13			
		28	7.12	2.98			
		30	7.02	2.88			
		35	6.93	2.79			
		40	6.8	2.66			
		45	6.67	2.53			
		50	6.37	2.23			
		55	6.2	2.06			
		60 (1hr)	6.07	1.93			

PUMPING TEST DATA SHEET

Location : NOBBER Borehole Name : PW No.1 Date : 20-07-95

Test : Drawdown Data from PW No.1

Weather : Drizzle

Duration : 12hrs. Well Depth : 24m approx. Depth of Pump : 15m approx.

Height of datum point above ground level : 0.55m Datum Point : Edge of manhole cover.

Date	Time	Time since pumping began (min.)	Water level below datum (metres)	Drawdown (metres)	Discharge m3/d	Temperature C	Conductivity uS/cm @20 C
20-07-95	06:00	0	8.7	0			
		0.5	10.9	2.2			
		1	11.8	3.1			
		1.5	12.35	3.65			
		2	12.7	4			
		2.5	12.92	4.22			
		3	13.06	4.36			
		3.5	13.16	4.46			
		4	13.22	4.52			
		4.5	13.28	4.58			
		5	13.32	4.62			
		6	13.38	4.68			
		7	13.41	4.71			
		8	13.44	4.74			
		9	13.46	4.76			
		10	13.48	4.78			
		12	13.52	4.82	176		
		14	13.53	4.83			
		16	13.55	4.85			
		18	13.57	4.87		12.0	562
		20	13.6	4.9	177		
		22	13.61	4.91			
		24	13.62	4.92			
		26	13.64	4.94		10.9	560
		28	13.65	4.95			
		30	13.67	4.97			
		35	13.7	5		11.0	547
		40	13.74	5.04			
		45	13.75	5.05		10.9	552
		50	13.78	5.08	177		
		55	13.8	5.1			
	07:00	60 (1hr)	13.81	5.11		11.1	554
		75	13.87	5.17			
	07:15	90	13.93	5.23		10.9	554
		105	13.98	5.28			
	08:00	120 (2hrs)	14.02	5.32		10.9	554
		135	14.06	5.36			
	08:30	150	14.12	5.42		10.9	555
		165	14.15	5.45			
	09:00	180 (3hrs)	14.16	5.46		10.9	555
		200	14.21	5.51	176		
		220	14.26	5.56		11.0	552
	10:00	240 (4hrs)	14.31	5.61	176	11.4	561
		260	14.36	5.66			
		280	14.38	5.68			
	11:00	300 (5hrs)	14.42	5.72	176	11.2	560
		330	14.47	5.77		11.6	563
	12.00	360 (6hrs)	14.53	5.83	175	11.5	562
	12.30	390	14.56	5.86			
	13.00	420 (7hrs)	14.63	5.93		11.7	564
	13.30	450	14.67	5.97	174	11.6	563
	13.47	467	14.69	5.99			
		Water Level at Pump Intake					

Location : NOBBER Borehole name : PW No.1 Date : 19-07-95

Test : Recovery Data form PW No.1

Duration : 9hrs. Weather : Fair

Well depth : 24m approx. Depth of Pump : 15m approx.

Height of datum point above ground level : 0.55m Datum Point : Edge 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
19-7-95	21.00	0	14.68	5.98			
		0.5	12.2	3.5			
		1	11.13	2.43			
		1.5	10.93	2.23			
		2	10.83	2.13			
		2.5	10.8	2.1			
		3	10.75	2.05			
		3.5	10.7	2			
		4	10.67	1.97			
		4.5	10.64	1.94			
		5	10.61	1.91			
		6	10.58	1.88			
		7	10.54	1.84			
		8	10.51	1.81			
		9	10.48	1.78			
		10	10.46	1.76			
		12	10.42	1.72			
		14	10.38	1.68			
		16	10.34	1.64			
		18	10.31	1.61			
		20	10.28	1.58			
		22	10.26	1.56			
		24	10.24	1.54			
		26	10.22	1.52			
		28	10.2	1.5			
		30	10.18	1.48			
		35	10.12	1.42			
		40	10.08	1.38			
		45	10.05	1.35			
		50	10	1.3			
		55	9.96	1.26			
	22.00	60 (1hr)	9.91	1.21			
		75	9.8	1.1			
		90	9.72	1.02			
		105	9.63	0.93			
	23.00	120 (2hrs)	9.55	0.85			
		135	9.48	0.78			
		150	9.4	0.7			
		165	9.35	0.65			
	24.00	180 (3hrs)	9.3	0.6			
20/07/95	00:15	195	9.5	0.8			
		220	9.17	0.47			
	1.00	240 (4hrs)	9.12	0.42			
		260	9.08	0.38			
		280	9.04	0.34			
	2.00	300 (5hrs)	9	0.3			
	2.30	330	8.96	0.26			
	3.00	360 (6hrs)	8.91	0.21			
	5.00	480 (8hrs)	8.76	0.06			
	5.40	520	8.72	0.02			
	6.00	540 (9hrs)	8.7	0			

Shallow Water Limestone

Shallow Water Limestone

Balfes Bridge

North

Shallow Water Limestone

Calp Limestone

Calp Limestone

Shallow Water Limestone

Calp Limestone

Calp Limestone

Calp Limestone

Calp Limestone

PW No.1

PW No.2

Calp Limestone

Calp Limestone

Calp Limestone

Scale: 6 Inches to 1 Mile

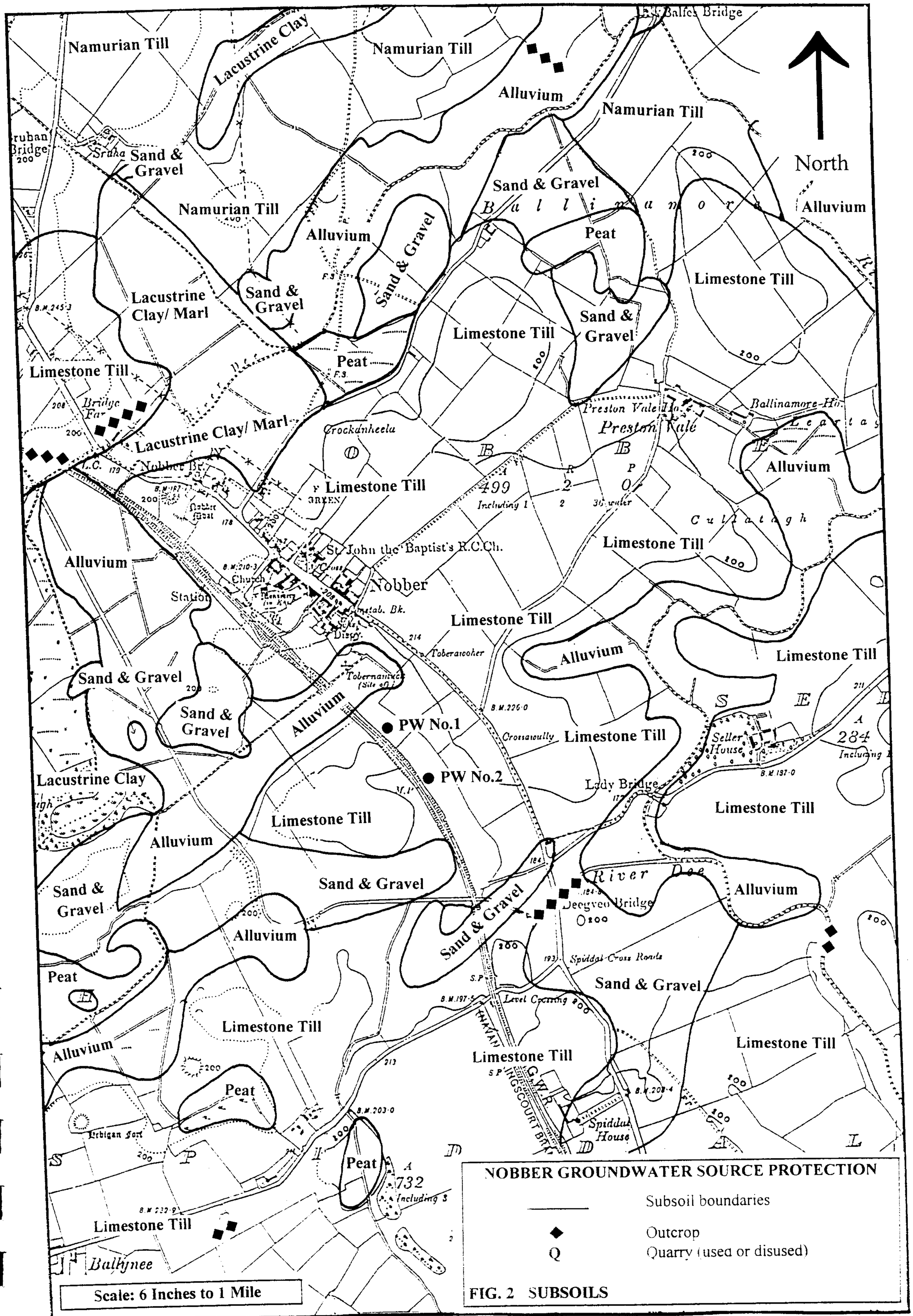
NOBBER GROUNDWATER SOURCE PROTECTION

● Public supply wells

——— Lithological Boundary

10 Direction and Dip of Bedding

FIG. 1 GEOLOGY


Namurian Till
Lacustrine Clay
Namurian Till
Alluvium
Namurian Till
North
Sand & Gravel
Namurian Till
Alluvium
Sand & Gravel
Sand & Gravel
Peat
Limestone Till
Lacustrine Clay/ Marl
Sand & Gravel
Peat
Limestone Till
Limestone Till
Sand & Gravel
Lacustrine Clay/ Marl
Limestone Till
Alluvium
Nobber
Limestone Till
Alluvium
Limestone Till
Sand & Gravel
Alluvium
Sand & Gravel
Alluvium
PW No.1
Limestone Till
PW No.2
Limestone Till
Lacustrine Clay
Alluvium
Limestone Till
Sand & Gravel
Sand & Gravel
Alluvium
Alluvium
Peat
Limestone Till
Alluvium
Peat
Limestone Till
Sand & Gravel
Limestone Till
Scale: 6 Inches to 1 Mile
NOBBER GROUNDWATER SOURCE PROTECTION
Subsoil boundaries
Outcrop
Quarry (used or disused)
FIG. 2 SUBSOILS

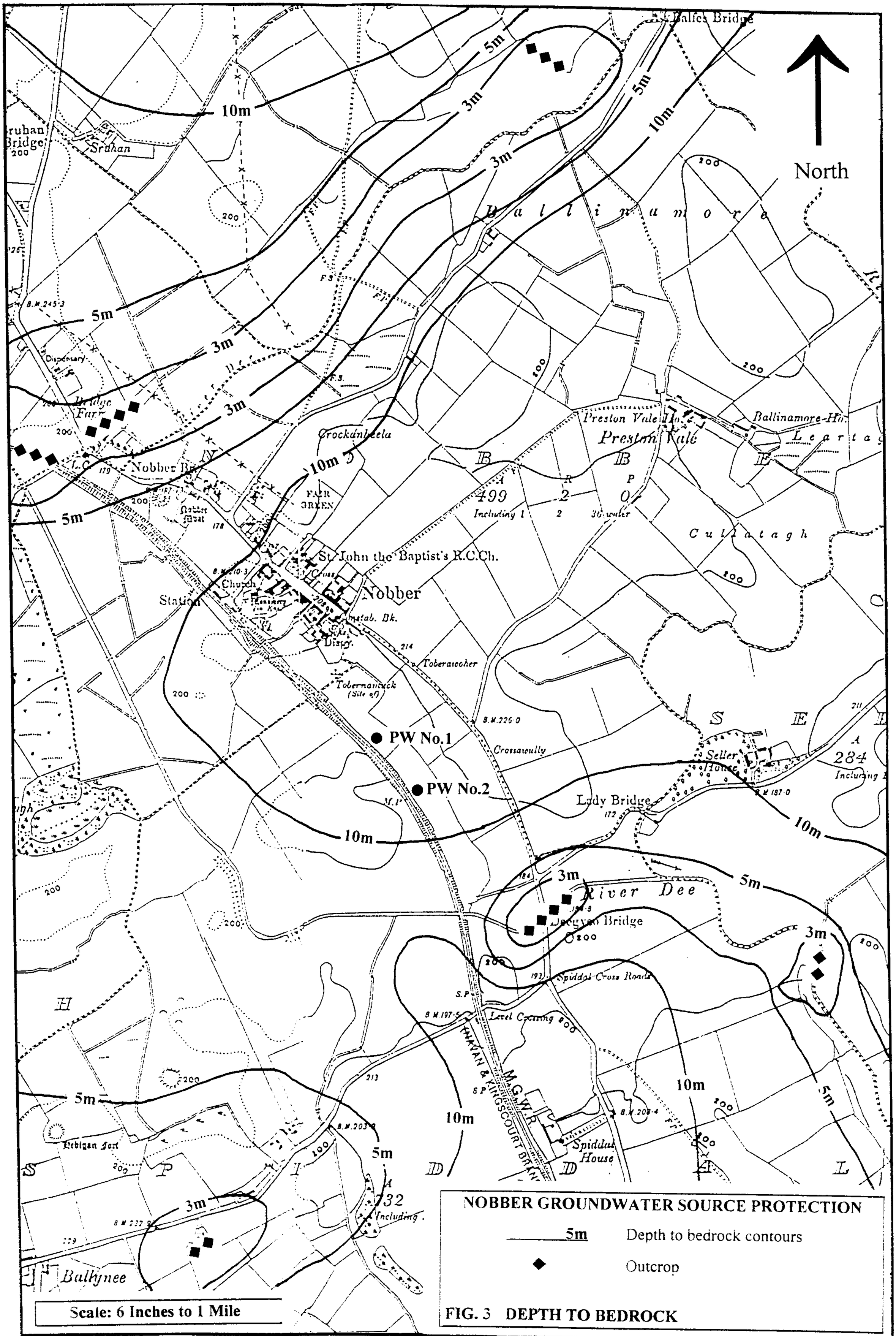


FIG. 3 DEPTH TO BEDROCK

North

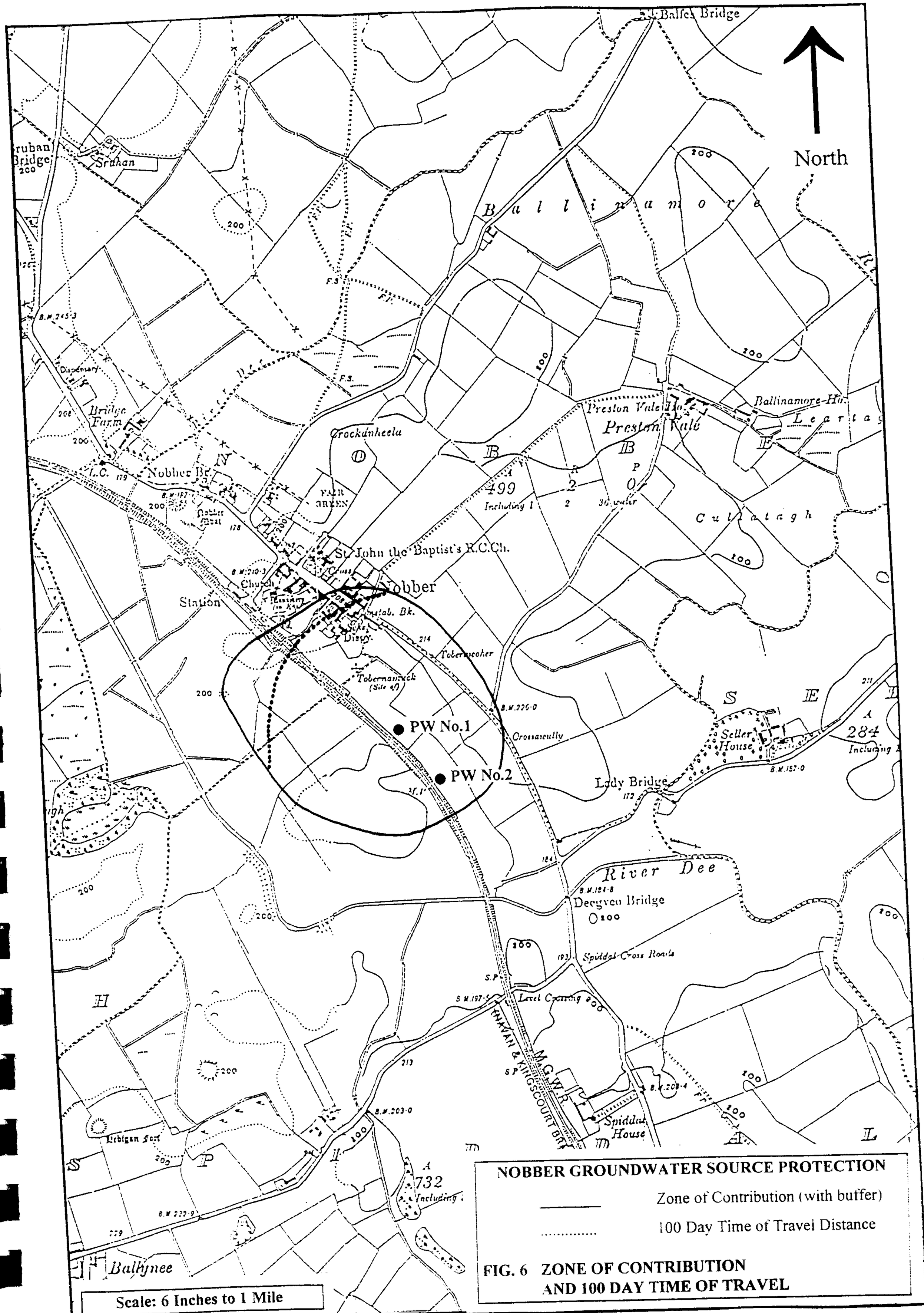
Scale: 6 Inches to 1 Mile

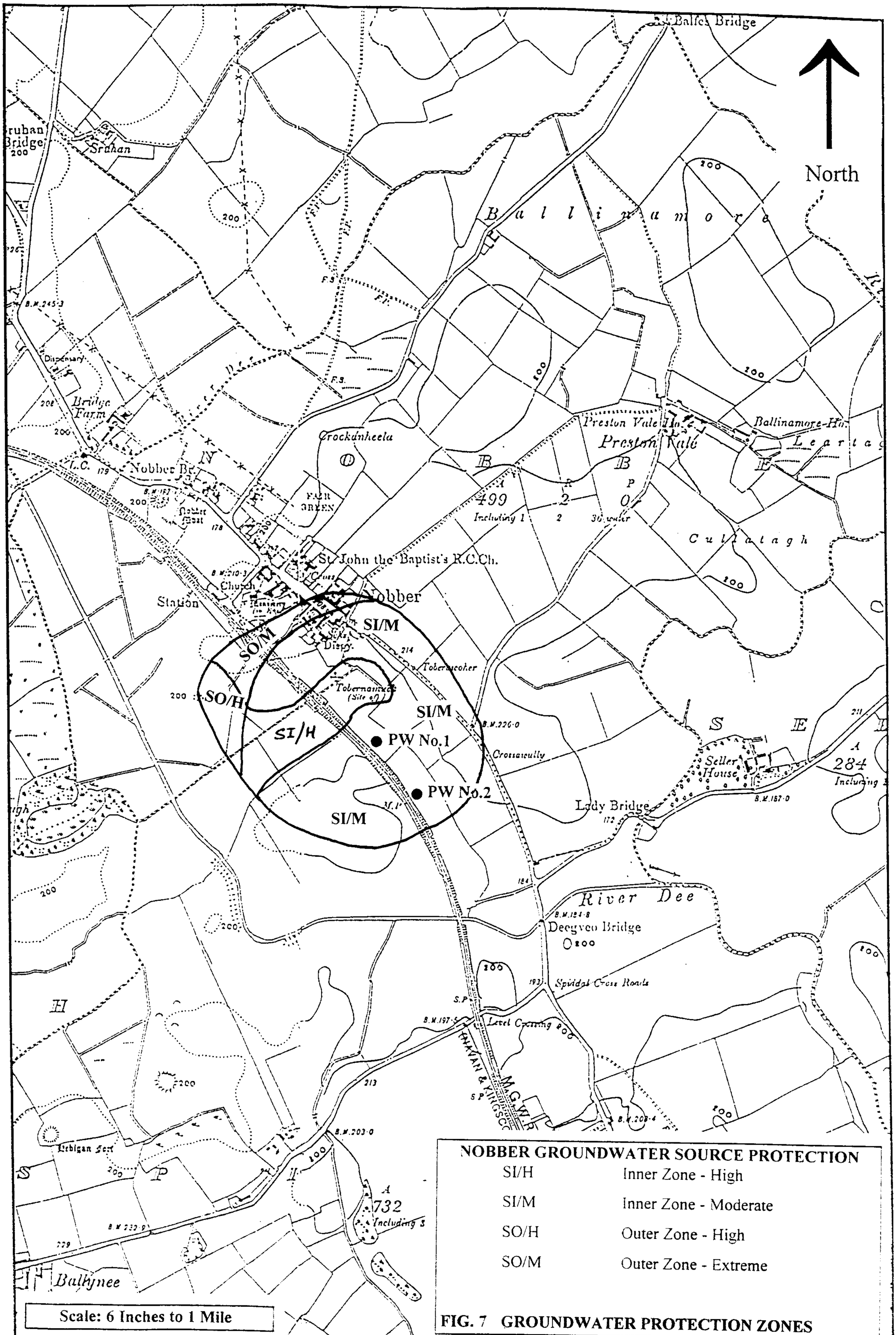
NOBBER GROUNDWATER SOURCE PROTECTION

H	House with septic tank
F	Farmyard

FIG. 4 HYDROGEOLOGICAL SURVEY

FIG. 5 VULNERABILITY


North
Balfes Bridge
Srubanbridge
Srubban
Ballinamore
Bridge Farm
Dispensary
Nobber Br.
Nobber
Crockanheela
Preston Vale
Preston Vale Ho.
Ballinamore-Ho.
Culhatagh
St John the Baptist's R.C.Ch.
Church
Station
Tobernacoher
Tobernaveck
(Site of)
PW No.1
PW No.2
Crossaculty
Seller House
Lady Bridge
River Dee
Deegveo Bridge
Spiddal Cross Roads
Level Crossing
M.G.W.R.
Spiddal House
Urbigan Fort
Balkynee
Scale: 6 Inches to 1 Mile
NOBBER 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



NOBBER GROUNDWATER SOURCE PROTECTION

SI/H	Inner Zone - High
SI/M	Inner Zone - Moderate
SO/H	Outer Zone - High
SO/M	Outer Zone - Extreme

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
GSI
Beggars Bush, Haddington Rd, Dublin 4

Nobber

1:25,000

0 1 2 Kilometres